State of Nature in Flanders

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1. INTRODUCTION

The information in this subchapter is based on the Nature Reports of 1999 (KUIJKEN 1999) and 2001 (KUIJKEN *et al.* 2001). These two documents have been compiled by the Institute of Nature Conservation, following its legal obligation to report every two years on the state of nature in Flanders. Information on the main biotopes in Flanders and the status of major taxonomic groups is presented, as well as an overview of the most important threats to biodiversity in Flanders. An outline of actions taken and of strategies under development to protect biodiversity in Flanders is given to conclude this subchapter.

2. SPECIES DIVERSITY

Recent information estimates the total number of species in Belgium between 40,000 and 50,000. Approximately 80% of the species are found in Flanders. Most of them -about 75%- are invertebrates (insects, spiders, etc.). The 'flora' (higher plants and fungi) and vertebrate animals respectively represent 24% and 1% of the species. The numbers are probably underestimated, especially for invertebrates. For example, 4,500 Diptera species (flies, mosquitoes, etc.) are recorded in Belgium (GROOTAERT *et al.* 1991). In neighbouring countries, the total number of Diptera is estimated to be more than 6,000. This indicates that it is not known whether or not an extra 1,500 to 2,000 species are present in Belgium. If those figures are extrapolated to other orders of insects and groups of invertebrates, it can be assumed that several thousands of species still have to be discovered.

Knowledge on the distribution and densities of most species is still very limited. Information is usually available on traditional groups like vertebrate animals, higher plants and the larger, colourful groups of invertebrates. For most of those groups, Flanders has compiled Red Lists of threatened species. Table 1 gives an overview of the status of the major groups of organisms in Flanders and figure 1 summarises the proportion of species for each Red List category.

About one-third of the investigated species living in Flanders are extinct or threatened to disappear (Red List categories extinct, critically endangered, endangered and vulnerable). Approximately 7.5% of the species have not been found since 1980 and are considered as extinct (319 species). If those figures are used to estimate the species numbers of the different groups -taking into account the share of the Flemish fauna in the Belgian fauna and the number of invertebrates not yet discovered- it can be estimated that out of a total of 42,000 species in Flanders, about 14,000 can be considered as Red List species. Of those Red List species 5,000 are already extinct (several species in Flanders certainly became extinct before being discovered). Those figures are probably underestimations since algae and other unicellular organisms (approximately 5,000 existing species in the Netherlands), and bacteria (> 1,000 existing species in the Netherlands) were not taken into account.

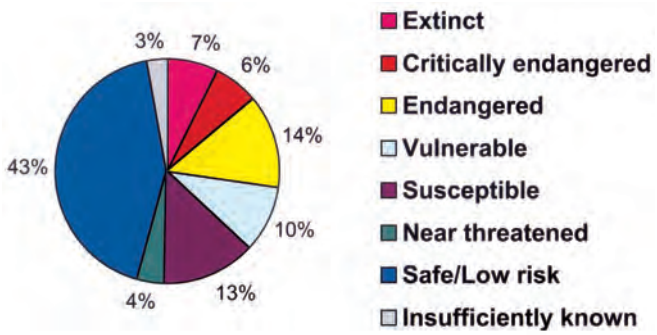
Table 1. Number of Red List species in different taxa in Flanders (adapted from MAES & VAN DYCK 2001). Total numbers refer to native species.

Taxonomic group	Total species number	Extinct species	Red List species	% E + RL
Mammals (CRIEL 1994)	60	11 (18%)	13 (22%)	40%
Breedings birds (DEVOS & ANSELIN, in prep.)	159	4 (3%)	44 (28%)	31%
Amphibians & reptiles (BAUWENS & CLAUS 1996)	19	2 (11%)	6 (32%)	43%
Fish (VANDELANNOOTE & COECK 1998)	55	11 (20%)	2 (4%)	24%
Butterflies (MAES & VAN DYCK 1996)	64	19 (30%)	22 (34%)	64%
Carabid beetles (DESENDER *et al*. 1995)	352	32 (9%)	66 (19%)	28%
Grasshoppers (DECLEER *et al*. 2000)	39	5 (13%)	13 (33%)	46%
Dragonflies (DE KNIJF & ANSELIN 1996)	61	9 (16%)	20 (34%)	50%
Dolichopodid flies (POLLET 2000)	260	22 (8%)	39 (15%)	23%
Spiders (MAELFAIT *et al*. 1998)	604	9 (1%)	144 (24%)	25%
Higher plants (BIESBROUCK *et al*. 2001)	1416	81 (6%)	325 (23%)	29%
Mosses (HOFFMANN 1999)	502	33 (7%)	126 (25%)	32%
Lichens (HOFFMANN 1999)	338	50 (15%)	170 (50%)	65%
Macrofungi (WALLEYN & VERBEKEN 1999)	552	43 (8%)	230 (42%)	50%

For some groups, the speed of decline is decreasing. Bats, the most threatened group of vertebrates, underwent a strong decline after World War II but numbers have stabilised in recent years. However, the number of bats is so low that their populations are still very vulnerable. Their recent stabilisation can probably be explained by the use of less toxic pesticides (e.g. ban on DDT) as well as the protection and management of their winter residence (VERKEM & VERHAGEN 2000). This example shows that correct measures can make a difference. A major problem is the time lapse between measures taken and subsequent visual improvements of biotopes or species.

2.1. Mammals

In Flanders, 69 species of mammals have been recorded. Sixty are considered as native (18 species of bats, 39 species of land mammals and three species of marine mammals), seven species are considered as exotic and two as gone wild (CRIEL *et al*. 1994). Strictly, only one marine mammal, the common seal (*Phoca vitulina*), is found in Flanders. The other two are found in the North Sea, which is federal territory.



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Proportion of species in Flanders in each of the Red List categories.

Eight species of insectivores (Insectivora) can be found in Flanders. They belong to three families: hedgehogs (Erinaceidae), moles (Talpidae) and shrews (Soricidae). The mole (*Talpa europaea*) is common and is able to maintain its populations in Flanders. The hedgehog (*Erinaceus europaeus*) is also a common species. It can be found principally in areas where forests are bordering grasslands. However, there is a clear lack of information on population densities and their evolution. Road traffic is probably the most important threat to the species (populations can be decimated locally), with mowing being another source of danger. Systematic information on traffic and mowing victims is currently still lacking. Of all insectivores present in Flanders, shrews are the most affected by population decline.

Bats are found mainly in the double belt of fortresses around Antwerp, in the marl pits of southern Limburg and in ice cellars spread across the region. Of the 18 species present in Flanders, 14 are on the Red List. Bats are especially active in the evening and at night and this explains the limited ecological research carried out on those species. Because bats do not make nests, they depend on natural and/or artificial cavities. Bats can be classified in two groups: tree- and cave-dwelling bats. As Flanders only has a limited amount of natural caves, cave-dwelling bats must make use of artificial constructions reproducing natural conditions. This has serious consequences towards nature management for the different bat species.

Lagomorphs (Lagomorpha) are represented in Flanders by two species: the rabbit (*Oryctolagus cuniculus*) and the hare (*Lepus europaeus*). The rabbit is one of the most widespread mammals living in Flanders. The hare is also ubiquitous, however in much smaller numbers. The history of the rabbit is rather special: the species was present in Flanders before the last glaciations, and then disappeared before being reintroduced from the Mediterranean by the Romans.

Fourteen species of rodents (Rodentia) can be found in Flanders. Another three species have been introduced: the Siberian chipmunk (*Tamias sibiricus*), coypu (*Myocastor coypus*) and muskrat (*Ondatra zibethicus*). Only the muskrat is well adapted and widespread. The other two species survive in small local populations. The hamster (*Cricetus cricetus*) is probably the most threatened rodent. It is the only land mammal in the Red List category 'critically endangered'.

Siberian chipmunks were first imported in the 1960s for the pet trade. Now, there are a small number of distinct wild populations in Flanders. Populations in the Sonian Forest increased from about 150 individuals in 1981 to several thousand individuals in 1998 (Van den Broecke 2002). Coypu were imported from South America for their fur at the beginning of the 20th century. In Flanders, they have now established wild populations

in the Province of Limburg. With only a few hundred individuals in Belgium, numbers are still relatively low compared to other European countries. However, due to the absence of cold winters in the past few years, coypu numbers have been increasing, raising concern about their potential negative impacts on local ecosystems (VERBEYLEN & STUYCK 2002). The muskrat was also introduced for the fur trade in the early 20th century and originates from North America. It has an extremely high reproductive capacity and provokes serious harm to waterways. Active and intensive eradication campaigns are carried out to limit its damage (STUYCK 2002).

The order Carnivora is represented in Flanders by 11 species. Eight of them are native: the weasel (*Mustela nivalis*), ermine (*Mustela erminea*), polecat (*Mustela putorius*), stone marten (*Martes foina*), pine marten (*Martes martes*), badger (*Meles meles*), otter (*Lutra lutra*) and fox (*Vulpes vulpes*). Three exotic species or subspecies are found in addition to the native ones: the American mink (*Mustela vison*), ferret (*Mustela putorius furo*) and cat (*Felis catus*). The two last species are wild pets. The raccoon (*Procyon lotor*) and raccoon dog (*Nyctereutes procyonoides*) are only sporadic but are considered as escaped animals (e.g. from animal parks). Badgers and foxes are currently expanding their range. The last remaining localities where the badger can be found are situated in the most southeastern part of Flanders. After a long lasting decline, the populations have increased slightly since the nineties. During the same period, Flanders has also experienced a remarkable increase in density and area expansion of the stone marten, which can be replaced in the context of the general increase in populations in Europe from the 1960s onwards.

The order Artiodactyla is represented in Flanders by the wild boar (*Sus scrofa*) and roe deer (*Capreolus capreolus*). The commercial raising of fallow deer (*Dama dama*) for human consumption could lead to an introduction of this non-native species. The red deer (*Cervus elaphus*) disappeared in Flanders at the end of the 18th century as a consequence of massive poaching.

Several species of whales have been encountered in Belgian marine waters or washed ashore along Flemish beeches. However, only the porpoise (*Phocoena phocoena*) and bottlenose dolphin (*Tursiops truncates*) are considered to belong to the native fauna of Belgium. Both species are recorded on the Red List. The short and narrow coastal strip of Flanders does not offer much adequate space for seals. The only seal species that can be considered as native in Flanders is the common seal.

Legal protection and international importance

In Flanders, 34 land and three marine mammals are legally protected (DE PUE *et al*. 1998) by the Royal Decree on Nature Conservation in Flanders (1980) and its amendments. All insectivores, except the mole, are protected by the aforesaid law. Twenty-three terrestrial and two marine mammals are listed in Annex II of the Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention, 1979). One species is listed in Annex II, 11 terrestrial and two marine mammals are listed in Annex II and IV and 15 terrestrial mammals are listed in Annex IV of the EU Habitats Directive. All bats and marine mammals are listed in Annex II of the Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention, 1979).

It should be noted that the legal protection of mammal species cannot be effective if no action is undertaken against the destruction of, and the damage to, their natural habitats.

2.2. Birds

2.2.1. Summer visitors

Since the beginning of the twentieth century, 159 bird species have bred in Flanders during at least ten years. Non-native species are not taken into account in this number. During the twentieth century, four native breeding bird species became extinct, a little more than a quarter are threatened, 10% are rare and a little more than half of the species are not threatened. Four species do not breed any more on a yearly basis.

For a large number of breeding bird species, there are not enough quantitative data to show trends. However, sufficient information is available to give a general overview of trends during the last decades for a number of species. Comparison of the number of present-day populations with estimations and/or extrapolations of numbers of breeding birds in Flanders in the past shows a negative trend for most of the species. One of the most obvious conclusions is the dramatic decline of reed and marsh birds such as the black tern (*Chlidonias niger*), great bittern (*Botaurus stellaris*), little bittern (*Ixobrychus minutus*), Savi's warbler (*Locustella luscinioides*) and great reed warbler (*Acrocephalus arundinaceus*). The sedge warbler (*Acrocephalus schoenobaenus*) and reed bunting (*Emberiza schoeniclus*) also show a decline but no detailed figures are available. The decline for those species is partly caused by the disappearance of their habitat (marsh) and by the worsening situation in their hibernation sites. For species inhabiting dryer biotopes, like the northern wheatear (*Oenanthe oenanthe*), black grouse (*Tetrao tetrix*), common skylark (*Alauda arvensis*), woodlark (*Lullula arborea*), European nightjar (*Caprimulgus europaeus*), tree pipit (*Anthus trivialis*) and common stonechat (*Saxicola torquata*), the situation is not much better. The tawny pipit (*Anthus campestris*) even completely disappeared as breeding bird in Flanders since 1987. The populations of the northern wheatear, woodlark and crested lark (*Galerida cristata*) show a strong decline that can be related to the decreasing surface of hatching sites. Those species suffer from growing tourism pressure as well, especially along the coast.

Bird species inhabiting agricultural landscapes also have problems to maintain their populations. Species of wet, extensively used agricultural land show a strong decrease in numbers, e.g. corn crake (*Crex crex*), common snipe (*Gallinago gallinago*), whinchat (*Saxicola rubetra*) and garganey (*Anas querquedula*). Species from small-scaled agricultural areas with linear landscape elements and traditional cultivation techniques are seriously threatened, e.g. red-backed shrike (*Lanius collurio*), northern shrike (*Lanius excubitor*) and ortolan bunting (*Emberiza hortulana*). Various data also show a dramatic decline in numbers for the grey partridge (*Perdix perdix*), tree sparrow (*Passer montanus*), corn bunting (*Miliaria calandra*) and yellowhammer (*Emberiza citrinella*) in Flanders during the past twenty years.

The programme 'Bijzondere Broedvogels Vlaanderen' monitors rare, colonial and introduced breeding bird species in Flanders. Alien bird species already breeding are the lesser white-fronted goose (*Anser erythropus*), Canadian goose (*Branta canadensis*), barnacle goose

(*Branta leucopsis*), Egyptian goose (*Alopochen aegyptiacus*), mandarin duck (*Aix galericulata*), ring-necked parakeet (*Psittacula krameri*) and monk parakeet (*Myiopsitta monachus*).

Legal protection and international importance

All native birds living in the wild are protected in Flanders. It is prohibited to catch, kill, eradicate, transport, import and export them, at all times. The protection not only concerns the birds themselves but also their eggs, nests and feathers. Annex I of the EU Birds Directive lists 25 species of birds found in Flanders. The European conservation status of 15 species is considered as vulnerable, 40 species as stable, 18 species as declining and one species is considered as localised.

2.2.2. Migratory birds and winter visitors

For many bird species, Flanders is an important hibernation area. Flanders is also an important staging area for migratory birds. The presence of protected areas with suitable resting and feeding grounds is an essential factor. Different monitoring projects register numbers and area distribution of winter visitors and migrant birds. However, available data differ from species to species. The data gathered for specific species groups (e.g. water birds, raptors, seabirds, passerines) are strongly influenced by numbers, biotope choice and the difficulty of observation.

The following paragraphs illustrate the importance of Flanders as a hibernation and stopping place for migratory water birds. Even though Flanders lacks major wetlands, it is an important to very important area for certain species of water birds. This can be explained by the geographical location of Flanders in the European lowland plain, its mild winter climate and its rigidly enforced hunting regulations. Water birds belong to the following families: divers (Gaviidae), grebes (Podicipidae), cormorants (Phalacrocoracidae), herons and egrets (Ardeidae), storks (Ciconiidae), ibises and spoon bills (Threskiornithidae), swans, geese and ducks (Anatidae) and rails (Rallidae). Waders (Charadrii), gulls and terns (Laridae) also fit into this group but are not discussed because of the lack of standardised counting data in Flanders. Traditional midwinter counts of 'wildfowl' started in 1967.

In Flanders, 67 species of water birds can be considered as yearly winter visitors and/or migratory birds (exotic species excluded). For 47 of those species, Flanders is of minor importance, mostly because the species reach the outer limit of their distribution range in Flanders or because suitable habitats are lacking. Species for which minimum 1% of the total northwestern European population stays regularly in Flanders are the little grebe (*Tachybaptus ruficollis*), great crested grebe (*Podiceps cristatus*), great cormorant (*Phalacrocorax carbo*), tundra swan (*Cygnus columbianus*), pink-footed goose (*Anser brachyrhynchus*), greater white-fronted goose (*Anser albifrons*), greylag goose (*Anser anser*), common shelduck (*Tadorna tadorna*), gadwall (*Anas strepera*), common teal (*Anas crecca*), mallard (*Anas platyrhynchos*), northern pintail (*Anas acuta*), northern shoveler (*Anas clypeata*), common pochard (*Aythya ferina*), tufted duck (*Aythya fuligula*) and common coot (*Fulica atra*). Three other species reach this 1% criterion occasionally, mostly during harsh winters: bean goose (*Anser fabalis*), barnacle goose (*Branta leucopsis*) and smew (*Mergus albellus*).

The number of wintering water birds in Flanders has shown a strong increase during the last decades. Until the early nineties, no clear trend emerged and large differences between winters could be explained by weather conditions. The average number of water birds was approximately 113,500 during mild winters and increased to 172,500 in severe winters. In 1986, numbers peaked following the large influx of geese from the north during a severe cold spell. Since the nineties, there has been a continuous increase in the numbers of water birds: from 140,000 in 1992 to more than 300,000 in 1997. Again, weather conditions played an important role. The winters of 1993-94 and 1994-95 were very wet in Flanders. Floods in the valleys attracted large populations of water birds. The following two winters were very cold, so larger numbers of water birds flew in from the north. A remarkable fact is that the recent numbers of water birds during cold winters are much larger than during the cold winters of the eighties.

The recent increase in numbers of water birds is not caused by just a few species. From the 17 most important species of water birds, 14 show a significant increase between 1979 and 1997. Only the little grebe, mallard and northern shoveler show a status quo or a fluctuating trend. There is no negative trend for any of the species, except for the common pochard in the second part of the eighties.

Population growth is not always caused by the same factor. Most of the time, a combination of different factors is observed. For some species, increasing numbers in Flanders just follow the increasing numbers of the whole northwest-European population (e.g. pink-footed goose and gadwall). Fluctuating weather conditions are often responsible for short-term fluctuations. Hard frost can drive birds from more northern areas to migrate to Flanders, as for the common pochard and Eurasian wigeon (*Anas penelope*). The improvement in water quality during the past 10 years may also have contributed to the population growth. Fish-eaters like the great crested grebe and great cormorant probably took advantage of the increasing fish stock. The improved quality of the lower part of the river Scheldt -with increasing numbers of invertebrates as a food source- is probably responsible for the growing numbers of water birds in this part of Flanders.

Legal protection and international importance

All free-living birds of the European Union are legally protected in Flanders. It not only concerns breeding birds, as seen in the previous paragraph, but migratory birds, wintering birds and vagrants as well.

Exceptions are made to this strict legislation for some species: harmful birds, cage birds and game birds. As foreseen in the hunting decree of July 1991, a large number of birds are added to the category of game birds. Listed game birds include species mentioned earlier such as the mallard, gadwall, northern shoveler, tufted duck, common pochard, northern pintail, common teal, garganey, Eurasian wigeon, greylag goose, bean goose, greater white-fronted goose, pink-footed goose, Canada goose, common coot and common snipe. Other species include the greater scaup (*Aythya marila*), common moorhen (*Gallinula chloropus*), jack snipe (*Lymnocryptes minimus*), northern lapwing (*Vanellus vanellus*) and golden plover (*Pluvialis apricaria*). Hunting seasons are determined for each species individually, with a revision every five years by the Flemish Government. For example, between 1 July 1998

and 30 June 2003, hunting is only allowed and regulated for the Canadian goose, mallard, Eurasian wigeon and common coot. It is specified where, when and how each of those species can be hunted. The other game birds cannot be hunted during that period. In some EU Birds Directive areas and in Ramsar areas, specific hunting restrictions apply.

Some conventions and European directives protect bird species at the international level. The Bern Convention offers stringent protection within Europe to bird species listed in its Annex II. In Flanders, the Royal Decree of 1981 protects all Annex II species. A special agreement under the Bonn Convention also provides special protection to a number of migratory species (Agreement on the Conservation of African-Eurasian Migratory Waterbirds, 1996).

2.3. Amphibians and reptiles

Flanders hosts 14 indigenous species of amphibians and five species of reptiles. The green frog synklepton of three closely related species is counted as one species. One species of each group became extinct in the second part of the twentieth century. The yellow-bellied toad (*Bombina variegata*) has been absent in Flanders since 1984, whereas no natural populations of the grass snake (*Natrix natrix*) have been found between 1975 and 1994. There is currently one re-introduced population of the grass snake.

Six other species (four amphibians and two reptiles) show a clear decrease in their distribution range and are now part of the Red List: the common midwife toad (*Alytes obstetricans*), common spadefoot (*Pelobates fuscus*), common tree frog (*Hyla arborea*), fire salamander (*Salamandra salamandra*), adder (*Vipera berus*) and smooth snake (*Coronella austriaca*). Four amphibian and two reptile species, fairly common or rare, are listed as susceptible: the natterjack (*Bufo calamita*), moor frog (*Rana arvalis*), northern crested newt (*Triturus cristatus*), palmate newt (*T. helveticus*), slow worm (*Anguis fragilis*) and viviparous lizard (*Lacerta vivipara*). Only five species, all amphibians, are not threatened for the moment: the Alpine newt (*T. alpestris*), common newt (*T. vulgaris*), common toad (*Bufo bufo*), common frog (*Rana temporaria*) and edible frog (*Rana esculenta* synklepton).

The distribution range of amphibians and reptiles is decreasing for most of the native species (Bauwens & Claus 1996). The decline is caused by a series of factors that vary as a function of the location and the species, the most important ones being the loss of natural biotopes, habitat fragmentation, acidification, eutrophication and desiccation.

Most amphibians and reptiles are very sensitive to habitat loss. Amphibian survival is directly linked to the presence of suitable 'wet' and 'dry' biotopes, with a good linkage between both. Native snakes divide their activities between summer and winter habitats. When one of these disappears, or when the migration between the two becomes impossible, the population will react negatively. It can lead to the extinction of the population if no suitable alternatives can be found in the immediate neighbourhood.

The disappearance of linear landscape elements and the creation of migration barriers (roads, cultivated land, etc.) lead to the fragmentation of habitats. This can result in smaller populations, which face risks of extinction even if the habitats are appropriate.

The acidification of surface waters has a negative effect on the reproductive success of most species of amphibians. When the degree of acidity drops below a threshold value, different for each species, normal egg development is hindered. This problem is very acute for species living in relatively acid waters, like *Triturus helveticus*, *Bufo calamita* and *Rana arvalis*.

Eutrophication of surface waters leads to algal blooms. The consequent shortage of oxygen in the water can result in an increased mortality of amphibian eggs and larvae. Eutrophication also influences the terrestrial habitats of amphibians and reptiles. The loss of nutrient-poor habitats is only one example.

The lowering of the water table level, following the pumping of groundwater for drinking water and industrial purposes, results in dry reproduction pools early in the reproductive season. Massive mortality of larvae has been observed as a logic consequence.

Species diversity for amphibians and reptiles is highest in the eastern part of Flanders. Other species-rich areas are the valley of the upper Scheldt, the forest complexes of the Brabant hills (Hallerbos, Meerdaalwoud, Rodebos), the valley of the Demer and the area of Voeren.

Introductions of non-native amphibian and reptile species as pets or for ornamental purposes in garden ponds are very common in Belgium. In Flanders, the marsh frog (*Rana ridibunda*) and American bullfrog (*R. catesbeiana*) have already built reproductive populations in the river valleys of the Scheldt, Dijle and Grote Nete. The marsh frog lives in strong ecological competition with the indigenous edible frog and also threatens the populations of native species at the genetic level. The influence of the bullfrog on European green frogs remains speculative and needs to be further investigated. The North American red-eared terrapin (*Trachemys scripta elegans*) is probably the most commonly kept exotic turtle. Feral populations are now found in numerous ponds, rivers and canals throughout the region as the result of the dumping or escaping of pet turtles (Jooris 2002). Largest concentrations are found in the neighbourhood of large cities and tourist regions (coastal area).

Legal protection and international importance

The Royal Decree on Nature Conservation in Flanders (1980) strictly protects all native amphibians and reptiles. The only exceptions are the edible frog and the common frog. They can be caught and killed in private rearing ponds if the owner has a special license.

The Bern Convention legally protects indigenous species. The following species listed in its Annex II are found in Belgium: the yellow-bellied toad, common midwife toad, spadefoot and natterjack as well as the common tree frog, moor frog, northern crested newt and smooth snake. Specific laws have to guarantee the protection of Annex II species and of their environment. Annex III lists all other native species, for which special protection measures need to be taken. These protection measures are included in the Flemish Decree on Nature Conservation of 1997. Two species found in Belgium are listed in Annex II of the EU Habitats Directive: the northern crested newt and yellow-bellied toad. For amphibians and reptiles, Annex IV of the Habitats Directive is identical to Annex II of the Bern Convention.

The legal protection of amphibians and reptiles is well regulated in Flanders but this is not enough to prevent the extinction of some species. Additional measurements and management of the species are necessary.

2.4. Fresh and brackish water fish

Seventy-nine species of fish can be found in Flanders: 40 species are defined as freshwater fish while the other 39 species are considered as brackish water fish or marine fish temporarily migrating to brackish or fresh water. A species is called a freshwater species when it remains for the largest part of its life cycle in fresh water. In addition to those 79 fish species, two freshwater species recently became extinct while five other species are caught only occasionally and do not reproduce anymore in Flanders. Another six species have not been seen for more than 20 years. The highest diversity in species is found in the eastern part of Flanders (Kempen), with local hotspots in other areas (e.g. polders region).

While all brackish and seawater fish are native, this is only the case for 26 out of 45 species of freshwater fish. The other 19 species have their original distribution range in Eastern Europe or were accidentally introduced from North America and Asia. VANDELANNOOTE & COECK (1998) compared the fish fauna in 457 sections (100 m long) of brooks and rivers in Flanders during 1983-87 and 1994-97. All parts of the watercourses were sampled. During both periods, an average of 2.9 fish species was found in each section. When both inventories were compared, the number of species stayed constant in 154 sections, decreased in 179 sections and increased in 124 sections. The average decrease (2.3 species) was smaller than the average increase (3.2 species). Water treatment can lead to a spectacular increase of the fish stock, especially when water treatment is carried out in a basin with a reasonable fish stock and without migration obstructions. However, positive results in some areas are obscured by the loss of fish life in other areas. The number of brooks with no fish life increased significantly. Pollution is the source of the problem most of the time, but the decreased input of water due to land consolidation is a major cause especially in the upper part of the watercourses.

A thorough literature study recorded the introduction of 35 fish species belonging to nine families in Flanders since 1800. Recent introduction of fish species has been characterised by two peaks: first, at the end of the 19th century for sport and ornamental purposes and later on around the 1960s for aquaculture and angling. About 13 non-indigenous species are currently encountered in Flemish surface waters, of which seven have become established (ANSEEUW *et al*. 2002). Established American exotic species, like the eastern mudminnow (*Umbra pygmaea*), pumpkinseed (*Lepomis gibbosus*) and brown bullhead (*Ameiurus nebulosus*) do not spread spectacularly anymore. Since the 1990s, a new Asian species, the stone moroko (*Pseudorasbora parva*), has established reproductive populations and spread very quickly over the whole Flemish territory.

Monitoring of the fish fauna in the Scheldt estuary since 1991 has led to the observation of eight introduced fish species. All marine species recorded in the estuary arrived from North America while all freshwater species arrived from Eastern Europe and Asia. The presence of marine species is probably due to transport via ballast water of ships docking at the port of Antwerp. Freshwater species almost invariably occur following deliberate introductions (STEVENS *et al*. 2002).

The opening of the Main-Danube canal in 1992, linking the Danube to the Main and indirectly to the Rhine, might lead to the arrival of new eastern European species in Belgium, as it has been observed already in the Netherlands (ANSEEUW *et al*. 2002).

Legal protection and international importance

In Flanders, 12 fish species enjoy total protection through the freshwater fisheries legislation (1992). Other species receive a more limited protection through minimal catch size (15 species), discontinued fishing periods and a ban on specific fishing gear.

Six species still present in Flanders are listed in Annex II of the EU Habitats Directive: the brook lamprey (*Lampetra planeri*), river lamprey (*L. fluviatilis*), bitterling (*Rhodeus sericeus*), spined loach (*Cobitis taenia taenia*), weatherfish (*Misgurnus fossilis*) and bullhead (*Cottus gobio*). Annex II of the Habitats Directive lists six species extinct in Flanders: sea lamprey (*Petromyzon marinus*), salmon (*Salmo salar*), allis shad (*Alosa alosa*), twaite shad (*Alosa fallax*), houting (*Coregonus oxyrinchus*) and Atlantic sturgeon (*Acipenser sturio*). Annex V of the Habitats Directive lists species still present in Flanders such as the river lamprey and barbel (*Barbus barbus*) and extinct species like the salmon, allis shad, twaite shad, houting, Atlantic sturgeon and grayling (*Thymallus thymallus*).

The Red List of worldwide threatened species (IUCN 1996) lists five species present in Flanders: river lamprey, brook lamprey, weatherfish, crucian carp (*Carassius carassius*) and smelt (*Osmerus eperlanus*). It also lists four species presently extinct: Atlantic sturgeon, allis shad, twaite shad and houting.

2.5. Invertebrates

2.5.1. Butterflies

In Flanders, 89 species of butterflies (Lepidoptera, Rhopalocera) have been observed since the middle of the 19th century. Sixty-four species are considered as resident butterflies, four species are regular migrating butterflies and 21 species are considered as erratic and/or introduced. A Red List of butterflies in Flanders was established in 1996 (MAES & VAN DYCK 1996). Thirty-seven species have been included in the list: 19 of those are regarded as extinct (MAES & VAN DYCK 2001) and one-third are more or less threatened (eight critically endangered, six endangered and seven vulnerable species). Of the remaining species, 5% are rare and 35% are not threatened. There is not enough information available for the classification of one species. Currently, the areas richest in butterflies are found on the sandy soils in northeastern Flanders (Kempen), where heathlands, nutrient-poor grasslands and forested areas still co-occur.

Butterfly diversity in Flanders declined strongly during the 20th century, with 44 species showing a negative trend and only 13 a positive one. The proportion of extinct species is amongst the highest in Europe. MAES & VAN DYCK (2001) calculated that the average extinction rate was 0.95 species per five-year period during the 20th century but with very high differences between 1901-1950 (0.20 species per five-year period) and 1951-2000 (1.70 species per five-year period), indicating that the extinction rate increased more than eight fold during the second half of the 20th century.

Furthermore, about 90% of the former hot spots (both diversity and Red List species hot spots) have been lost despite the strong increase in recording intensity. Causes vary from one area to another. Butterfly species typical of open woodlands, grasslands and heathlands in forest clearings have disappeared from forested areas around Brussels following economic exploitation of the woodlands or the lack of appropriate conservation management. In the coastal dune areas, increased urbanisation for tourism led to the disappearance of semi-natural grasslands and to the cessation of grazing in several of the remaining plots, reducing the availability of early successional habitats favourable to many species. In northeastern Flanders, nutrient-poor grasslands and heathlands were transformed into arable lands, conifer plantations or other land uses (MAES & VAN DYCK 2001).

Species restricted to oligotrophic habitats particularly suffer from population decline, compared to mobile species and species from eutrophic habitats. The limited dispersal rate makes it very difficult for sedentary species to find suitable new habitat patches once their original habitat has been destroyed. Species of oligotrophic habitats were found chiefly in traditionally managed agricultural landscapes. The intensification of agriculture during the second part of the twentieth century has led to massive emissions of nitrogen and phosphorus: 201,451 tons of nitrogen and 22,649 tons of phosphorus have been cited for 2001 (VAN STEERTEGEM 2002). This eutrophication of oligotrophic grasslands has had for consequence the disappearance of the natural habitats of several species of butterflies and, of course, of the species themselves.

Policy-makers are well aware of the existing problems. The development of the Flemish Ecological Network aims to create an ecological network of large nature units (total area: 125,000 ha), large nature development units (total area: 150,000 ha) and ecological corridors. However, populations of some Red List species (*Thecla betulae*, *Satyrium w-album*, *Cupido minimus*, *Aricia agestis*, *Polyommatus semiargus* and *Melitaea cinxia*) are mainly situated outside the preliminary defined networks and need additional protection measures (MAES & VAN DYCK 2001).

Legal protection and international importance

In Flanders, 13 species of butterflies are legally protected. Three legal instruments play an important role in the protection of butterflies: the Royal Decree on Nature Conservation (1980) and two international instruments, the Bonn and Bern Conventions. A few butterflies are also listed in the EU Habitats Directive.

The Alcon blue (*Maculinea alcon*) is the only species with legal protection status under Flemish law still present in Flanders. Three other protected species are now considered as extinct: the false ringlet (*Coenonympha oedippus*) since 1912, the marsh fritillary (*Euphydryas aurinia*) since 1959 and the scarce large blue (*Maculinea teleius*) since 1980. Some of the protected species have never been resident butterflies in Flanders: the Arran brown (*Erebia ligea*), large copper (*Lycaena dispar*), dusky large blue (*Maculinea nausithous*), scarce swallowtail (*Iphiclides podalirius*), large blue (*Maculinea arion*), woodland brown (*Lopinga achine*) and scarce fritillary (*Euphydryas maturna*). The monarch (*Danaus plexippus*) is occasionally observed as vagrant.

Five butterflies (once) present in Flanders are mentioned in the proposed European Red List of Butterflies (VAN SWAAY *et al*. 1997) in the category 'vulnerable': the scarce large blue, Alcon blue, marsh fritillary, large heath (*Coenonympha tullia*) and scarce heath (*C. hero*). Three of those species became extinct many years ago. Only the large heath, with probably only one population present or recently extinct, and the Alcon blue are still found in Flanders. The World Red List of threatened species (IUCN 1996) lists two species in the category 'low risk/ near threatened' with a dispersal in Flanders: the Alcon blue and scarce large blue. Species threatened at the international level are only found in the northeastern part of Flanders.

2.5.2. Carabid beetles

Since the middle of the 19th century, 368 species of carabid beetles (ground and tiger beetles) have been observed in Flanders. Of these, 352 are indigenous while 16 are considered as vagrants. Carabid beetles occupy all types of terrestrial habitats, whether natural, semi-natural or heavily influenced by man (e.g. fields, pastures or urban areas). These characteristics, together with a high degree of habitat preference, make them excellent indicators of habitat quality. About 28% of the native species are listed on the Red List of threatened species for Flanders: 32 extinct, 20 critically endangered, 21 endangered and 25 vulnerable species. Another 91 species are rare, seven are data deficient and 144 are not threatened.

Table 2. Percentage of threatened species of carabid beetles (Extinct, Critically endangered, Endangered, Vulnerable, Rare and Indeterminate) per habitat in Flanders (after DESENDER *et al*. 1995).

Habitat	% threatened
Chalk grasslands, stony slopes and other xerothermic habitats	96,43
Dunes and beaches	95,45
Salt marshes	88,00
River and rivulet banks	84,62
Heathland and bogs	80,00
Woodland (stenotopic species)	74,29
Dry grasslands and other habitats on dry sandy soil (stenotopic species)	62,32
Oligotrophic standing water	55,56
Moist grasslands	43,75
Woodland (eurytopic species)	43,48
Ruderal sites and arable land	40,91
Marshes and eutrophic standing water	40,48
Dry habitats (eurytopic species)	5,41
Moist habitats (eurytopic species)	3,45

As mentioned earlier, the protection of species is extremely difficult without the protection of their natural habitats. Table 2 shows clearly that chalk grasslands and stony slopes, dunes and beaches, salt marshes, river and rivulet banks, heathland and bogs, woodland, dry grasslands and other habitats on dry sandy soils are the most threatened habitats for carabid beetles. Those habitats need to be protected and managed properly in order to protect their typical fauna and flora.

Legal protection and international importance

In Flanders, all species of the family Cicindelidae (tiger beetles, four species) and of the genera *Carabus* (15 species) and *Calosoma* (four species) are legally protected by the Royal Decree on Nature Conservation. MAELFAIT *et al*. (1992) showed that the Flemish legislation is outdated and that the protected groups are not representative of currently strongly endangered carabid beetles in Flanders. A re-evaluation of the list would be desirable. Protection should target species rather than whole genera, in which some species do not require any protected status.

No ground beetles present in Flanders are mentioned in the annexes of the Bern Convention or in the EU Habitats Directive. The International Red List of threatened species (IUCN 1996) lists one species (*Carabus intricatus*) probably extinct in Flanders.

2.5.3. Grasshoppers and crickets (Orthoptera)

A provisional Red List for Flanders is based on the temporary atlas of the Belgian grasshoppers and crickets (DECLEER *et al*. 2000). So far, 39 species of grasshoppers and crickets have been found in Flanders. Five (13%) of them are extinct, whereas 13 species can be considered as minimally vulnerable, eight species as rare and 12 species as not threatened. Not enough information is available to place one species in a specific category.

The highest number of species is found in the eastern part of the region (Kempen), where also the majority of Red List species are located (40% of the occurring species). Despite its severe deterioration, the coastal dune landscape also accommodates important metapopulations of several species, with a total diversity of about 20 species (DECLEER & DEVRIESE 1992).

Most of the Red List species are typical of rather dry biotopes, such as unfertilised dry grasslands and heathlands, where four out of five extinct grasshopper species used to be found (*Decticus verrucivorus*, *Gampsocleis glabra*, *Tetrix bipunctata* and *Psophus stridulus*) and where it is still possible to come across two species threatened with extinction (*Stenobothrus lineatus* and *Gomphocerripus rufus*) and one vulnerable species (*Chorthippus mollis*). Six Red List species of grasshoppers are typical for humid grasslands and heath: one extinct species (*Locusta migratoria*), one threatened with extinction (*Tetrix tenuicornis*), and four vulnerable species (*Tetrix ceperoi*, *Stethophyma grossum*, *Omocestus viridulus* and *Chorthippus montanus*).

Legal protection and international importance

The Royal Decree on Nature Conservation lists only two Orthoptera: *Locusta viridissima* and *Oedipoda caerulescens*. None of the grasshoppers and crickets found in Flanders are listed in the annexes of the Bern Convention or the EU Habitats Directive.

2.5.4. Dragonflies

In Flanders, 65 species of dragonflies have been observed out of a total of 69 species recorded in Belgium. Only 52 species were observed during the period 1990-95. Of the 65

species mentioned above, four species are only known as vagrant. Three of these species, with several populations in Flanders, originate from the Mediterranean region.

Of the original dragonfly species of Flanders, 16% are extinct, 34% are more or less threatened, 10% are rare, 4% are not well known and 36% can be considered as not threatened (De Knijf & Anselin 1996). The occurrence of Red List species shows that the most diverse dragonfly fauna is located in the central and eastern part of Flanders (province Antwerp and Limburg). Nevertheless, they occur over the whole Flemish territory. Species threatened with extinction require high quality habitats and their distribution is almost limited to the provinces Antwerp and Limburg, where relatively large and undisturbed nature entities including brook valleys and several oligotrophic pools can still be found. The Red List species labelled as threatened are found in the same area. Species found outside those provinces all correspond to *Coenagrion pulchellum*, *Cordulegaster boltonii* and *Sympecma fusca*. The species belonging to the Red List category vulnerable are more widespread compared with the former two Red List categories. The distribution of the species belonging to the Red List category rare is historically limited to the provinces Antwerp and Limburg, exception made for *Calopteryx splendens*.

During the past 15 years, eight species of dragonflies with a 'normal' distribution in the south of Belgium were observed more frequently: *Lestes barbarus*, *Coenagrion scitulum*, *Aeshna affinis*, *Anax parthenope*, *Orthetrum brunneum*, *Crocothemis erythraea*, *Sympetrum meridionale* and *Sympetrum fonscolombii*. Up to the beginning of the 1990s, those species were observed occasionally, but they are now present every year in Flanders, including several observations of reproduction.

Legal protection and international importance

The Royal Decree on Nature Conservation protects all dragonfly species. Three species extinct in Flanders are listed on the Red List of species threatened at the global level (IUCN 1996). The species mentioned in the annexes of the Bern Convention and of the EU Habitats Directive are no longer present in Flanders.

2.5.5. Dolichopodid flies

In contrast to well-known and frequently collected invertebrate groups such as butterflies, dragonflies, ground beetles and spiders, most dipteran families including long-legged or dolichopodid flies are quite obscure, even to most entomologists. Nevertheless, dolichopodid flies show all the features that make this family especially suitable for bio-indicatory purposes (high species richness, distinct habitat affinity, high sensitivity to environmental alterations). Pollet (2000) states that a total of 295 species has been established in Belgium with certainty, 260 of which occur in Flanders. A complete species list is given by the author. Of these species, 22 are extinct in Flanders, 10 critically endangered, 14 endangered, 16 vulnerable, 86 susceptible or rare, 39 insufficiently known and 73 are considered safe/at low risk.

The dolichopodid fauna of salt marshes is by far the most threatened in Flanders with 68% of threatened and/or rare species. In reed marshes and other marshlands, moderately to very

humid woodlands, coastal dunes and humid heathlands, threatened and rare species constitute one-third or more of the entire dolichopodid fauna, which makes these habitats among the most valuable in Flanders. Nearly all threatened and rare salt marsh species are typical for this habitat, whereas characteristic heathland and coastal dune species make up about half of the threatened and/or rare species in these habitats.

Legal protection and international importance

Neither the European, Belgian nor Flemish legislation foresee the protection of dolichopodid flies.

2.5.6. Spiders

The Red List of spiders in Flanders (MAELFAIT *et al.*, in preparation) mentions 604 species out of about 700 species for Belgium. About half of the 592 species are not threatened, 9% are threatened with extinction, 14% are threatened and 10% are vulnerable. Another 10% of the species are rare, whereas 1% is extinct. A Red List for the family Lycosidae was prepared by ALDERWEIRELDT & MAELFAIT (1992).

Because of their numerousness and their occurrence in all biotopes, spiders are excellent organisms to measure the quality of the environment (MAELFAIT & BAERT 1997). With the exception of the water spider (*Argyroneta aquatica*), all spiders are terrestrial and occupy a vast range of biotopes. The species most at risk are found in the sandy habitats of eastern Flanders (Kempen) and in the coastal dune areas.

The wasp spider (*Argiope bruennichi*) appeared in Belgium for the first time around 1870. The spider's distribution has slowly extended northwards and, since the 1980s, has reached its most northern distribution in Flanders. Its expansion occurs through the valleys of the main waterways and their tributaries, as is typical of southern species progressing northwards. Although its opportunistic behaviour of colonising man-made habitats has enabled its progression, the species remains vulnerable due to the unstable characteristics of its habitats (PUTS 1989).

Legal protection and international importance

The Royal Decree on Nature Conservation protects four species of spiders in Flanders: the wasp spider (*Argiope bruennichi*), purse-web spider (*Atypus affinis*), raft spider (*Dolomedes fimbriatus*) and water spider (*A. aquatica*). The latter three species belong respectively to the Red List categories vulnerable, critically endangered and vulnerable. There are currently no native spiders listed in the annexes of the Bern Convention and EU Habitats Directive.

2.6. Higher plants

Historically, 1,416 species of higher plants belonging to the wild flora have been observed in Flanders (BIESBROUCK *et al.* 2001). Of these, 1,039 species belong to the original native flora, while 358 were introduced by man and became naturalised (VERLOOVE 2002). Nineteen species have an uncertain status. Of the exotic species, 115 were introduced after

the major voyages of discovery. Almost 6% of the higher plants are extinct in Flanders, a quarter are more or less threatened, 15% are rare and a little more than half of the species are momentarily not threatened.

Hot spots of Red List higher plant species can be divided into 5 eco-regions: coastal dunes, polders, sandy region, loamy region and Kempen. Major hot spots in the coastal dunes area can be found in the western part of this region, such as in the Westhoek (De Panne) nature reserve and the Ter Yde-Groenendijk (Oostduinkerke) dune complex. Important biotopes for higher plants are humid dune valleys, unfertilised dry grasslands of decalcified dunes and scrubs on calcareous soils. In the polders, important hot spots can be found in unfertilised wet (salty) grasslands (e.g. Lissewegen), coves (e.g. Assenede, Sint-Laureins) and salt marshes along the lower part of the river Scheldt. In the sandy region, a number of sites contain many Red List species: Vloetemveld en Gulkse putten (Wingene) and the valleys of the Moervaart and Dam. Important flora elements are found in unfertilised wet pioneer vegetations. In the loamy region, hot spots are found especially in thickets and forests (e.g. Sonian Forest, Vlaamse Ardennen, Hallerbos, etc.). Large numbers of Red List species are also found in species-rich permanent pastures (e.g. Voeren). In the Kempen, the most important hot spots can be found in wet heaths, raised bogs, degraded heaths and some grasslands.

Higher plants are often introduced from other regions in the world. Some of the exotic species become problematic because of their fast spread. Examples of invasive higher plant species are the black cherry (*Prunus serotina*), water pennywort (*Hydrocotyle ranunculoides*), Japanese knotweed (*Polygonum cuspidatum*), common waterweed (*Elodea canadensis*), and common cordgrass (*Spartina angelica*).

Legal protection and international importance

Legal protection exists for 79 species of the Flemish native higher plants (De Pue *et al.* 1997). The legislation concerning protected plants dates back to 1976 (Royal Decree on the protection of wild plant species, based on the Law on Nature Conservation of 1973). The figures given below only concern native species. However, a number of legally protected Belgian species were never found in the wild in Flanders. The legislation uses three categories:

- category A contains 38 species. Those species enjoy total protection except in gardens and parks. Picking, transplanting, damaging, trading or transporting are forbidden (also in dried condition);
- category B contains 36 species. Those species enjoy protection for subterranean parts. Digging out, transplanting, damaging, trading or transporting of those parts are forbidden (also in dried condition);
- category C contains 5 species. The complete species is protected against harvesting, transporting or exporting for commercial purposes (also in dried condition).

At the European level, species of Annex I of the Bern Convention are protected by the same measures as the species that enjoy complete protection in Flanders (category A). It concerns three species for Flanders: the creeping marshwort (*Apium repens*), fen orchid (*Liparis loeselii*), and floating water-plantain (*Luronium natans*). As far as species of Annex II of the

EU Habitats Directive are concerned, Flanders has to designate and protect areas in such a way that the existing populations of those species can survive. For Flanders, they are the same species as those listed in Annex I of the Bern Convention.

2.7. Mosses

Around 500 species of mosses are found in Flanders. Because of the lack of a reference situation, it is extremely difficult to place existing species into Red List categories. Based on best professional judgement, HOFFMANN (1999) states that a quarter of moss species in Flanders are more or less threatened, a quarter are declining and half are not threatened.

Important areas for the biodiversity of mosses are the lake areas in the central part of the Province of Limburg, specifically 'De Maten' and 'Het Wik' in Genk, 'Het Groot Schietveld' in Brasschaat, the freshwater part of the intertidal area of the river Scheldt and the Flemish coastal dunes. Forested areas in the centre of Flanders (Meerdaalwoud, Zoniënwoud, Walenbos, etc.) are also noteworthy moss habitats, as well as the fens and marshes in the eastern part of the region (Kempen).

Legal protection and international importance

All *Sphagnum* species are protected under Annex C of the 1976 Royal Decree on the protection of wild plant species.

2.8. Lichens

The description of the situation of lichens is currently under preparation. Based on observations in the field, herbarium material and literature sources, the maximum number of observed lichens in Flanders is estimated at 338 species. Fifty of these species can now be considered as extinct. The major part of the extinct species has not been seen since the beginning of the twentieth century. If the species found in Brabant are taken off this estimation (it is not sure that the species are found in the Flemish part of the district), the total number of species found in Flanders decreases to 308. Of those species, 35 are extinct. This brings the present number of lichen species in Flanders to 273.

A Red List for the lichens of Flanders does not exist at present. Broad repartition into rarity categories indicate that about half of the lichen flora is threatened to some extent (from very rare to extremely rare), about 60 species are rare and the rest is common to very common. This latter category only represents 11% of the Flemish lichens.

A general requirement for lichens is the absence of nutrients. In comparison with mosses and higher plants, lichens are very weak competitors and therefore mainly occur in locations where mosses and higher plants have great difficulties to establish stable populations. This explains why they prefer dry heaths, dry calcareous grasslands, unfertilised dry grasslands of decalcified dunes and bare forests.

As epiphytic lichens prefer areas with a low degree of air pollution, hot spots for those species are found in the coastal dune areas, polders and large forests of the loamy region.

Hot spots for stone-growing lichens mainly correspond to old artificial stone substrates such as found in old churches and graveyards. Because of the buffering effect of the substratum, these species suffer less from the acidic effect of air pollution.

Legal protection and international importance

Only the species of the subgenus *Cladina* (reindeer moss) are protected against harvesting, transporting and exporting for commercial purposes under the Flemish law (Annex C of the 1976 Royal Decree on the protection of wild plant species). The EU Habitats Directive protects none of the lichens present in Flanders.

2.9. Macrofungi

In 1999, WALLEYN & VERBEKEN produced a documented Red List of macrofungi in Flanders. Due to the very large number of species and because sufficient information is not available for a number of groups, the authors only used groups for which they had relevant information to carry out quantitative judgements. These groups consist of 552 native species observed in Flanders. It is estimated that they correspond to about 20% of the total species of macrofungi. In the groups studied, 8% of the species are currently extinct (43 species) and 47% of the species still present are on the Red List (46 threatened with extinction, 66 threatened, 118 vulnerable, 35 rare and 32 in decline and probably threatened because they are found in rare to very rare biotopes). This means that only one-third of the macrofungi species can be considered as not threatened.

WALLEYN & VERBEKEN (1999) also describe trends and threats in relation to macrofungi: the decline seems to be higher within ectomycorrhizal species (only 32% of species are considered as safe) than within saprophytic species (40% are safe). The decline of the mycoflora is a widespread phenomenon, with eutrophication probably being the main underlying cause. Species of poor grasslands, marshes, peat bogs, wet heathlands, coastal dunes and most of the forest types are particularly threatened. Numerous ectomycorrhizal fungi appear to be banished from forest areas to poor grassy roadsides or parks. The adequate management of these mycorrhizal refuges is necessary for the conservation of threatened species. Conservation actions include: the increase in the volume of dead wood, the protection and appropriate management of sites with a high number of Red List species, a more frequent burning of logging waste *in-situ*, the plantation of indigenous tree species rather than exotic ones, and the conservation and/or development of endangered habitats. A significant reduction of soil eutrophication is of paramount importance.

Legal protection and international importance

None of the Red List macrofungus species in Flanders are protected. The only protection macrofungi enjoy in Flanders is the ban to harvest them in most nature reserves and areas listed in the Flemish Forest Decree. At the European level, there exists a European list that is not connected to any legislative instrument.

The description of the Flemish biotopes is based on the Biological Evaluation Map for Flanders and on derived land use maps. Table 3 summarises available information for the main biotopes found in Flanders. As a region is often described as a complex of mapping units, it is difficult to give a precise estimation of the surface area of a biotope and data are presented as 'minimal area' and 'maximal area'.

Table 3. Surface area of the main (semi-)natural biotopes in Flanders (after VAN LANDUYT *et al.* 1999).

Biotope	Minimal area (ha)	Maximal area (ha)
Heathlands and fens	9,800	18,400
Marshes	5,800	15,400
Wetlands	8,925	11,985
Dunes	1,440	2,940
Semi-natural grasslands	4,640	8,870
Species-rich grasslands	9,270	11,450
Grasslands with disseminated biological value	29,050	42,630
Pioneer vegetation	3,750	6,610
Scrubs	585	985
Mesophilic forests	22,550	56,410

2

Forest fen with *Sphagnum* and purple moor-grass, *Molinia caerulea*. Koersel, Province of Limburg (photograph by J. PACKET, Institute of Nature Conservation).

3.1. Heathlands and fens

Heathlands are ecosystems developing on poor, usually acid, sandy or gravely soils in lowlands while fens are ecosystems developing on alkaline, neutral or slightly acid wet peat. In Flanders, biotopes belonging to these groups include oligotrophic to mesotrophic waters, dry heath, Atlantic wet heath (*Ericetum tetralicis*), sometimes with species of raised bogs, dry heath with *Vaccinium* (*Calluno-Vaccinietum*), heath of raised bogs (*Vaccinio-Ericetum*), sometimes with dominance of *Molinia caerulea*, several types of degraded heath, inland drift sands, active raised bogs, degraded raised bogs, species-rich *Nardus* grasslands (*Violion caninae*) and unfertilised dry grasslands (*Thero-Airion*).

Heathlands and fens together cover 0.7 to 1.4% (9,800-18,400 ha) of the total surface of Flanders. They are mostly found in the northeastern part of the region (Kempen). Heathlands in East and West Flanders are particular, as they form an intermediate variant of the North Atlantic heath (from Kempen to North Germany) and the Atlantic heath (England-Brittany). Nowadays, the area of this heathland is very reduced and only small remnants still exist. More than half of the surface area of heathlands and fens disappeared during the past decades, following the lack of management (i.e. spontaneous forest development) or deforestation. Fens also suffered heavily from atmospheric pollution and eutrophication.

Although heathlands host a relatively low number of plant and vertebrate species, they are of crucial importance for invertebrates. They also accommodate the greatest number of Red List species, in particular for plants and invertebrates. For example, 11 species of butterflies are found in Flemish heathlands, three of these are extinct while the other eight are threatened.

Legal protection and international importance

Heathlands and fens are now better protected, thanks to their status as Special Areas of Conservation under the EU Habitats Directive and their inclusion in the Flemish Ecological Network. Appropriate management practices start to improve the state of flora and fauna in the large heathlands. Management of small heathlands and fens remains inadequate, especially when these are surrounded by agricultural land. Small areas should be better isolated from the influences of intensive agriculture, especially regarding drainage and fertilisation. Special interventions in the water systems are required and buffer zones with less intensive agricultural activities should be established around the heathlands.

3.2. Marshes and wetlands

Marshes are typical plant communities developing on wet but not peaty soil. They include herbaceous vegetations as well as marsh forests and form a rather heterogeneous group of biotopes, of which the main ones are reedlands (*Phragmition*), vegetations of *Scirpus maritimus*, vegetations of *Cladium mariscus*, tall sedge vegetations (*Magnocaricion*), quaking fens, acid fens (*Caricion curto-nigrae*), alkaline fens (*Caricion davallianae*), dune slack calcareous fens and moist tall herbaceous vegetation with *Filipendula ulmaria*.

Marshes cover only 0.5 to 1.1% of the total surface of Flanders. They consist mostly of reedland, moist tall herbaceous vegetation with *Filipendula ulmaria* and mesotrophic ash-

alder wood. Other biotopes occupy very limited surfaces (max. 300-600 ha). Marshes are distributed all over the Flemish territory, mostly in brook and river valleys. Alkaline fens are only found in the Kempen region.

Recent trends in the distribution of marshes and wetlands are not available, but the comparison between historical maps and the current situation shows that they have strongly regressed. Their surface area is now highly fragmented. The main regression causes include drainage and changing land uses (including reforestation, deforestation and transformation into grasslands). Most types of marshes disappeared almost completely. Tall herbaceous vegetations with *Filipendula ulmaria* are rare to extremely rare in Flanders while reedland is rare to very rare.

Their fauna and flora are very rich and specific. Many threatened plant species are found in tall sedge vegetation, quaking fens, acid and alkaline fens. About half of Flemish Red List dragonflies (14 species), five of which are already extinct, are characteristic of marshes and wetlands. For butterflies, the situation is not better. Out of a total of eight species found in marshy areas, six are currently extinct in Flanders and two are threatened.

The conservation of marshes and wetlands is only possible through the strict protection of a number of rare habitat types. Marshes play a crucial role for water purification and storage as well as nature conservation. This is particularly the case in buffer zones and verges of waterways or in flood plains. Thus, the amelioration of water quality, in particular the reduction of pesticides and nutrients, is a primary condition for the conservation of biodiversity in those areas.

Other wetlands occupy only 0.4 to 0.6% (5,260-7,970 ha) of the Flemish territory. Eutrophic waters occupy the largest surface (3,240-5,130 ha) and are concentrated in the valleys of the rivers Scheldt, Demer, Dijle, Senne, Nete and in the 'Vijvergebied Midden-Limburg'.

Biotopes typical for salt and brackish water are only found along the coast, the upper part of the river Scheldt, in the creek area of the Province of East Flanders and in the polders. All biotopes typical for salt and brackish water are extremely rare and are recognised of international importance.

Legal protection and international importance

Many marsh and wetland areas are now protected under the EU Birds and Habitats Directives or under international conventions. The Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar Convention, 1971) has put forward a number of criteria in order to determine whether a wetland area is of international importance to water birds. Two of the most important criteria are based on bird numbers. The first criterion requires the regular presence of at least 1% of all individuals of a population or subpopulation. The second criterion requires the regular presence of at least 20,000 water birds.

The first designation of Belgian Ramsar sites in 1984 was based upon KUIJKEN (1972). Following information from the Flemish Institute of Nature Conservation, SCOTT & ROSE

(1996) gave an overview of all areas in Flanders where the 1% criterion is reached from 1991/92 to 1995/96.

Four sites in Flanders are currently protected under the Ramsar Convention: 'Het Zwin' and its surroundings (530 ha), 'De Blankaart en de IJzerbroeken' (2,460 ha), 'De Schorren van de Beneden-Zeeschelde' (398 ha), and 'Kalmthoutse Heide' (2,183 ha). The coastal shallows 'Vlaamse Banken' in the North Sea (1,700 ha) belong to the federal competence. Three more sites have been proposed but have not officially been designated yet.

Flanders accommodates more than 5% of the total population of seven species, which makes it an area of international importance for those species: the pink-footed goose, greater white-fronted goose, Eurasian wigeon, gadwall, common teal, northern shoveler and common pochard. The Flemish coastal polders accommodate among others more than 90% of the total Spitsbergen population of pink-footed goose each winter.

3.3. Grasslands

The group of biotopes referred to as 'historically permanent grasslands' include semi-natural grasslands, species-rich grasslands (including relics of semi-natural grasslands) and grasslands with disseminated biological value.

Semi-natural grasslands include dry calcareous grasslands (*Brometalia erecti*), grasslands on decalcified dunes, moderately fertilised wet meadows (*Calthion*), unfertilised wet meadows (*Molinion caeruleae*), mesophilic hay meadows (*Arrhenatherion elatioris*) and the moderately fertilised wet meadows dominated by *Juncus*. Species-rich grasslands include species-rich permanent pastures (sometimes in transition to wet meadows) and salt marshes with permanent pastures containing ditches or micro-relief. Grasslands with disseminated biological value include species-rich permanent pastures with ditches or micro-relief sometimes including elements of reedlands or *Calthion* grasslands.

Semi-natural grasslands occupy only 0.3 to 0.6% of the Flemish territory (4,640 to 8,870 ha). The total surface of species-rich grasslands is not exactly known for Flanders. Grasslands with disseminated biological value are considered rare, covering 0.9 to 1.3% of the Flemish territory. These grasslands have been mown and/or grazed for many years, leading to a high biological diversity. When ploughed and re-sown, much of this diversity is lost. Eutrophication, overgrazing and desiccation through the lowering of the water table also threaten biodiversity. Random samples taken in the Flemish polders indicate that 50% of the total surface of historically permanent grasslands was lost between 1980 and 2000.

Little quantitative data are available for species in grasslands. Most of the existing data refers to semi-natural grasslands. For example, more than one-third of Red List species of spiders and one-third of Red List species of butterflies are found on unfertilised dry grasslands. This large number indicates the importance of those grasslands for biodiversity in Flanders. It should be noted that one-third of the species originally occupying semi-natural grasslands have already become extinct.

Legal protection and international importance

Adequate rules are urgently needed to stop this negative trend, as historically permanent grasslands are unique and very important among others for migrating birds. The Nature Decree of 1997 forbids the change of historically permanent grasslands into specific categories of land use destinations. Fertilisation limitations and management agreements can also bring improvements. However, due to the fragmented and *ad hoc* application, effectiveness is very low. Moreover, the multi-functional use of the historically permanent grasslands causes much tension and challenge. At the European level, the EU Habitats Directive protects most types of historically permanent grasslands found in Flanders, while the EU Birds Directive protects a number of grassland bird species.

3

Meadow with soft rush, *Juncus effusus*, and cuckoo flower, *Cardamine pratensis* (photograph by Y. ADAMS, Institute of Nature Conservation).

The forest cover is relatively low in Flanders (less than 10% of the territory). It differs considerably from one area to another, the major wooded areas being located in the Kempen.

Much of the forest biodiversity has been lost over centuries due to massive deforestation and very intensive forest use. Present Flemish forests often consist of relatively young, even-aged stands with little structural variation. Old trees, bright clearings and dead wood are rather scarce. Remaining forested areas are very fragmented -less than 10% cover more than 400 ha- and often incomplete from a biological point of view. Forest also suffers from environmental impacts such as acidification. As a consequence, many forest species are threatened or extinct. This is the case of mushrooms (macrofungi), for which many forest species are currently threatened: many mycorrhizae and saprophyte species of nitrogen-poor forests suffer from eutrophication, whereas other species are sensitive to acidification. This latter factor particularly affects conifer forests, where 18% of typical mushroom species are currently extinct and another 29% are critically endangered. As far as the fauna is concerned, studies carried out in 56 wooded areas identified 932 species from 43 taxa, of which at least 12% stand on the Red List. Occurrence varies greatly from one group to another and it is difficult to extract general distribution patterns.

Legal protection and international importance

Fortunately, forest management practices changed during the last decade. The Flemish Forest Decree (1990) lays the basis for the new forest policy, in which the protection of the remaining 'old-growth' or semi-natural forests is a key element for the conservation of biodiversity. The transformation into a more diverse structure and composition, the use of local tree and bush species, the aging of trees, the preservation of dead wood and the creation of bright clearings are strongly encouraged.

Data on the results of this change in management strategy are not available yet. Of course, changes in forest maturity cannot be carried out on a short-term basis. Although there is already more dead wood in our forests, it is still limited. The trend for a number of forest species improves, especially for birds. The latter is mainly attributed to the aging of trees. Many threatened plants and invertebrates react much more slowly to habitat improvements. Some factors are also far more difficult to recover. One of these is acidification of forest soils, which still continues. This is particularly threatening for forests of moderately acidic soils such as the valuable 'old-growth' forest complexes in the central part of Flanders. Soil acidification is also one of the major causes of increasing tree mortality. This cannot be solved by improved forest and nature policy alone. A fine tuned general environmental policy will be needed.

Eight forested habitats listed under the EU Habitats Directive are found in Flanders, including two priority types (bog woodlands and relict alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior*).

Waterways (rivers, streams, canals and polder ditches) and their valleys are important linear elements of the landscape. They do not necessarily accommodate typical flora and fauna, but form very important migration routes for many species. Waterways can be divided into four major types: streams (11,923 km or 74%), rivers (501 km, 3%), tidal rivers (224 km, 1%) and man-made waterways (3,564 km, 22%). The amount of standing waters is also quite extensive, with some 5,700 lakes and ponds inventoried in Flanders (7,500 ha). The percentage of waterways and ponds with good water quality in combination with valuable structural characteristics is extremely low.

During the nineties, the extension of water purification plants resulted in reduced water pollution. A number of invertebrate and fish species reappeared in the region. The Belgian Biotic Index (based on the inventory of invertebrates) shows that water quality of most brooks improved during the last decade. The highest improvement was recorded for the most polluted waters. The number of sample points with very high water quality increased too, but is still restricted to only 7% of the locations. The fish index indicates a critical to poor quality: only 10 of the 965 locations sampled showed an index of high natural quality, the basins of the Meuse (8 locations) and Nete (2 locations) being the most valuable. Spring brooklets and the larger lowland brooks are amongst the most valuable brooks. However, even in the most precious brooks, invertebrate populations vary strongly from year to year, which indicates instability. Only some of the smaller spring brooklets and lowland brooks that flow through pristine river valleys attain a continuously high water quality.

Too often, severe environmental pressures affect very valuable watercourses. Although direct dumping of waste materials clearly decreases, diffuse pollution continues to grow. In watercourses with naturally very low phosphate concentrations, a small increase is measured which is due to a gradual influx. Even these limited changes are responsible for changes in the aquatic communities. In addition, historical pollution such as the accumulation of heavy metals causes more and more problems. Intensive land use in river valleys results in reduced water quality and simplification of structural characteristics of the courses. Naturally meandering rivers and brooks are only found in marshes, forests or historically permanent grasslands. In agricultural land, these watercourses are usually straightened, while riverbanks are usually reinforced in urban areas. At numerous locations, dams, culverts or waterfalls block the network of watercourses. Migration of many species, especially fish, is seriously hampered or even impossible, which results in isolated and fragmented populations.

Flemish standing waters are strongly polluted. Most water bodies suffer from a vast nutrient influx. Fens in the Kempen and the Flemish sandy region are usually acidified. Only in a very limited number of relict areas, water quality of standing waters is still satisfactory. Some smaller and younger brook systems and deeper excavations are of better quality. To restore the pure quality of standing waters, a general improvement of the environmental quality (atmospheric depositions, ground and surface waters) is needed. The management practice applied in many standing waters is far from nature friendly. Progress is urgently needed.

4

The 'Goorvijver' in Retie (Province of Antwerp) originated as a consequence of sand extraction and is now part of a designated Habitats Directive site. On the foreground, in the water: bulrush (*Typha latifolia*) and common reed (*Phragmites australis*). On the background: grey willow (*Salix cinerea*), silver birch (*Betula pendula*) and Scots pine (*Pinus sylvestris*) (photograph by J. PACKET, Institute of Nature Conservation).

Legal protection and international importance

The new water policy regulation is steered by the European directive for establishing a framework for community action in the field of water policy (the EU Water Framework Directive, adopted in 2000). The aim is a better integration of water use and water management. To achieve the quality ambitions in the field, a better integration of the 'renewed' environmental and country planning is necessary. Together with transport and agriculture policy, these policy fields have to generate more space for water and nature. The development of area-specific standards, better tuned to the specific needs of the water-courses, is necessary.

The main objective of the EU Water Framework Directive is to reach a good ecological quality in all surface waters. A good ecological quality is described as a situation showing at the maximum a slight disturbance compared to an undisturbed situation. In addition to a global quality improvement, the Directive asks specific attention for the quality of estuarine and coastal waters. Towards 2004, the EU Member States are bound to prepare a list with protected areas under the Water Directive. The specific objectives for each of those protected areas should be completed by 2015.

3.6. Coastal dunes

Coastal dunes include different biotopes such as embryonic shifting dunes, shifting dunes along the shoreline with *Ammophila arenaria* (white dunes), fixed coastal dunes with

herbaceous vegetation (grey dunes), Atlantic decalcified fixed dunes (*Calluno-Ulicetea*), dunes with *Hippophae rhamnoides*, dunes with *Salix repens* ssp. *argentea* (*Salicion arenariea*), wooded dunes and humid dune slacks.

Dunes can be found all along the Flemish coastline. However, they are very fragmented as more than 50% of the original dune area has already disappeared. The high pressure on dune ecosystems arises mainly from tourism, including the expansion of tourist accommodation, but also from agriculture, industry and desiccation. Desiccation is caused by the pumping of groundwater, the drainage of polders and a diminished rainwater infiltration due to urbanisation. It is a very important pressure for nature conservation in the dunes.

The coast and coastal dunes are very rich in species. For instance, 862 species of higher plants (67% of the Flemish total) are found in an area of 7,500 ha (0.55% of the Flemish region). Depending on the taxonomic group, 5 to 10% of the species distributed along the coast can be considered as specific to the dune biotopes. The management of the coastal dunes is still dominated by their protective role against the sea. In the future, an adequate management of the coastal dunes has to give more importance to the natural values of these habitats.

Legal protection and international importance

In the seventies, the zoning plans for the Flemish coastal areas protected approximately 3,100 ha of coastal dunes under the status of nature reserves. During the following years, a large part of this area was lost to ever-increasing urbanisation pressures. The Dune Decree of 14 July 1993 now distinguishes two categories of protected areas: areas where limited agricultural activity is allowed and protected areas where building activities are absolutely forbidden, except for nature development and coastal protection.

Coastal dunes are also included in the list of habitats protected under the EU Habitats Directive. Two priority habitats are found in Flanders: fixed coastal dunes with herbaceous vegetation ('grey dunes') and decalcified fixed dunes with *Empetrum nigrum*.

3.7. Urban areas

Nature in urbanised areas corresponds to green areas within the surrounding grey urban environment, pockets where one feels good and wild flora and fauna can establish spontaneously. In general, the Flemish urban environment harbours less species than the surrounding natural areas. Many species are very common species, usually adapted to cultivated conditions, or imported (invasive) species. The natural state can be improved by planting native species, or by allowing spontaneous (re)colonisation.

4. Environmental disturbances

Changes in environmental quality due to eutrophication, acidification, desiccation, pollution and/or habitat fragmentation impose heavy pressure on fauna and flora. These major problems in Flanders are detailed below. Other human influences on nature include the over-exploitation of natural resources (hunting, fishing, harvesting) and the trade in exotic species (agriculture, forestry, gardening, pet trade, aquaria, etc.).

4.1. Eutrophication

Nature is flooded by an excessive nutrient influx from the air, surface waters, ground water and too often through direct over-fertilisation. These nutrients are assimilated by the vegetation or animals, fixed to the soil, or are transported downstream by means of ground and surface waters to river valleys, estuaries, and finally to the sea. The nutrient level in Flemish watercourses is amongst the highest in Europe. Nitrogen concentrations in Flemish watercourses are decreasing but remain high, with more than 40% of the sample points above the 50 mg/l level (VAN STEERTEGEM 2002). Because the nutrient input exceeds the nutrient output in most systems, nutrients accumulate practically everywhere. In every ecosystem, the nutrient excess disturbs the ecological balance. In most cases, biodiversity drops. During last century, vegetations of nutrient-rich environments gradually replaced the vegetations of nutrient-poor environments all over Flanders.

Over-fertilisation also induces the regression of many species groups such as invertebrates or fungi. The present policy that aims to tackle the problems at the source should limit nutrient emissions. However, the atmospheric nitrogen depositions barely decreased. Nitrogen emissions are still far above the medium-length objectives set out by the 1991 EU Nitrates Directive for maximum admissible concentrations (VAN STEERTEGEM 2002). Nutrients continue to accumulate in nature, constituting a disturbance factor that will last for a long time in the future. Nutrient load can be reduced locally by reducing the input or by exporting nutrients through hay or sod removal. The knowledge on nutrient flows through the landscape and the consequences for nature is still very fragmentary. There is an urgent need for monitoring, norms based on natural limitations and modelling of nutrient flows with particular attention for the most vulnerable ecosystems.

4.2. Acidification

Natural acidification is accelerated by atmospheric depositions, and sometimes by changes in hydrology and vegetation. An important side effect of acidification is the release of toxic aluminium. During the last 50 years, soils of many Flemish forests have become more acidic. Biodiversity in these forests, especially for naturally moderately acidic forests, is threatened. In particular, the state of the old broad-leaved forests of the loamy region and of mesotrophic waters is critical. Thanks to the reduced emission of sulphur dioxide, acid depositions have decreased from more than 17,000 million acid equivalents in 1990 to less than 11,000 million acid equivalents in 2001 (VAN STEERTEGEM 2002). However, these depositions are still too high for nature. In order to reach policy goals (national emission maxima) more effective actions are needed. The area-specific policy in relation to acidification has to pay particular attention to ecosystems of moderately acidic environments. More applied research is necessary to formulate recovery actions for degraded forest soils, while data collection should be organised to follow up the state of sensitive ecosystems.

4.3. Desiccation

Flemish legislation and policy plans increasingly recognise the problem of desiccation. However, progress in the field is slow. The implementation of the European Water Framework Directive should speed up actions. The total amount of water resources is

crucial in policy actions against desiccation. Based on the specificity of each type of environment, the sectors involved in water extraction should evaluate the amount of the different types of water sources that can be used for different activities. The number of water extraction points (among others for agricultural use) is still rising, and, coupled to additional illegal extractions, leads to an ever-increasing desiccation problem. Keeping ground water for high quality usage (e.g. drinking water) and using alternative sources (e.g. rain) where possible should improve the state of nature. Actions to reduce desiccation go hand in hand with actions to reduce flooding. These are area-specific initiatives where knowledge of the water system on the one hand, and of water extraction and drainage on the other, is crucial. Objective methods to assess desiccation effects and long-term monitoring of (ground) water levels are necessary as a base to formulate policy measures. The realisation is of primary importance.

There is a strong interaction between desiccation, acidification and eutrophication. A disturbed water balance influences soil properties. Maintaining acid rain in the upper layer or decreasing seepage can cause acidification of the soil. The lowering of the groundwater table leads to an increased mineralisation of organic matter and can lead to an increased eutrophication.

4.4. Pollution

Heavy metals constitute an important problem in several Flemish localities. Measurements in plants, woodlice, spiders, fish and tits (*Parus* spp.) indicate that heavy metals accumulate in the food chain. The distribution patterns coincide with historical contamination sources. For a number of contaminants, the latter is regionally determined. As an example, important cadmium and zinc concentrations are found in contaminated soils in the Kempen area for both woodlice and fish. There are only limited data available on the possible effects for these organisms. Some point studies indicate deleterious effects in various organism groups from different trophic levels in the food chain. These are growth limitations in plants, genetic adaptations in spiders, a reduced condition in gudgeon (*Gobio gobio*) and reproductive problems in tits. In order to assess the effects of pollution such as heavy metals on ecosystems, it will be necessary to select appropriate indicator species and to develop a continuous monitoring system. At the moment, much attention is paid to the reduction of emissions to prevent further pollution. However, parallel to this, additional attention is needed to study existing historical contamination and contaminant flows through the system. These are not only responsible for the present effects on ecosystems, but will be of continuous importance because of lag effects. In some situations, such as heavy metal contamination of ground and surface waters, important effects have not appeared yet!

4.5. Habitat fragmentation

Fragmentation can be defined as the loss of structures and order. Habitats become smaller and more isolated. The connectivity between habitats is also reduced due to intensified land use (such as urbanisation) and the associated increase in disturbances, such as pollution and noise. The number and size of barriers increase, and, as a consequence, small isolated populations become vulnerable to extinction.

The knowledge on the impact of habitat fragmentation on nature is itself very fragmental. The problem of fragmentation is recognised in present policy and is incorporated in several policy plans and notes. The realisation of these plans is a priority aim for the next years. A small number of 'defragmentation' (or connectivity restoration) actions are prepared, but due to elaborate administrative procedures, the realisation in the field is largely delayed. The realisation of these 'defragmentation' actions is not sufficient. It is necessary to assess the effective use by the target species, and to monitor the impact on their populations.

Many freshwater fish populations decrease because their migration routes are blocked by weirs, water mills and dams. The impulse to migrate disappears because the water speed decreases above a weir. The Benelux Decree concerning Fish Migration postulates that by 2010 fish migration should be possible, for all fish species in all watercourses of the Benelux. To comply with this, a priority map was constructed. Based on the standstill principle (nature should not decline any further), it was chosen to start with the most valuable watercourses. The migration bottlenecks of this priority map can be consulted at http://vismigratie.instnat.be (in Dutch).

Habitat fragmentation is caused especially by an increased use of the open space: the surfaces occupied for residential building (+25%), industry (+29%) and trade (+19%) all increased during the last decade. On the other hand, the use of open space for agriculture decreased with 5% (VAN STEERTEGEM 2002).

For many animals, road infrastructure is an important barrier. The impact of increased traffic, as seen in Flanders, needs to be carefully interpreted. Increasing traffic seems to have only a limited effect on major roads as these roads are always a barrier, even with low traffic intensity. On smaller roads however, traffic intensity is a much more important factor.

5. ACTIONS TO DEVELOP AND SUSTAIN BIODIVERSITY

5.1. Towards more space for nature

The Birds Directive (1979) and the Habitats Directive (1992) are European directives for respectively the protection of birds, and the conservation of natural habitats and wild fauna and flora. Special Protection Areas under the Birds Directive have been designated in 1988. Special Areas of Conservation under the Habitats Directive have been identified and, after approval by the Flemish government, proposed to the European Commission for their incorporation in the list of 'Sites of Community Importance' that will constitute the European ecological network (Natura 2000). The European Commission announced in September 2000 that they would take Belgium to the European Court of Justice because the translation of the Habitats Directive into national legislation was not sufficient. The Flemish government decided to accelerate this translation and, in 2001, 42,000 ha were added to the list of proposed sites (while 10,000 ha were dropped due to refinements). At the moment, about 102,000 ha have been designated. Like practically all European members, Flanders experiences some problems with the protection of its designated areas: in 2001, 11 cases on specific violations of the Birds and Habitats Directives were on trial in Flanders. A better structured organisation to handle these cases and transparent procedures to follow up violations are needed. An important issue is the need for the rapid realisation of

agreed compensation measures when designated areas are affected for ''compulsory reasons of general and critical public interest''.

The Special Protection Areas and the proposed Sites of Community Interest will be included in the 'Flemish Ecological Network' (VEN), or in nature zones with mixed function. The VEN is a coherent and ecologically functional cluster of natural areas wherein management practices are oriented towards the conservation and development of high-standard nature. Nature conservation precedes other activities. The Flemish government endeavours to designate 125,000 ha.

The VEN is supported by an 'Integral Interweaving and Supportive Network' (IVON) that is composed of so-called interweaving areas (150,000 ha) and of interconnecting areas between the natural areas of VEN and IVON. Although the aim of management is to preserve high-standard nature, other human activities such as agriculture, forestry, military activities or the extraction of drinking water are allowed in IVON. The connective areas are also important to allow the migration of plants and animals between populations and natural areas. The Flemish government plans to designate 150,000 ha as nature zones with mixed function.

At the moment, the preparation of the designation process has started. It is a complicated process that requires frequent tuning with other policy fields and local authorities. Agricultural structure, regional planning, regulation of environmental quality, integral water management and the like are all involved. During the process, much attention is devoted to an easy communication and early policy agreements. This procedure should result in an improvement of the integrated management at the official level. It is recommended that voluntary organisations that are directly involved (forest, agricultural and nature organisations) can play a formal role. In this way, they are also more closely involved in the subsequent distribution of information and the enforcement of the plans. Based on the present state of the designation procedure, it is doubtful whether it will be realised towards 2003. More people are needed, both in the administration and the scientific staff.

Regional planning forms an important base to create the necessary space for nature and, as a consequence, the designation of VEN and IVON. The administration of regional planning is responsible for the enforcement of the Decree on Regional Planning (1997) and the Spatial Structure Plan for Flanders (1997). Due to the extensiveness of the assignments, priorities need to be formulated. At the moment, the implementation plans barely take nature into account. The total area of natural areas and nature reserves listed in the country planning schemes has increased by 6,411 ha during the period 1994-2001. In order to achieve the goal of an extra 38,000 ha of green areas towards 2007, as fixed in the Spatial Structure Plan for Flanders, an accelerated implementation is needed. The major obstacles that remain concern the old, not yet expired land parcelling and the illegal weekend cottages in green areas. Good complementarity is needed between the three decision-making levels (regions, provinces and local authorities), in order to attain a coherent system of protection. It is therefore important to keep the provinces and local authorities formally informed on the progress made in the designation of the regional VEN and IVON. The provinces can actively contribute through the associated Provincial Spatial Structure Plans. For the time being, it is necessary that both the Provincial and the Municipal Spatial Structure Plans state

that they will give priority to VEN and IVON over their own plans, when more information becomes available.

5.2. Higher quality for nature

Nature and forest reserves fulfil an important role in the realisation of high quality nature. Early 2001, Flanders comprised 743 nature and forest reserves with a total surface of 19,700 ha for nature reserves and 1,600 ha for forest reserves (these include both officially recognised reserves and reserves that applied for ratification). It is clear that the total surface of nature reserves increases, but it is insufficient to reach the goal of 50,000 ha by 2007. Many reserves are located on rented land and their status is insecure in the long run, even though financial support by the Flemish government has increased. Moreover, the nature reserves are not evenly distributed over the different ecoregions. There are relatively more nature reserves in the sandy regions in the eastern part of Flanders. Because forests are under-represented in Flanders, the Flemish government aims to extend the total surface with 10,000 ha towards 2007. However, the present progress is too slow to realise this goal.

Early 2001, 268 nature and forest reserves (11,243 ha) were officially recognised in Flanders by the government. This status can only be granted to natural areas belonging to associations or the government. The recognition of a reserve entails a contract with specified results, which must be achieved, and allows subsidies for management, monitoring and public access. Management practices should conserve or develop predefined specific nature target types. In this regard, a first manual for monitoring focal species and groundwater levels in recognised reserves has been compiled, while a second one is in preparation (monitoring of management). A monitoring programme for forest reserves was started in 2000. There are no monitoring requirements for the other types of reserves.

Specific 'nature development projects' are usually designed for large interconnected areas for which 90% of the surface area is situated within the Flemish Ecological Network or in green, park, buffer or forest areas of the country-planning scheme. Nature development projects comprise a set of measures and activities focussed on the optimal organisation of space for conservation, restoration or development of nature. In January 2001, 13 nature development projects were finished on paper (total surface of 4,190 ha). End 2002, the implementation of one project was finalised. Several others are in progress for the moment.

Area-specific concepts are developed for large areas with a high amount of interconnected nature. Four of those are presented here.

During the last century, the coast has been transformed into an urban network, where the only currently remaining natural functions are filled in by the few residual dune areas. Within the natural areas, nature management and development have allowed some progress, but outside these areas (e.g. inner dunes), nature development is much more laborious.

The project 'Living Border-Maas' uses an innovative and transboundary approach (Flanders-the Netherlands) to nature development, gravel extraction, river management and flood protection. This project should create a large continuous natural area and should

improve the status of a number of species such as the corn crake (*Crex crex*), night heron (*Nycticorax nycticorax*), kingfisher (*Alcedo atthis*), barbel (*Barbus barbus*) and greater yellow rattle (*Rhinanthus alectorolophus*). The implementation of the project, however, is very laborious because of obscure objectives and ineffective co-operation and communication among the different policy levels involved.

The Scheldt estuary is a tidal system with a gradient from fresh to salt water, and contains numerous natural areas of international importance (Ramsar, Birds Directive, Habitats Directive). Fish biodiversity increased thanks to improved water quality. Several areas with a nature designation are situated along the banks of the Sea-Scheldt. In the river forelands, this is less the case, but a positive shift from a sectoral to an integral approach in the planning of management is noticeable. The realisation in the field, however, is very laborious.

Integrated water management aims at a better integration of the different functions of river valleys. At the moment, two instruments are operational: 1) the ecosystem visions, usually for un-navigable watercourses, and 2) the ecological area visions for navigable watercourses. Possibilities for nature development are formulated, taking into account the strict basic conditions in the valley. A number of ecosystem visions are finalised on paper (Demer, Zwarte beek, Yser and Durme), but there is no realisation in the field, except for the Dijle valley where some first initiatives have been taken.

5.3. Nature everywhere

Agriculture, as the most important manager of open spaces, shoulders a large part of the responsibility for the state of nature. Rural development schemes under the European Common Agricultural Policy offer farmers the possibility to endorse nature management agreements. In this way, they commit themselves to enforce the so-called 'agri-environmental measures' on their land. These include for example the postponing of mowing dates, the development of grasslands of high biological value and the preservation and creation of hedgerows or ponds. The system has just started but there is no monitoring program to follow up the effects. Due to the standstill principle (no decline of nature) and the 'obligation to be careful' (possible damage to nature has to be prevented, restricted or recovered), the attention for nature grows in rural renovation and land re-parcelling schemes. Since 2000, ecological requirements are integrated in the land re-parcelling process and the resulting effects are monitored.

The 'Environmental licence' postulates that an official permission is required for certain activities such as filling ponds or ploughing historically permanent grasslands. However, this obligation is not applicable to all areas, leading to a lack of legal protection in some particular situations. For example, historically permanent grasslands in agricultural areas of high landscape value are not protected and can still be transformed into agricultural fields. Private owners need to apply for a licence to the local authorities (municipalities), while governmental services must apply to the provinces. The 'Nature administration' provides advice. The number of applications has increased gradually over time. During 1999-2000, about 75% of the 3,000 applications concerned the felling of trees and hedgerows. Many fail to apply for authorisation for activities such as ploughing up historically permanent

grasslands. For practically all permissions, special stipulations are imposed, such as re-plantation. Only a small number of applications are rejected. Often, there is no legal action when regulation is violated. Under other circumstances (e.g. felling of trees), the regulations are not very relevant for nature conservation. To make regulations more effective and give more time to the priority aims of nature policy, one can search for alternative instruments. One of these priorities is to increase the awareness of the community and public authorities on the nature development permits.

There are few data available on the integration of nature motives in other systems of permits (town planning, environment, etc.). Legislation there is merely symbolic and too vague for concrete application. More precise knowledge is needed on how to better integrate nature conservation objectives in granting permissions. The compilation of directives and the propagation of knowledge concerning nature-friendly actions could (hopefully) motivate local administrators.

The application of compensations for habitat loss needs a reference context, in order to provide guidance to the administrations that give advice on, or issue permits. In order to be able to follow up on the countervailing measures, it is necessary to make an inventory of the measures that have been agreed upon and carried into effect. It is the only way to check if the standstill principle has been respected.

Recent regulations on town planning and land parcelling show an increased interest in nature. The term 'spatially vulnerable areas' was introduced in certain implementation regulations on regional planning. The future VEN, as it will be designated, is taken into consideration. According to the new regulations, the administration should give advice on the new applications for land parcelling or town planning, for all sites which are in the framework of spatially vulnerable areas, such as green areas, parks, forests or agricultural land with ecological importance. The administrations involved, however, are insufficiently trained in the application of the regulations on changes in vegetations and small landscape elements.

5.4. Man and nature

Proper nature policy needs broad public support. The concept 'public support' is rather new in the Flemish nature and environmental policy. It means that the public does not only accept policy measures, but also that the public is actively committed to the conservation of nature. Public support not only concerns the general public, but also civil servants and politicians. Research on this topic in Flanders has mainly focused on the general public. It has shown that 94.5% of the Flemish population regards nature as important. For more precise questions, social factors such as area of residence, social class (education, profession, income) and age become determining for the answers. The amount of public support is not static. It can be increased by social (education, communication), legal (legislation, rules and regulations) and economic (taxes and grants) instruments. The Nature Report 2001 stresses the importance of a good communication to create a solid public support for nature.

Ecological insight, appreciation of nature and nature-friendly behaviour can be stimulated by education. Education is a term with many angles of incidence. In our fast evolving

society, it is no longer restricted to children and schools. Teaching about nature is done by public bodies and volunteer associations in different manners at different levels in society. Many volunteers are involved in nature and environmental education. The primary and secondary education have taken their own responsibility by formulating minimum requirements on what pupils need to know. Higher education also takes initiatives. The most important bottleneck is the division of labour and complementarity. Target groups with high impact on nature get too little attention. They need a specialised education.

5.5. More data for nature reporting

A solid, well co-ordinated monitoring system is needed to compile a biannual report on the state of nature. Far more species need to be monitored. Networks for environmental monitoring need area-specific refinements. A (better) formulation of nature target types should allow the comparison of results recorded by the monitoring system with predefined objectives. A systematic monitoring of policy (both for measures taken, as well as for the results for nature) is needed. Finally, public support and education for nature can only be evaluated based on relevant indicators. Monitoring has to be tuned to specific needs of the system (species, habitats, measures, etc.) but needs integration where possible.

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