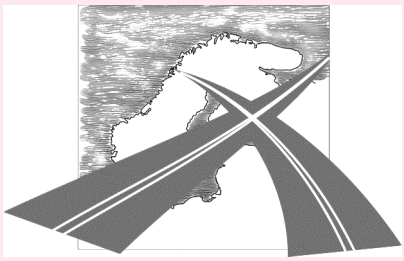
SOCIETY AND LANDSCAPE 7

SPACE INTRUSION AND HABITAT DESTRUCTION

A view of a valley crossing the Carpathian mountains in western Ukraine. The originally wooded area has been broken up by farms, fields, and patches where timber has been cut by the forest industry; a road, railroad, and power grid are hidden below. All are typical for how society intrudes into the landscape. One might easily imagine what this landscape once looked like. Some of its original character is still there. (Photo: Lars Rydén.)

"Intervention into habitats by human activity is the greatest threat to the richness of life on Earth. The most visible form is habitat destruction, direct habitat removal. A proportion of the habitat available to a particular species may simply be destroyed for urban and industrial development, or for production of food and other natural resources such as timber. Forest clearance has been, and is still, the most pervasive of habitat destruction, with annual deforestration rates often at the level of 1% yearly or more in tropical rainforest areas." (Begon et al., 1996.)



When travelling where we live, most of us see cities and industries, roads and bridges. Outside the cities we see fields, forests, and water. This landscape, or almost all of it, is in one way or the other man-made and artificial. In our minds we might recreate a picture of the same area, 50, 100, or even 1,000 or 2,000 years ago. The changes that have to be reconstructed for such a picture mean removing the most far-reaching impact man and society have had on the environment.

We may ask if this impact is constructive or destructive. Certainly the answer to such a question has varied much over time and depends on what aspect of the landscape change is discussed, and the values of the individual. We need to establish criteria to evaluate answers to this question.

Biodiversity is one such criterion. In general, space intrusion and biotope destruction is the main reason for reduction of biodiversity. Wildlife has suffered because of landscape changes. But it is not one-dimensional. Some types of cultivated landscapes are richer in biodiversity than native forest. Some urban areas provide good and varying biotopes for plants and many animals with easy access to food and shelter.

The answer has also varied over time. During a period, the romantic, "wild" landscape, with dramatic water falls and mountains, was the ideal. Later the "economic" landscape, even one with smoke rising from chimneys, became a sign of human success and a good life. Today it is clear that the comparatively untouched, "virgin" landscape has a large value. Mountains and coasts, bird reserves and wetlands, and large forests are increasingly protected not only because they are the last traces of a virgin landscape but also because they constitute a resource for genetics, recreation, and tourism.

In this chapter we will describe the major aspects of landscape changes in the Baltic Sea basin over a long period, from the non-populated landscape which man inhabited after deglaciation until today. With a very small population in the region, the impact was initially small but it grew as the number of people that required food and shelter increased. The largest impacts are the result of development during the last 150 years when industrialisation and urbanisation changed society and our lives completely. Still, it was not until 1950-70 that these changes had full impact. In the last wave of urbanisation cities expanded dramatically as did transport and traffic. Even agriculture is today largely industrialised.

Deforestation, drainage, and building infrastructure have been singled out as key categories of spatial intrusion of man over the centuries. They represent impact on the landscape, the waterscape, and the built environment. Their environmental consequences may be described as biotope depletion, erosion, and pollution. Though many values have been lost in the world we have created, it is still often beautiful, but not sustainable.

Authors of this chapter

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Society and landscape

Space intrusion and habitat destruction

The history of landscape change

Shrinking forests and growing fields

Where it started

Some 7,000 years ago Europe was a continent covered by deciduous forests. The climate was several degrees warmer than now. In the Baltic Sea region grapes grew as far north as the Gulf of Finland. The dominant tree species in these large forests were oak, elm, ash, and lime (also called linden) and basswood. Pine trees took over on poor soils and on higher altitudes. The forests were quite open as the common tree species do not like shade.

Water as always played an important role in the landscape. Rivers and streams meandered through forests. Open areas were found in the flood plains along the large rivers. Lakes were common, and large areas were constantly wet as bogs or mires. Every spring when snow was melting, rivers rose over the banks and flooded the river plains. Autumn rains brought along another flood. In the high mountains in Scandinavia, numerous waterfalls fed by melting snow roared down the rocks.

Wildlife was rich. Animals were plentiful in the forest and the natural watercourses had a rich flora and fauna. Salmon and trout swam upstream to spawn in the rivers. Beavers and otters lived in forest streams and lakes. In the wetlands a remarkable number of birds gathered, both those remaining there for the nesting season and those using them as resting places during their long journeys to the Arctic and back.

The first few scattered human settlements were typically situated on the sea coast or along the rivers. There the first dwellers had a plenitude of food. Fishing and seal hunting was important. Gradually over the centuries, human settlements became more numerous and denser.

The landscape we live in today is quite different. It has been reshaped by water, wind, climatic changes, and the actions of some 300 generations of humans. The extensive wetlands have been drained and the forests cleared in order to create space for agricultural fields and the built environment. The large

Figure 7.1. River in western Ukraine. There is a small farm on the left, and the hillside is largely naked due to logging. The field in the front is used for cattle grazing. (Photo: Lars Rydén.)

Review
Box 7.1

What is a landscape?

Landscape as the interface between society and nature
Landscape can be understood as man's tangible surroundings, where culture and nature meet. No clear boundaries exist in the landscape between what is cultural and what is natural. There is a constant interplay between conditions of nature and factors of society in shaping the landscape.

Of course, nothing prevents us from referring to landscapes as either natural or cultural, but these are only ways in which to articulate the specific interest of a certain landscape study. In reality, there are few areas left untouched by human societies. Therefore, every study of the processes in the landscape must incorporate an understanding of how society organises itself, economically, socially and politically, to extract from nature some of the basic requirements of its existence.

The dynamic landscape
The appearance of the landscape has changed during the course of time. It has changed in response to natural factors, such as coastal regression, as well as cultural changes and technical innovations. Many of these changes leave traces as imprints in the landscape. Thus, the landscape itself – its very appearance – can be used as a source of information on environmental changes, both those of the past and those that are still to come. Adding the time dimension, we can no longer approach the landscape as eternal or static, it is dynamic from the invisible chemical changes of the soil to the much more apparent process of urbanisation.

Landscape as the initial step in an environmental study
Clearly, there are innumerable factors influencing the appearance of the landscape, and they can hardly be tackled in one single study. Yet, landscapes vary, and the appearance of landscapes is seldom created by chance. The variations, or their absence, are not only aesthetically attractive, but also intellectually stimulating.

Geographers and other academics, as well as the layman and the artist, have always asked questions based on the landscape. *Why* does an area appear as it does? *Why* does it differ from other areas, in such a way that we find it unique? *What* advantages or drawbacks are involved in a specific land use? Who governs the decisions of the same? *How* can we improve our land use, both in terms of efficiency and sustainability? As such, observing the landscape is often the initial step in a spatial study.

In this chapter, forestry, water management, agricultural activities, urbanisation and landscape protection are discussed in a long-term time perspective. These are typical activities of society that are to a large extent based on the natural setting, its resources and topographical structure.

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flooding rivers have been pressed into narrow embankments and dikes; the meanders have been cut off; and the waterfalls have been directed into pipes to run turbines and create electricity.

There is no doubt that the reduction of the forests and the wetland areas are among the most far reaching impacts of the environment that the human society has ever undertaken. Some of these changes have been very drastic and destructive, in many ways more devastating than the much more recent chemical pollution. The consequences are different between different landscapes, but some features are more or less the same all over the world irrespective of where when they occur, in historic times and in the present, as we will discuss in this chapter.

Early human agriculture in the Baltic Sea region

The warm period after the last ice age began some 8,000 to 10,000 years ago. By then the first humans had already settled in the Baltic Sea region. Among the first were the nomadic reindeer hunters, the ancestors of the Saami. Further south people first settled on coasts and nearby water bodies. But some headed further inland. They were hunters and gatherers of plants, fruit, and roots. The inland people influenced their landscape significantly. They burnt down the forest to create more space for animals and for their own hunting. After a fire the soil became rich and grass grew well. In addition they needed bushes with hazelnuts and berries and these were easier to find after the fire. Each hunting group of humans roamed over a large area. It has been calculated that some 1,000 ha was needed to support one person. The number of inhabitants in today's Sweden, for example, was in the order of some 10,000 people, i.e. one-thousandth of today's population.

The Neolithic farmer entered the scene about 3,500 BC. He, or perhaps rather she, relied more on animal husbandry than on grain production. Again fire was used to develop more grassland for grazing animals. Burning was

Figure 7.2. Heathland in Halland in south-west Sweden. The soil in the originally forested area has been robbed of its nutrients by a long period of burn beating agriculture, up to early 20th century. Heathland is covered either only with sprigs, such as *Calluna vulgaris*, or pine forest. (Photo: Harriet Axelsson.)

repeated perhaps as often as at 30 year of intervals. The hunting-gathering lifestyle continued in parallel when farming took over, and, in fact, did not end until the 19th century.

Slash-and-burn agriculture was mostly used in the southern parts of the Baltic Sea region, although a special form of slash-and burn-agriculture, for spruce areas, was introduced from the east into Finland during medieval times.

Some 4,000 years ago, the temperature started to decrease and a new climatic era commenced for the Baltic Sea region. Spruce immigrated from the north and pine forests took over on areas where previously oak, elm, and lime had dominated. From the south the beech tree was brought in by humans and came increasingly to dominate the deciduous forests. Beech tolerates shadow well, as does spruce. The forests became denser and consequently darker.

Cattle now had to be kept indoors during the winter and it became necessary to gather grass for hay. The wetland meadows were the major resource. These meadows were fertilised through the annual rhythm of flooding by nutrient-rich water each spring, creating a rich grass growth later in summer. At the same time the cattle on the farms constituted a new nutrient resource. The manure was used to fertilise fields and the practice of growing crops on heavily manured fields used every year was established.

Around 1,000 AD, a landscape had developed with organised villages which had fenced fields and meadows in the vicinity of the farm buildings and common grazing areas outside the fenced area. Such outlying common land could be open or wooded. While in the south the farming of permanent fields was well established, most of the northern parts of the region were still dominated by gatherers and hunters. In some areas the soils allowed meadows with deciduous trees. Here cattle was kept for grazing, and leaves were harvested for winter needs. A rich flora and fauna developed in these meadows.

A flow of nutrients from meadows to fields became the base of this agriculture. It was a stable system built on self-sufficiency. Natural resources were utilized by farming society for many purposes, e.g., building, food, energy, clothes, and medicine.

From the 1700s to the 1950s – creating the reference landscape

The exploitation of the forests through grazing and fire continued, and eventually the light soils wore down and became increasingly poor and changed slowly into heathland. Even today these soils are unfit for agriculture and exist as replanted open pine forests. As long as there was grass coverage, erosion and loss of soil was minimal. However in Denmark and southern Skåne, the southernmost part of present Sweden, large areas finally turned into sand dunes. Descriptions of terrible sand storms in these areas during the 1600s and 1700s

BC = Before Christ
AD = Anno Domine, after Christ
BP = Before Present

Phases in development of agriculture and landscape structure

First phase
10,000 years BP
Hunting-gathering, first settlers after deglaciation

Second phase, early part
5,000 years BP
Farming society based on cattle, goats outside all year, small fields
Warm period

Second phase, later part
About 800 AD
Grass from wetlands and meadows for the animals indoors in winter
Climate becomes colder
Fields for crop production fertilized with manure, village system

Third phase
From about 1750
Fields increased, meadows turned into fields for crop production
Population expansion
Drainage of wetlands to increase agricultural area, crop rotation system

Fourth phase
From about 1950
Industrialized agriculture; large scale landscape, fossil fuels and chemical fertilizers
Total area decreases

Fifth phase?
From about 1990
Tourism
Landscape management

"Forest" is derived from the Latin *foris*, meaning "out of doors."

According to the FAO Forest Resource Assessment, forest is an area where crowns of trees create a continuing canopy that covers at least 10% of the area. The CORINE Land cover Forest Classes mapping system requires at least 30% cover for an area to be defined as forest.

Table 7.1. Agricultural areas in Sweden. The values for 1750 and 1995 are estimated. (Bodin & Ebbersten, 1997).

Year	Field area (million ha)	Part of total land area (%)
1750	0.6	1.5
1920	3.8	9.0
1980	3.0	7.1
1995	1.4	3.3

were numerous. In Denmark, oak forests covered about 25% of the country in the early 1600s. Around 200 years later, about 1800, the forests had been reduced drastically to less than 3%. Sand and soil erosion by wind was dramatic and the dust bowls were problematic. Linnaeus described terrible sand storms in Skåne during his journey to the area in 1749.

In the 18th and 19th century the human survival rate increased, and population growth became important in the entire northern Europe. Important causes were fewer wars, better health, and new crops such as potatoes and turnips. Primary were, however, major societal changes where the demand for labour increased both in agriculture and in the budding industry. An increased demand for food caused farmers to cultivate the existing land more intensely and to successively claim new arable land from meadows. Major reorganisation took place in agriculture through most of the countries of the Baltic Sea region when the traditional open fields consisting of numerous parcels were redivided into larger enclosed fields, where the common lands were subdivided among the farms of the village and where farm buildings of numerous farms were moved out from the villages into their new allocated lands. Forest fire intervals decreased from some 30 years to about 5-10 years. New areas in the Baltic Sea region were colonised as people moved north. Others chose to emigrate to North America in order to create a better future than what was possible in an increasingly divided society. From the middle of the 19th century, a total of about 30 million people from Europe as a whole left to form their future on the new continent.

The farmers who stayed on could to some extent increase their land by draining marshes and lakes. The soils in these drained wetlands had accumulated a rich humus from many years and this formed a new capital for agriculture. Other soils consisted of clay, that is deposited bottom sediment in the big lakes

Case Box 7.2 — Agricultural production

The introduction of agriculture into society increased the capacity to feed a population by some 50 times. As a consequence, the need to move to new places to feed a group diminished. Man became stationary. In addition, not all members of society were needed to take part in the production of food. These general tendencies, which were introduced into the Baltic Sea region about 6,000 years ago, are in fact still continuing to this day.

The carrying capacity of the region has expanded enormously through the development of agriculture. Estimations of the carrying capacity from a hunting society up to our present industrialized agriculture are given below. The major steps in development that need to be mentioned are:

1) bringing land into cultivation by burn-beating and reclamation;
2) use of draught animals and tilling techniques;
3) development of crop rotation and plant nutrient management, introduction of breeding and development of new varieties of crops and new breeds of animals;
4) use of chemical fertilizers and pesticides; and
5) use of fossil fuels, mechanization and structure rationalization.

The figures below (Bodin & Ebbersten, 1997) are approximate and vary with the character of the landscape. The estimates refer to the northern part of the region (lower bound) and the most fertile plains (upper bound). Today, on the very best soils, 0.1 ha is enough to feed one person.

Society/ Production system	Carrying capacity inhabitants/km² (100 ha)	Techniques	Time for introduction
Hunter	0.001-0.1	spear, traps, bow	
Gatherer	0.01-0.6	simple digging tools	7000 BC
Nomadic	0.9-1.6	cattle in south and reindeer in north	5000 BC
Burn-beating agriculture	2-40	fire	3000 BC
Shifting cultivation	2-80	plough, oxen, horse	800 AD
Crop rotation	3-100	crop sequence effects	1800 AD
Systematic breeding	4-150	selection, line breeding, genetics	1900 AD
Mechanized agriculture	5-300	tractor, fossil fuel, mineral fertilizer	1950 AD
Industrialized agriculture	10-600	specialization, pesticides	1960 AD

Outlook
Box 7.3

Deforestation is a global environmental problem

Even Greece and southern Europe are known to have been covered by forests before antiquity. In fact, antiquity provides a very good example of how the landscape was already then drastically changed by human intervention. Forests were cut to provide timber and for finding new areas for agriculture. Some of the open spots were grazed first by sheep then by goats, which do not leave much behind. The barren soil was badly eroded by wind and water and the land soon became infertile.

The same chain of events are now going on in many places in the world. In many areas in Eastern Africa, deforestation, overgrazing, and erosion have left few trees or fertile soil behind. Women often have to walk very far to find scarce firewood.

In many tropical forests trees are cut for export or to open new areas for cattle grazing. The thin layer of humus is lost very quickly through erosion and the land becomes infertile. In the 1980s this happened in large areas of South America. Today Southeast Asia is still suffering badly from deforestation and erosion of previously tropical forests. Consequences include a decreased capacity of the land to keep water and consequently dramatic changes in water flow in some big rivers, flooding, or drought. The recently aggravated problems of flooding of the Ganges in Bangladesh is believed, among other factors, to be due to deforestation in the Himalayas.

The cutting of tropical forests of course dramatically changes the ecosystems in that area. The old species dependent on the trees disappear and a new fauna and flora enter the scene that is typically made up of fewer species. The old inhabitants of the area are pushed back into what is left of the forest. Very old forests, tropical rain forests in particular, are characterised by a large share of endogenous species, life forms present only in a very limited area in a forest. The cutting of such forests results in large and irreversible losses of biodiversity and genetic variety.

from thousands of years back. Such heavy clay soils required heavy iron ploughs, which were used over large areas.

Many meadows, established in the old farming practice, were cleared from stones to become fields that could be ploughed. A source of nutrients for the animals disappeared with this change and instead the strategy became to grow grass, or better clover, on the fields between the years of crop production. An increasingly complex agricultural system built on crop rotation was introduced from the 17th century onwards. Clover or alpha-alpha could fix atmospheric nitrogen and was thus self-fertilising the fields. In some areas, forests disappeared almost entirely. The changes in agriculture from the 16th century were equally radical as those which had developed an organised village society during the early iron age. In southern Sweden large areas were turned into open land. At its maximum around 1900, some 6 million ha was used for agriculture. At the same time, 65% of the territory of Estonia was in agricultural use and 21% was forested. In Saaremaa, the biggest of the Estonian islands, the proportion of agricultural land reached 88%.

Until the 1940s the rural landscape blossomed. Much of the land was in some kind of agricultural use. Cattle and sheep kept grasslands tidy. Where possible, forests were also used for grazing, thus keeping back brushwood. Views

Figure 7.3. The reference landscape. The reference landscape is not a fixed concept but varies with time and culture. For many it refers to a landscape of much variation, where smaller fields are interrupted by patches of bushes and woods, and water is a natural component as rivers and brooks. This view is from the Kashubian area south of Gdansk in Poland. (Photo: Lars Rydén.)

Figure 7.4. Cultivated corniferous forest. (Photo: Courtesy of Stora Enso.)

were open, and some streams still unregulated. This is the reference landscape that we often use for evaluating the present.

Developing forestry in Scandinavia

One might imagine that the forest up to our times was a free non-limited resource. In reality, however, it has been alarmingly scarce. For centuries, large areas of Sweden, and Finland, suffered from a shortage of wood to heat homes and cook food. In some places they had to use peat or even dried manure for the stove in the household. One reason was the farmer's practice to burn the forest. Another was the increasing need for charcoal from an expanding iron industry. Iron production required massive amounts of wood and charcoal. Sweden had 30% of the world iron production during the 1700s. A major reason for this dominance was the extensive availability of wood. The role of Swedish iron production decreased when charcoal was slowly replaced by black coal and when Russia's enormous forest resources were brought into use for iron production. In 1820, the Swedish part of world iron production had decreased to 8.3% and in 1870 it was 2.6%. By then black coal was used in many places, not least in Central Europe.

The use of forests was not limited only to firewood and charcoal. The Baltic Sea region was the world's leading tar producer from medieval times and the 19th century saw a large increase in production of timber and planks for export and for the expanding industry. The large increase in forest exploitation was made possible through bringing the large forests in northern Sweden and Finland into use. The timber was floated from these remote regions on the large rivers to the coasts where sawmills and ports were located.

In this way, wood production in Sweden doubled from some 20 million cubic meters in 1850 to 40 million cubic meters in 1900 (see Table 7.2). During

Table 7.2. Wood production in Sweden from 1850.

Year	Wood production (million cubic meters)
1850	20
1900	40
1950	40
1975	65

the same period, the practice of slash and burn agriculture also ended. This was not a result of legal regulation. The reason was that increasing timber prices made timber production economically much more interesting than poor farming. The forest however continued to be a resource for the poorest people, who used it for goats and sheep up to the mid 1900s.

As early as 1297, the first forestry regulation was issued by the Danish king Erik Menved to protect the forests of the Estonian island Naissaar/Nargö – of course for navigational use. In Sweden the government had made efforts to regulate the use and management of forests since the 17th century. During the 19th century there were large debates in the Swedish parliament between different interest groups on reforms for rational forest production. None of the regulations introduced, however, were comprehensive. It was not until 1923 that a new legal regulation of forest use passed the parliament. By then, forests in Sweden were treated as production areas, just like arable fields in agriculture. As a consequence, biodiversity decreased and forests in different parts of the country became more homogeneous. Production wise this was successful. From 1950 to 1975 annual timber production in the country increased by 70% to 65 million cubic meters. There were similar reforms in Finland and Norway for rational and sustainable forest production.

Forestry in Poland

In Poland in the historic past, the forests covered almost the whole country. The original form of forest utilisation, uprooting and burning, was used to produce ash for soil fertilisation. From the 12th century, in connection with the development of

Table 7.3. Deforestation of the Poznan region from the 14th to the 20th century. (Broda, 1988)

Century	Area of forests and swamps (1,000 ha)	Timber stand (%)
12th	first efforts to utilize forests	
14th	511	59
16th	439	50
18th	340	39
20th	291	33

Case
Box 7.4

The forests of Poland

The forested area

The timber stand of Poland (mean value for the country) at the end of the 19th century was 36%; in 1920, it was 38%, and in 1945, it decreased to only 20.8%. In the years 1947-1970, 1.2 million ha were afforested and the timber stand increased to 27%. At present the area of forests in Poland is 8.8 million ha or 28.1% of the total area of the country. The home program to increase the timber stand, accepted by the Polish Government in 1995, foresees an additional afforestation of 1.5 million ha of arable land, and this action is supposed to increase the timber stand of Poland by the mid-21st century to about 35%.

Ownership and productivity

The ownership structure of forests in Poland is twofold: in the eastern and southern parts of Poland, the forests are private, co-operative or belong to the church; in the western and northern parts of Poland, they are mainly State-owned. The achieved economic effects in State-owned forests are distinctly better. The average wealth of stands in Poland is actually 183 m^3/ha of afforested area, while the wealth of State-owned forests is 201 m^3/ha, and that of the private forests is only 118 m^3/ha.

The soils are quite different and consequently the timber stand varies between 12.3% in mid-Poland and 48.6% in southeast Poland.

The characteristic feature of Polish forests is the low biological resistance of forest ecosystems to pests and diseases. The health conditions of the Polish forests are influenced by the unfavourable water balance of the country, the systematic transformation of big areas into steppe, and pollution.

Species structure and biodiversity

The deforestation processes at the turn of the 19th century were accompanied by a decreased species composition and biological diversity of forests. Actually, the percentage participation and the tree species composition of the forest stands in Poland is

pine	75.5%
spruce	8.8%
fir	2.7%
hornbeam	2.2%
beech	3.3%
alder and birch	3.1%

The rest, 4.4%, is occupied by oak, willow, poplar, and a small number of limetrees, ash, maple, and elm.

Coniferous species (pine, spruce, and larch) make up 76% of the forested area. The development of coniferous forests is favoured by the climatic conditions of the country and the demand since the 19th century by the wood and paper industry for this type of wood. Still the Polish forest is rich in species. The percentage of deciduous species increased during the period 1920-1965 to 23%, favoured by the changes in the forest economy after World War II. This percentage is today still increasing, which is favourable for the biological diversity.

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(Sources: State Year Books and former Ministry of Environmental Protection, Natural Resources and Forestry in Poland; Broda, 1988.)

Year/Country	1960	1970	1980	1985	1990	1993
Belarus	n.a.	75,030	n.a.	71,920	73,834	73,720
Czechslovakia	44,000	44,550	45,780	45,860	46,180	46,180
Denmark	4,380	4,720	4,930	4,930	4,660	4,450
Estonia	14,616	17,220	19,019	n.a.	18,692	20,220
Finland	217,610	223,710	233,210	232,220	233,730	231,860
Germany	102,100	102,150	102,750	103,380	103,930	107,000
Eastern Germany	29,550	29,480	29,550	n.a.	29,830	-
Western Germany	72,550	72,670	73,200	n.a.	74,100	-
Latvia	23,986	25,617	27,286	27,700	28,032	28,390
Lithuania	16,774	18,339	19,550	19,580	19,677	20,000
Norway	66,000	78,900	83,300	83,300	95,650	83,300
Poland	77,500	85,460	86,840	87,280	87,540	87,850
Sweden	276,500	278,000	279,200	280,050	280,150	280,000

Table 7.4. Dynamics of wooded area between 1960 and 1993 (in km^2)**. (**Sources: European Comission, 1995; World Resources, 1996; Statistical Compendium, 1996; Kuusela, 1994.)

Explanatory note: 1993 for Czechslovakia correspond to the sum of the Czech republic and Slovakia; 1985 for Belarus and Russia correspond to 1983; data for 1995 correspondingly, to 1994 and 1993; n.a. = data not available; - = missing category.)

settlements in forest areas and the introduction of the tree-field system of land cultivation, the borders between forests and fields for agriculture became visible.

In the period of feudalism, forests were divided among the land owners, and the freedom of utilising forests owned by somebody else, was limited. Uprooting and burning was still the most destructive form of forest utilisation. In the 16th -17th century the Polish forest supplied the country not only with ash but also with great amounts of tar and charcoal. The well shaped Polish spruces and larches were used in the whole world as masts for sailing vessels. Burnt forest areas developed into agricultural fields, and in this way the timber stand of the country decreased. For instance, the forested area of the Poznan region was halved between the 14th and the beginning of the 20th century (see Table 7.3), while arable land increased.

The socio-economic development in the 1800s and 1900s with quickly growing population and developing agriculture was made possible by a good supply of wood and agricultural products. Polish forests underwent a far going transformation. The timber stand, which at the end of the 19th century was 36%, had in 1945 decreased to only 20.8%. The year 1945 was, however, the time of minimal forestation in Poland. In the period 1947-1970, 1.2 million ha were reforested, and at present the forest area in Poland is 8.8 million ha, corresponding to 28.1% of the country (see further Case Box 7.4).

Towards industrialised agriculture and reforestation

It is not only in the forest sector that rational production and efficiency have been the goals. From the 1950s until the present day the agricultural landscape has dramatically changed once more to allow for industrial agriculture. We may talk about a fourth phase of change. Simultaneously the production capacity increased dramatically. The factors that made this change possible were the availability of artificial fertilisers, the use of chemical pesticides, new varieties of crops, and the introduction of motorised equipment, especially tractors, changes that were gradually introduced over almost a 100 year's period but now put into heavy use.

With an increased productivity, the area necessary for feeding the population decreased. The large areas used to produce hay for horses were also abandoned when horses were replaced by tractors. The energy content in hay from pastures and meadows was replaced by fossil fuel. Typical for the industrial agricultural landscape is less variety and more chemicals.

The changed economic structure forced many thousands of small and less productive farms to close every year. In more fertile areas smaller farms were merged to become much larger farms and farms specialized in either crop production or animal production. As neighbouring fields were joined to allow efficient and machine-based farming, former field walls, ditches and hedgerows were removed as troublesome obstacles. The result was that the former typically

patchy field pattern was turned into a large, seemingly endless complex of fields.

During the process less favourable land and land unmanageable with machines was abandoned and replaced by planted forests, or sometimes just deserted. Meadows grazed for centuries were often very species-rich. As grazing ended, the former plant communities disappeared and the natural succession resulted in bushes and later in forests, typically dominated by spruce or alder.

Landscape – value and change

Despite different economic systems, landscape changes on both sides of the Baltic Sea were at least seemingly similar in the late 20th century. Socialist agriculture in the east created a landscape with vast and regular fields. The farms scattered in the landscape were to a large degree replaced by villages with multi-storey houses close together. Winding roads were straightened as were meandering streams. The land was "improved." In the west, agriculture in the capitalist economy produced fields that were very much the same but the scale of the farms was smaller and the farmsteads of the enclosure period were normally kept fairly intact.

To sum up, during the last 50 years, the agrarian landscape of the Baltic Sea region has changed from a small-scale farm landscape into an *industrialised* one. The former mosaic pattern of fields, pastures, woodland, hay meadows, and forests has been replaced by a simple subdivision of fields and forests, fulfilling the needs of modern farming and forestry.

Landscape change is important not only from an agricultural point of view. Every landscape has economic, ecological, cultural, and aesthetic values. Economic values change, when production methods change. Usually, this harms ecological values. Culturally and aesthetically people tend to appraise the landscape of their past and every change in the landscape also influences these values. The task of sustainable land use is to optimize these values in the landscape.

What will happen in the future? In the east with the fall of socialism the landscape is again changing rapidly. In Mecklenburg-Vorpommern and Brandenburg in former DDR in Germany, for example, some 20% of the agricultural land was abandoned in the 1990s (Breitfeld et al., 1992). In Estonia, the estimate of land abandoned in the early 1990s is around 300,000 ha, i.e. around one-third of all arable land. Abandoned areas are now to some extent reclaimed by decendants of the pre-Soviet owners, and former fields, now forests, are once more cleared. In Poland, on the contrary, the present policy asks for reforestation of 1,500,000 ha of arable land to increase the area covered by forests from 28% to 35% by the mid-2100s. Certainly these trends will be very much influenced by European Union policy when agriculture in the Baltic Sea region will be seen from a European perspective.

Figure 7.5. Wetlands have a typical flora. A typical peat bog plant is *Drosera rotundifolia*, a plant that catches small insects on its sticky leaves, which then quickly close. It is one of the very few carnivorous plants in the Baltic Sea region. (Photo: Pawel Migula.)

Draining the Baltic waterscape

A rich variety of wetlands

Wetland, broadly speaking, are all wet areas between land and the deeper water, with depth often given as 6 m. However, there are dozens of definitions of wetlands, and we will adopt a descriptive approach here (see Table 7.5). In Northern Europe, the glaciation created an ideal framework for wetlands. The Baltic Sea region, therefore, has an abundance of wetlands of a large variety.

Sweden, Finland, and Russian Karelia are very rich in lakes, in Sweden and Finland there are all together about 160,000 lakes (see Chapter 4). There are also many smaller and several large and impressive rivers in the north which at part of their course had dramatic waterfalls and rapids. In the south, with an older landscape, there are many fewer lakes, and rivers are slower but still allow for seasonal variation.

Marshes, mires, and swamps are very common especially in the north. Mires give rise to large areas of peatland. Peat is a traditional fuel in the region and is mined, nowadays industrially.

There are several large-scale changes in the waterscape caused by natural processes, land uplift after the last glaciation might be the most important (see Chapter 4). Another is the development of lakes. Plants in lakes produce biomass that accumulates. On shallow bottoms, plants form tufts which then expand the land while the open water surface slowly shrinks. A shallow lake develops according to a succession (Chapter 3) into a marsh, flad, and peatland. This takes several hundred years, depending on how large an amount of bioproduction the area can support. But eventually the lake will diminish and turn into meadow and finally into forest. It is clear that this natural process is very different from the man-made draining of lakes that has been carried out the last one or two hundred years to develop more agricultural land. This process takes a few years instead of hundreds of years.

Societies controlling water – living by the river deltas

Water has been the most heavily controlled natural resource in the world since the dawn of human civilisation. The first societies grew up on river banks, flood plains, and deltas. The seasonal fertilisation of these areas allowed a sustained crop production and development of agriculture. The Indus, the Mekong, the two-river country at the Euphrates and the Tigris, and the Nile are all examples of rivers that fed civilisations living with the rhythm of the river that nurtured them, some of them for 10,000 years.

From history, we know about the sustainable farming systems of the Nile valley in Egypt. But when irrigation systems were created in similar conditions

Table 7.5. Wetland types.

Wetland type	Description	Occurrence
Deltas	Rivers entering the sea dividing in many arms and covering large areas	Larger deltas mostly gone, remnants
Coastal wetlands	Large shallow areas at coasts	Now less common
Floodplains	Plains inundated by rivers seasonal flooding	Larger floodplains, mostly gone
Rivers	Flowing water	
Lakes	Lakes, more shallow than deep, often eutrophic	A large number still exist
Forested wetlands	Flooded forest land	Rare, exist e.g. in Latvia
Marshes	Open water surfaces	Very common especially in the north
Fens	Receive water from groundwater flow	
Bogs	Receive water from surface water, often acidic and oligotrophic	
Peatland	Moist nutrient-rich organic soil	Very common

Figure 7.6. Swamp and marshes. The Baltic Sea region was once very rich in wetlands. In the north and east much remains. This pool-rich bog called Männnikjärve in Endla in Estonia has been monitored by biologists for 50 years. (Photo: Elve Lode.)

in Mesopotamia, in the area of present day Iraq, it lead to increased salination and loss of fertile soil. The same happened a few decades ago in Central Asia, where too intensive use of the waters of the Syr-Darya and the Amu-Darya for watering cotton fields led to the death of the Aral Sea, salinated soils and lakes with poisoned waters, such as Lake Sarykamysh in Turkmenistan.

The first attempts to regulate water in Northern Europe began in the Middle Ages. Water power was first used to run water mills; later it also supplied power for manufactures and industries. Usually, a river was closed by a dam upstream of "the water wheel" to increase the water level and supply water for drier seasons and winter time. Rivers were also regulated to improve the quality of the neighbouring fields and to prevent floods. In many smaller and larger river catchments in the Baltic Sea region we can count more than 100 dams or barriers to control water flows, many of them hundreds of years old. Regulation of water sometimes became a matter of conflict, e.g. between farmers and industry or cities, as their requirement for water differed.

The most spectacular wetlands were the deltas which formed when the large rivers entered the Baltic Sea. Large deltas were once situated at the places where the Neva enters the Gulf of Finland, and where Daugava, called Dvina in Russia and Belarus, enters the Gulf of Riga, and where the Wisła enters the Gulf of Gdansk. But the large rivers were also important waterways for transportation, trade and travel and the deltas, being the gates to the inland, became politically important to control. Thus, in all these three deltas large cities have developed. The city of Gdansk grew up 1,000 years ago, Riga from 1201 and St. Petersburg in the Neva delta only from 1703, although there was a Swedish fortress there and a city, Nyen, since the Middle ages, before Tsar Peter started to build St. Petersburg.

Today, we see only traces of the wetlands and deltas that once were there. Small areas close to the cities remind us of the spectacular bird life that must have once existed, and protected areas for birds have recently been formed at St. Petersburg and Riga. At the outlet of the Nemunas in Lithuania the lagoons, shallow coastal lakes, are still there as well as the special land of the Curonian spit. But an untouched river delta is something else. In Europe, they are found e.g. where the Danube enters the Black Sea in Romania, and where the Rhone flows into the Mediterranean in Provence in southern France, and where the Guadalquivir and the Guadiamar fall into the Atlantic at Doñana in Spain. These areas, protected as world heritage sites, exhibit a wealth of wildlife.

The functions of wetlands

Wetland has a multitude of functions, some are physical, others biological. Some of the more important functions are:

Bogs and mires, like huge sponges, accumulating water during the wet season and let it run during the dry season, thus working as water regulators. The decreased capacity of wetland areas to store water in many places around the world gives rise to larger and more dramatic floods than earlier.

Wetlands, in general, are very productive biotopes. The nutrient rich inland waters allow for a large bioproduction. Many fish species spawn in coastal areas. The production of mussels and various insects, etc., is attractive to birds and many wetlands are bird sanctuaries with a multitude of species. But there are also low-productive mires, for example some bogs

Wetlands also functions as filters in nature with the capacity to bind nutrients in biomass or by denitrifying nitrogen to atmospheric nitrogen. They also have the capacity to bind toxic organic substances as well as heavy metals to sediments, and thus clean the water.

The landscape value of wetlands should be pointed out as a special category. Wetlands are part of the waterscape with its special fauna and flora contributing to the richness we experience, compounded by such economic values as harvesting of berries, competitions, and recreation.

Outlook
Box 7.5

Wetland loss on a global scale

The global perspective

Wetland loss is typical for the world as a whole. It is estimated that as much as 50% of the wetlands of the world, on average, have been removed through human impact and intervention. Areas that have been changed dramatically the last decades include coastal wetlands in Southeast Asia and estuaries all over the ocean coasts. The coastal wetlands with large mangrove forests have been "developed" to allow for shrimp farming or different types of fish farming. The river plains and deltas of the world have lost the normal seasonal flooding due to regulation of big rivers through hundreds of dam projects to develop hydropower for electricity for industrialisation. In Africa, very large scale impacts include the construction of the Aswan dam which changed the flow pattern of the Nile, the largest river of the world, and Lake Kariba changing the Zambesi river. In Asia, several gigantic dam projects are ongoing, e.g. in Malaysia and also in China where the Yangze river is now looked upon as a potential source of hydropower through building one of the largest dams in the world.

Wetland as a resource

It is clear that the wetlands are regarded as a resource that may be put to many uses and man often choses differently from nature. In many cases, the changes made have been short-sighted or careless. Fish farming without consideration of protecting waters from eutrophication and other environmental impacts may ruin the productive capacity of the coast and not allow longterm aquaculture. In South East Asia, farmed shrimps is typically a cash crop but inflow of capital is accompanied by longterm destruction of the resources base. Some 60% of the mangrove forests of Thailand have now been removed to allow for fish farming.

The coastal areas constitute a resource for feeding about one billion people, so the social consequences might be devastating. The crop that feeds more people than any other in the world, rice, is a wetland plant. Coastal areas in general are nutrient-rich biotopes functioning as spawning grounds for many fish species living in the open sea. The consequences of wetland destruction may thus be more far reaching than can now be foreseen.

Wetlands and biodiversity

The loss of wetlands is also a major concern for the protection of biodiversity. One of the first international conventions for the protection of wildlife, the Ramsar convention, concerns the protection of wetlands. The IUCN, International Union for the Conservation of Nature, is running a global program to encourage the creation of nature reserves to protect natural wetland biotopes before they disappear.

Modern exploitation – hydropower

More recently the large scale exploitation of streaming water for energy production has had more far-reaching effects on the landscape. The first hydro-electric power stations were built in the last years of the 19th century and became important in the north. Norway has the world's largest production of hydropower electricity per capita. In Sweden starting from about 1910, but also in Finland, hydropower has become very important.

A large hydropower station requires a large dam upstream to provide a better fall height and a more controlled continuous supply of water. The effects on the rivers were thus twofold: reduction of the seasonal variation, and the permanent formation of large dams, even enormous lakes, upstream and often a very considerable reduction of water volumes downstream. The seasonal flooding of floodplains disappeared, as did a whole biotope and its often rich biology. Species dependent on seasonal variation were affected as were migrating fish, such as salmon. In addition, large aesthetic values were lost. The romantic and comparatively unaffected scenery of water falls, streams and floodplains was lost and substituted by desert-like areas where the old river bed laid barren.

Protests against this development, especially during the 1970s, led in Sweden to a new water law, which was passed by parliament in 1983, and the four remaining large rivers in the north were protected against exploitation. These are Torne river (on the border river between Sweden and Finland), Kalix river, Pite river and Vindelälven. In the south, large comparatively unaffected geologically "older" rivers are Wisła in Poland, with only one large power station at Płotsk; the Daugava with two power stations, in Salaspils, Latvia; and a small one in Belarus.

There are technical means to reduce the large environmental impact of hydropower. One such is the "salmon staircase" which allows migrating fish to pass the power stations on their way to spawning areas. Another option is to

develop double streams, such as in the Danube at the border between Slovakia and Hungary, to allow for both ecological and technical requirements: one stream is the old river bed where even flooding is arranged annually, the other is a canal for boat traffic. In the older stations new concession rules might today include a requirement that a small "natural" stream should be maintained in the riverbed. Lately, technology to build small hydropower stations with much less impact on the rivers have become available.

Expanding agriculture – reducing wetlands

For a long time, abundance of water was considered an enemy. Bogs and mires was an obstacle for agriculture: grain grows better if the land is drier. Flooding rivers threatened the early villages and fields. Therefore, logically, rivers should be put into channels. The shorter the river and the quicker it lets water through, the better. In addition, a river within dikes stays in a more narrow bed, leaving more of the surrounding landscape for other uses.

In the 1700s, the dramatic increase of the population in Europe gave rise to claims for more land to feed people. Wetlands were seen as reserve lands that could be reclaimed for human needs. In the Baltic Sea region the role of drainage in obtaining new agricultural land was important.

In Denmark, most of the mires were drained. The loss of the province of Schleswig-Holstein to Germany in 1864 triggered an intensive land reclamation campaign. The lost province had some of the country's best farmland, and the loss was to be compensated. Special drainage schemes were commenced to drain the peat bogs of Western Jylland. Also, the sand heaths were turned into agricultural land by planting shelter belts and improving the soil conditions. Thus, between 1880 and 1950, most of the Danish peat lands and heath lands gave place to fields and pastures in one quiet, but determined national assault (John, 1984).

In Sweden, reclamation of land through water drainage projects was most intensive during the second half of the 19th century. As it coincided with the transformation of meadows to tilled lands and the expansion of agricultural areas into forests, this time marks a turning point in Swedish landscape history. Altogether, the area of agricultural land grew from 1.5 million ha in 1800 to 3.4 million ha in 1880 and reached its peak with 3.8 million ha in 1930. Land was reclaimed mainly on the peripheral areas of the villages. Intensive drainage lasted until the middle of the 20th century, when about one-sixth of the total agricultural land had once been a lake or a wetland (Anderberg, 1991).

In Russia, drainage was used mostly to accommodate urban runoff. In agriculture, only small local schemes could be found until the 19th century and in the western regions of Russia. Mostly, these schemes were used to grow rye. In the 19th century, swamps were turned into pastures, but also for cereal cultivation and peat mining. Tile draining started in the middle of the 19th century. For agricultural purposes, drainage became more important only in the 1960s. In 1800-1861, only some 7,400 ha of land had been drained in the western regions of Russia (Karavayeva et al., 1991).

In Estonia, amelioration activities started in the middle of the 19th century. In the beginning, only big estates could afford amelioration. In 1897, an ambitious plan to reclaim 366,000 ha was drawn-up by the Estonian and Livonian Bureau for Land Culture. By 1917, 108,000 ha had been drained, mostly in forest areas, but also to improve meadows and fields. After the land reform in 1919, land reclamation increased rapidly, supported by the initiatives of the Homestead Board. Altogether, more than 350,000 ha was reclaimed by 1940 (Juske et al., 1991). During the Soviet period, this figure almost doubled. This increase was gained through two major campaigns in the 1950-60s and mid-1970s, when peat bogs and mires were proclaimed the worst enemies of the Soviet agriculture and big forces were sent to fight them. In newspapers, writers were talking

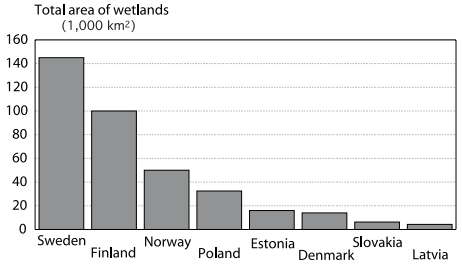

Figure 7.7. Wetland areas. Very large wetland areas still exist in northern Sweden and Finland. These wetlands often have a rather monotonous flora.

about conquering the bogs, taming the rivers, and subduing the sloughs. Today, however, many of these new land areas in Estonia stay abandoned.

In Belarus, the same campaign gave a bit different results. In Estonia, it raised a nature conservation movement that succeeded in keeping the reclamation activities in areas that really made sense to drain. Large bog areas were inventoried and by 1981 most of them were protected. On the contrary, Belarus took the task of fighting the bogs seriously. Before World War II, Belarus had the biggest marshlands in Europe. Now, most of them have been drained, used in agriculture for some years, and been abandoned.

In Finland, land reclamation and drainage reached its peak even later. During the 19th century, the Finns moved northwards to claim new lands and demonstrated their will and power to overcome the bad conditions and frosty and stony soils. As a result of World War II, Finland lost its best agricultural areas in Karelia. Karelian refugees had to be settled somewhere and fed. Consequently, a process of land reclamation started, similar to the Danish one three-quarters of a century earlier. In 1950s and 1960s, the Karelian refugees were settled in the newly reclaimed areas in the centre and south of Finland.

The consequences of draining

During the heyday of the draining projects nobody thought that lowering the ground water table was a problem, it was rather an indicator of success. It wasn't until later that the negative effects become evident of draining wetlands to develop new agricultural land.

Biodiversity loss is an important consequence. As mentioned, meandering rivers and excessive wetlands have their specific animal and plant communities. Drainage removed these habitats, and together with them, their biodiversity. Similarly, unregulated rivers often have large floodplains with oxbow lakes that depend on seasonal flooding. Diking cuts these off so that the whole habitat is destroyed.

Channelling of rivers increases the velocity of flow and the water passes through the river system more quickly than before. This increases the probability of severe hazardous floods. When the floodplains and oxbow lakes functioning as excess-water reservoirs are cut off from the main river, the water storage capacity of the river system decreases. Rapid snow melting or intensive rainfall may lead to disaster. During recent years there has often been news reports on floods moving rapidly downstream, wiping off bridges and breaking dikes, flooding houses, and inundating agricultural fields.

Figure 7.8. Wetland meadow. This meadow in south-east Sweden is covered by water each spring. The annual rythm of flooding was once a common feature in the landscape, today it is unusual. (Photo: Lars Rydén.)

Figure 7.9. Industrial agriculture. Draining is an important strategy in rational farming. Subsoil draining tubes substitute for ditches and allows for large uninterrupted fields, an important feature in industrial agriculture, as here in Scania in southernmost Sweden. (Photo: Lars Rydén.)

The increased flow velocity also increases erosion. The water digs itself into the bottom of the riverbed. When contact with groundwater increases, draining also increases, drying out the neighbouring areas. The diking of rivers has taken place all over Europe. For instance, in Hungary the Tisza river was diked with disastrous results. The former moist floodplain now suffers draughts. The water is forced to run through the puszta so rapidly that the river has dug itself below the groundwater table and has started to drain it. The Netherlands, on the contrary, is an example of fairly successful water management.

Removing wetlands decreases the water storing capacity of the river systems. In fact, wetlands are among the biggest mainland containers of fresh water. Draining lets the water out which in turn reduces water provision to neighbouring inhabited areas.

Channelling also reduces the capacity of streams and rivers to manage the nutrients in the water. A natural stream and wetland has a large capacity for denitrification, and also to bind phosphates. When this capacity is diminished eutrophication increases in the recipient, in the end the Baltic Sea.

Lowering of the groundwater table dries up former water saturated soils. This improves the cultivation but also triggers the mineralisation of the soils. Aeration allows for new bacterial activity. The organic content of the soil turns into carbon dioxide and soluble salts that are drained off with rain water. As a consequence, the soil shrinks, and the new water table comes closer to the surface. Quite often, the farmer is forced to carry out a new drainage operation. In some areas where, e.g. the level of a lake was lowered to drain agricultural land, a series of drainage projects took place and in the end nothing was gained neither economically nor agriculturally.

The mineralized nutrients, leaching out of the soil and carried by rain water through ditches, streams, and rivers to the Baltic Sea, causes eutrophication. Vegetation starts to boom in the river and again, the former habitat gets disturbed.

Expanding infrastructures

cities, roads, and industries

Human settlements

In the Baltic Sea region a sedentary style of life developed based on agriculture. Villages became prevalent from the Iron age and farms in the modern sense have been found since the Viking age. Villages and farms continued to be the dominating form of habitation up to our century. In these settlements, the environmental impact was relatively small, and resources brought in were recycled to the environment locally.

Cities developed as centres for trade in Viking times and later, and as centres for power at the time of state formation. With a few exceptions, these pre-medieval or medieval cities were quite small, with a few thousand inhabitants. Before 1800, only some 2-3% of Europeans lived in cities.

The medieval cities were, however, used by many more than those living in them. The population of some important trade cities grew several fold during annual markets. Religious events were important at other places. For the administration, for court processes and often for schooling and education, the cities were resources for the region. Thus the market place, the town hall, the church and the fortress were the centres and equally the functions of cities.

Roads leading up to the cities were often primitive or on water. The Baltic Sea, larger lakes, and rivers constituted an important part of the communication infrastructure.

Cities developed slowly up to about 1800. In the cities, many of the inhabitants were in fact busy a large part of the year outside the city limits growing food and taking care of their provisions for the rest of the year. There were often very unhealthy conditions within the city walls. Streets were muddy, and removal of household and toilet waste was not well organised. There were also quite a few animals. Pigs and chickens were common. Cows were located at points where milk could be taken into the city, and of course horses were used for all kinds of transport. All these animals required fodder and produced substantial amounts of manure.

Heating of homes was accomplished with individual furnaces. When fired with either wood or coal, they polluted the air with smoke and particles, both quite unhealthy.

It is obvious that from the very beginning the concentration of humans living in cities constituted an environmental problem on the site itself. However, the cities were neither numerous nor large enough to become a real problem for the environment and landscape in general.

The modern city and the four waves of urbanization

The situation changed with industrialisation. Factories required a large number of workers at one place. England was the first country where industrialism seriously changed the society and also the place where a new wave of urbanization took shape. Already in the mid-19th century some 40% of the inhabitants of England lived in cities. It is also here that the serious environmental impacts of the extreme concentration of individuals and activities typical of cities became overwhelming. Sewage, waste, energy, and pollution became acute problems in the English cities.

Increased mortality and bad public health, much worse than on the countryside, told the city dwellers about the situation. That cities were unhealthy

Our built environment

Cities, with suburban areas, service areas, industrial areas, roads, highways, railroads, bridges, tunnels, etc., constitute our built environment. Cities are expanding everywhere in the world, including in the entire Baltic Sea region, in some countries more rapidly than ever before. Satellite information from the 1980s indicate that about 3% of the land surface of the Earth is covered by technical infrastructure, the built environment. This percentage is of course much larger in densely populated areas.

Figure 7.10. Hammarby Sjöstad, south Stockholm, built in a former port area. Cities, towns, and other built environment cover large areas in the landscape. Already in the Middle Ages large cities developed where rivers enter the Baltic Sea. Later cities and towns were built wherever roads and railroads reach. (Photo: Lars Rydén.)

was also evident from the bad smell, bad air, and bad water. The large epidemics were concentrated in cities, and it was also in the cites that the cause and effect of waterborne diseases were established. In 1859, cholera was traced to toilet water leaking into the public drinking water in London. The smog produced from all the coal fired chimneys caused the death of thousands of individuals. The last large scale smog occurred in London in the 1950s.

In the Baltic Sea region, industrialisation started seriously during the second half of the 19th century. Germany and Poland were in the forefront. The northern regions became industrialised later, although St. Petersburg early became an important industrial centre. Environmental conditions in the cities were also alarming. St. Petersburg, for example, suffered a bad cholera epidemic in 1896. Air pollution was serious, e.g. in Polish cities where hard coal was used for heating homes. Smog was rampant in Krakow in southern Poland, both due to the industries in the city and the heating of homes, with serious health consequences. Still today the number of children with respiratory diseases is far above national averages in cities in Silesia in southern Poland and several places in eastern Estonia, and most likely in all other cities with bad air.

With industrialization the cities grew larger. Cities also formed the infrastructure that supported them: railroads, roads, energy distribution networks, etc. A wave of urbanization, the third counted from the origin of cities, spurred by industrialism and building of railroads, occurred in the Baltic Sea region at the end of the last century. Many cities on the coasts grew bigger and became important industrial centres, connected to their hinterland by railroads or sometimes with rivers, and to the rest of the world through ports and the Baltic Sea.

A fourth wave of urbanization took place between 1950 and 1975. If, in the earlier phases, cities had grown mostly through absorbing the population increase, in the fourth wave they grew by depopulating the countryside. If in the earlier phases the cities themselves developed, in the fourth phase, they grew through suburbanization and a large increase of communication, especially car traffic. The cities then became much bigger. The real megacities, typical for the

In some areas, a god example is Upper Silesia in southern Poland or the Gdansk region further north, where industrial activity has a long tradition, towns and cities grew together with industry. As a result borders between towns are not easily visible, and present only as administrative divisions seen on maps. In Upper Silesia there are at least 15 large cities and towns, over 100,000 inhabitants each, together inhabited by nearly 4 million people on an area occupying only 2.1% of Poland.

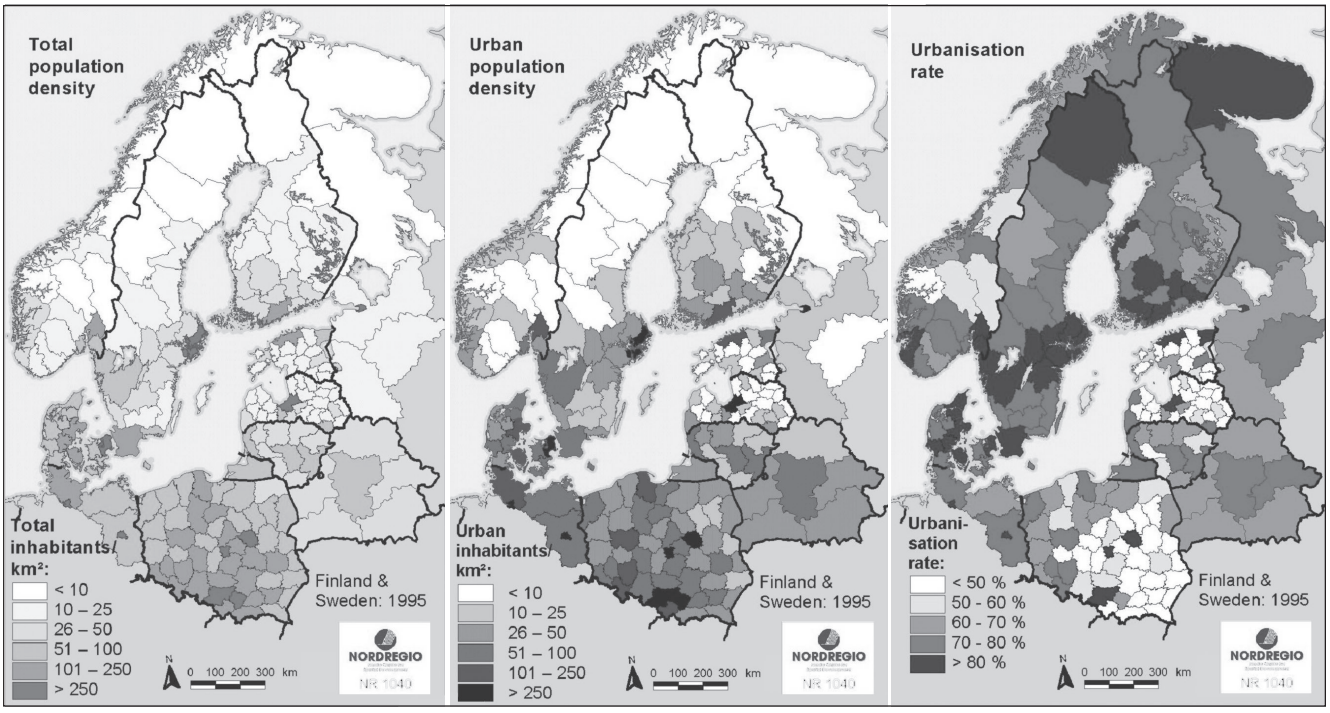

Figure 7.11. Urbanization in the Baltic Sea region is 60-90%. An area from St. Petersburg, to south Finland, Stockholm, Göteborg, and to Copenhagen has high degree of urbanisation, industrialisation, and economic growth. In eastern Europe urbanization is closer to 60%. Observe that the region in the maps is slightly different from the drainage area of the Baltic sea. (Source: Nordregio – Nordic Centre For Spatial Development.)

South, do not exist in the Baltic Sea region. Still, there are 53 cities in the region (see figure 7.12.) with over 200,000 inhabitants and 7 cities with over 1 million and one city (st. Petersburg) at 5 million. The degree of city dwelling is today close to 90% in many areas in Sweden, Denmark, and Germany, and 65% or more in Finland, and Eastern and Central Europe.

Industries and industrial infrastructure

Places where natural resources and workers were concentrated have existed for hundreds of years, especially for the production of iron and other metals. It was not until the mid-19th century, however, that larger scale manufacturing and industries became important. Many larger industrial sites developed on strategic places and then not necessarily close to cities. They depended on access to natural resources and transport. Thus, very large industries grew around mines and at the river mouths to which forest products or agricultural products could be transported. But also in cities slightly smaller industries, breweries, galvanic industries, chemical industries, and dye production, textile industries, etc., grew up in large numbers. In Russia, there was a tradition to have many of these manufacturing companies in the villages but in the late 19th century many moved to cities. With socialism, gigantic industrial companies were created. One example is Nowa Huta, the legendary steel plant outside Krakow in Poland, which had 40,000 workers at the peak.

Industries required much space, created much transport infrastructure, and were typically very polluting. The overwhelmingly bad smell in cities during the 19th century was largely due to emissions from a plenitude of industrial sources: the smell from slaughter houses, breweries, and chemical plants can be recognised today. It wasn't known until much later that other types of emissions, such as heavy metals, and different organic chemicals, could be even worse.

The industrial sector has undergone a series of structural adjustments since its beginning and in an accelerated pace. The society of 50 or 100 years ago has changed dramatically. The spatial intrusion of industries has changed in the sense that many industrial buildings that became obsolete due to these changes are being used for other purposes. Especially the smaller industries in cities

Figure 7.12. A highway cross in Germany. (Courtesy of Agim Meta.)

have in many cases been renovated and turned into offices and apartments. Also for the larger industrial sites it has in some cases been possible to make similar adjustments. For example, the ship building industry was reduced dramatically in the west in the 1970s and in the former communist states only in the 1990s. The large ship yard in Malmö in southern Sweden is used for the campus of a new university. The large, well known ship yard in Gdansk in Poland is since 1998 mostly empty and its future use is uncertain.

Communication infrastructure – transport

Even if travelling has always been a part of human life and indeed was more normal in the hunter-gathering society than today, it has for a large part of human existence not been supported by a built infrastructure. Travellers had to use waterways or simple paths cleared only by regular use. Walking or riding on horseback were the alternatives. Road building from the 1600s on improved the possibility to connect all important parts of the new states. Travelling by horse carriage became important, postal services organised, and inns were established on many major cross-roads. Still this system was a very small part of the landscape and did not intrude on any natural functions.

A radical change occurred with the railway. The invention of the steam engine and later a steam engine on wheels, the locomotive on rails, was part of the British industrialization. It spread to the rest of Europe during the second half of the 1800s. Mapping the expansion of the railways in Europe over a hundred years proves the dramatic growth, not only of railways themselves but of stations, bridges, tunnels, and other infrastructure needed for the railway transport system. The new communication infrastructure led to the building of cities in completely new areas. The inland behind large waterbodies became available for urbanization.

Today, a hundred years after the first big wave of railway building, we see a new phase of expansion of the railway net. More railways are today being built in Western Europe than in 100 years. Fast trains are a main reason for this expansion. These new connections require even more bridges, tunnels, etc., since they do not accept crossings with roads or paths at all. They also all require double tracks and thus quite broad areas in the landscape.

Simultaneously with the building of railways, the first motorcars were developed building on the combustion engine. The building of roads was first slow, but expanded enormously in the west with the mass automobilism from the 1960s and onwards. In the east in particular this expansion is still in a very active phase. Today, we increasingly see four-lane highways between all major cities.

LANDSCAPE ECOLOGY AND BIODIVERSITY

Landscape history and biodiversity

Landscapes form the living environment for plants and animals and its diversity is thus an important category of biodiversity. The effects of developing practices in agriculture, forestry, fisheries, and reindeer husbandry are important for biodiversity in the Baltic Sea region.

The manure-based agriculture, where domesticated animals and especially cows played a very important role, has dominated most of the agriculture in the region during the last 1,000 years. The dominating landscape type was the meadow. The animals needed large grazing areas, and they were, in addition, dependent upon areas where winter fodder in different forms could be produced. On fairly infertile soils about 8-10 times larger winter fodder areas were needed for producing enough manure for the fields. Add to this figure the large grazing areas for the summer season and it is obvious that from 1000 BP to 200 BP

Review
Box 7.6

The landscape as a resource

The landscape is limited

The planet has limited resources, a fact that is particularly easy to understand when it comes to the landscape. The surface of the Earth is 51 billion ha, of which 14.5 billion ha is land. There is 8.9 billion ha left after ecologically inactive areas, such as deserts and glaciers, are subtracted. With six billion inhabitants, this makes an average of 1.5 ha per capita for the Earth as a whole. This figure is larger for the Baltic Sea region, especially in the less densely populated North.

Ecological services and footprints

Man uses this area for all his needs. The landscape provides man with the *ecological services* needed in life: food, fibre, capacity to absorb waste, etc. The total surface area actually used by an individual for these services constitutes the person's *ecological footprint*. A footprint can also be calculated for groups of people or for any kind of unit, such as a country or city.

The composition of the footprint commonly includes five categories:

- agricultural land, needed for food production, both grain and meat
- forest land, needed for production of fibres, timber, paper, etc.
- energy land, needed for energy production, calculated as biomass or other forms of energy, such as ethanol from grain or methanol from wood
- waste sinks, land to absorb waste such as carbon dioxide and nutrients
- built land, land used for built infrastructure

The unused landscape, protected land, set aside for safeguarding biodiversity and untouched nature, is not included in the footprint. Its ecological services are not used.

Calculating your ecological footprint

The concept of ecological footprint was originally introduced by William Rees in the 1980s and further detailed by him and Mathis Wackernagel since 1990 (see Wackernagel and Rees, 1996). The calculation of a footprint is possible using rather simple means. These approximate measures are very useful for pedagogical purposes. It is easy to demonstrate that each person needs ecological services for his or her life and this is a use of the landscape. It is also easy to calculate the differences that will result from lifestyle changes. These differences might be fairly correct even if the total measure is approximate.

The concept of ecological footprint has also been much criticised. A reason is that it is not clear how much and what kind of land area is used for a certain service. The service itself can also be produced in many different ways. What is a correct measure is thus not evident. There are also large areas unaccounted for in the figures used today, especially the waterscape and oceans.

Figure 7.13. (Photo: Paula Lindroos.)

agricultural regions were dominated not by fields but by hay-meadows and grazing areas. In the most fertile areas in the south, the relationship between fodder-areas and fields could be 1:1, but in most cases, grazing areas and hay-meadows dominated over fields.

The types of areas for production of winter fodder and grazing varied enormously. Therefore, a large number of human-influenced habitats were created from the younger stone age until quite recently. All those areas gave the opportunities for a large number of plants and animals to immigrate into the region, or to expand their populations from small populations living in rare and quite specialised habitats to the "new" human created habitats.

There is an ongoing discussion if the now extinct megaherbivores, especially the aurox, ancestor to the modern cow, could have created a half-open "savannah-like" landscape in which many of the plants and animals could have been found before they moved into the agricultural landscape. Even if it is tempting to think that species-rich grazing areas have had pre-agricultural parallels, there is too little evidence to allow a good judgement. It might have been one factor leading to the species-richness now found in traditionally managed hay-meadows and grazing areas. In any case, it is clear that the expansion of human agriculture opened new opportunities for immigration of species found in natural open habitats of the region such as mountain areas above the timberline, shore-species, species living in cliffs, and some wetland species.

Two rich landscapes – virgin forests and traditional agriculture

One can ask if the expansion of agriculture, also in a long historical perspective, has been negative for the biodiversity of the natural, virgin, forests in the region. Obviously, it has been negative in the sense that the large and old trees in the forests, with a large variety of species depending on them, were cut down to create open grazing land. But otherwise it was not.

In a very simple way, we can say that there are two main classes of terrestrial biodiversity in our region. One is related to *virgin forest* and the other to *traditional agriculture*. In periods of success for one of the classes, the other suffered. Both classes have, however, been found in our region in varying proportions for at least 6,000 years. To be able to keep more or less all species today found in the region, large enough areas representing both forest and agriculture must be preserved. Both classes are today in principle threatened by either industrial forestry or industrial agriculture.

To complicate the situation, especially for the southern part of the region, we should keep in mind that much of earlier grazing and winter fodder collection took place in areas which we today may call either forests or open area. They were in fact in between, open forests or "*savannah-like*." It is likely that a number of forest plants and animal species, naturally living in more southern forests, have been able to adapt to this new environment. Therefore, it is not just to set aside forest which should not be touched. If we want to keep all organisms found in the region, we might also be forced to keep forests managed in some traditional way, perhaps with grazing cows and some harvesting of trees to provide habitats for all our endangered species. The deer-beetle, *Lucanus cervus*, is probably an example of such a species.

For coniferous forests of the northern part of the Baltic Sea region, it is perhaps easier as those forests have been less influenced by different agricultural practices. Forest fires have played a dynamic role there, probably occasionally speeded up by man.

There has been a very large variation among the different types of grazed habitats in the region. Wet grazed meadows occur both along rivers and lakes in the inland but also along the coast. The shore meadows are especially interesting from an ornithological point of view. Many species of waders occur there, such

Landscape ecology

Landscape can be thought of as being made up of different patches characterized by different organisms and environment – ecological mosaics of specific ecosystems. In landscape ecology a mosaic of natural, semi-natural and man-made ecosystems is studied. Landscapes may change in two ways: first, the individual elements, patches, may arise, change size or shape, or dissappear. Secondly, the structure, function, or composition of individual patches may change.

Figure 7.14. Traditional agriculture. The old type of agriculture with small plots, meadows, and many nutrient poor environments is an environment with large biodiversity, which is now dying out. A small-scale farmer in the mid 1950s, prepares his field after harvest. (Photo: Lars Rydén.)

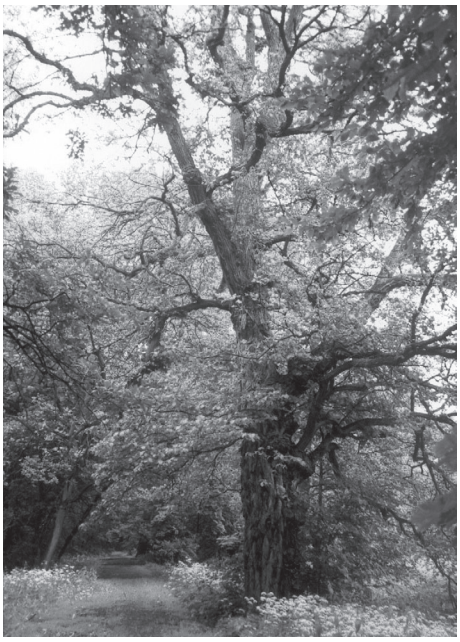

Figure 7.15. An old oak tree. Here we let the oak tree represent the virgin forest which is one of the two types of biodiverse landscapes in the Baltic Sea region. About 600 species, most of them insects, are part of the community that lives in, on, or close to an oak tree. An oaktree is in itself an ecosystem. (Photo: Pawel Migula.)

Traditional agriculture uses:
- natural fertilizer, manure
- biological methods to control pests and parasites
- a balanced animal and crop production
- a sizeable area of meadows for grazing

In traditional agriculture, biodiversity was comparatively high.

Fragmentation is the breaking or separation into fragments, process by which habitats are increasingly subdivided into smaller units, resulting in their increasing insularity as well as losses of total habitat area.

as ruff, dunlin, white-tailed godowit, oystercatcher, lapwing, and redshrank. Those coastal meadows, often found close to muddy and very shallow waters, are of great importance for migrating shore birds and wetland birds. These include a great number of Arctic birds, both waders and several geese species, for example brent goose and barnacle goose. The later have also during the last decade began to breed on Baltic Sea shore meadows, beginning with the island of Gotland and now spreading to, for example, Estonia.

In dryer grazing areas in the Baltic Sea region we find another bird fauna and another flora. Traditionally, such grazing areas were not fertilised. Today, much of the biodiversity of such dryer grazing areas are gone due to the more eutrophic conditions, caused by the use of fertilisers, compounded by atmospheric deposition of nitrogen in areas with substantial farming and production of meat and milk products.

Winter fodder for domestic farm animals was traditionally produced in different types of meadows, while nowadays, most of the fodder is produced in grain fields or on lei-land. The traditional meadows varied from totally open, often quite wet, areas to drier ones. There is even a gradient in many areas from naturally open wetlands which have been irregularly harvested for winter fodder, over to wetlands quite substantially modified by long-term winter fodder harvesting and finally also relatively wet meadows.

The water has in many cases been regulated to create local conditions for good natural grazing production. Some such systems have been very sophisticated with special small ditches used for water-regulation of the meadows. Especially in fertile areas with naturally high pH in the soil, traditionally harvested wet meadows were very species rich with for example a very rich flora of orchid-species. Today, the great majority of those meadows have been drained and transformed into fertile fields.

Finally, it should be mentioned that also newly created built environments, the cities, may provide habitats for plants and animals. Backyards and gardens, parks, etc., may be a reasonable place for living and a food supply for birds, small mammals, or insects. Thus, it is said that Berlin has the largest number of species of birds in Germany. This is reasonable considering the extensive green areas in this large city.

Habitat fragmentation

When a large, continuous habitat is both reduced in area and divided into two or more fragments it is called *habitat fragmentation*. Habitat intrusion thus has two components: (1) reduction of the total amount of habitat type in a landscape by direct habitat removal, e.g. clear-cutting of a forest, and (2) apportionment of the remaining habitats into smaller, more isolated patches (Meffe and Carroll, 1994).

Fragmentation is a complex process involving many variables. In terrestrial ecosystems, fragmentation typically begins with gap formation or perforation of the vegetation matrix. For a while, the matrix – the most common habitat type – remains as the natural vegetation. As the gaps get bigger or more numerous, they eventually become the matrix. The connectivity of the original vegetation has been broken. The most typical example of this process is when the matrix shifted from forest to farmland. When the process has gone far enough we have created fragments of natural habitats, "habitat islands," isolated by agriculture in the terrestrial landscapes.

Habitat fragmentation results in a reduction of the size of the original habitats, a great amount of edge habitat for a given area, reduced distance to the nearest edge, and isolation of remaining areas in a sea of unsuitable habitat. The effects of habitat loss on biological diversity are clear: the habitat being destroyed may contain the only site for a particular species. However, habitat fragmentation

threatens the persistence of species also in more subtle ways. Fragmentation acts to reduce biodiversity through five major mechanisms:

(a) *Initial exclusion*, elimination of species that occurred only in the portions of the landscape destroyed; for endemic species this means complete extinction.
(b) *Barriers and isolation*. Critical for animal species where individuals move between habitat patches, or which require a mix of different habitats with distinct resources. If these critical areas become separated by barriers – roads, hedgerows, urban areas, agricultural fields, clear-cuts – the population may decline rapidly to extinction.
(c) The *crowding effect* is the initial increase of population densities of mobile animal species in isolated fragments after destruction of the surrounding natural habitat. This phenomenon called a "crowding on the ark" has been described for tropical and temperate forest reserves (Noss, 1981; Leck, 1979). The initial rise is followed by collapse of the population.
(d) *Local and regional extinction*. When local populations become isolated, they face a higher probability of extinction. For example, the middle spotted woodpecker (*Dendrocopos medius*) is a sedentary forest species with poor powers of dispersal. A population in Sweden, isolated since about 1950, remained relatively stable at 15-20 pairs from 1976-1974, then declined rapidly to extinction in the period 1975-1983 (Pettersson, 1985).
(e) *Edge effects*. Climatic influences and opportunistic predators and competitors from the disturbed landscape penetrate into fragments, reducing the core area of suitable habitat. Some game animals, however, are adapted to habitat edges and thrive in fragmented landscapes.

There are several means to persist in a highly fragmented landscape. A species might survive in the matrix of farmland, that is within the human land use. It may also maintain viable populations within individual fragments, or finally survive by beeing highly mobile, as for example some birds or small mammals.

Several measures have been taken to reduce the impact of landscape fragmentation. In some countries, tunnels for animals have been built under big roads, and in the Netherlands, outside Utrecht, there is even an animal bridge over a highway that crosses a national park.

The dividing infrastructure itself may also be a considerable danger to wildlife, especially if it is in a place that is important for a species. Wildlife is killed on roads in large numbers. The hedgehog is an especially hurt species. Newly hatched frogs are killed in large numbers when passing roads on their way to the water. Electrical grids may kill large number of migrating birds. The bridge between the main land and the island Öland in the Baltic Sea first constituted an obstacle for migrating eider ducks. After a few years, however, they learned to avoid it. In Sweden, fences are built along the larger highways to separate animals, especially moose, from the traffic, and tunnels are built for the animals. Still, a large number of accidents with animal collisions, several fatal for the driver, occur every year.

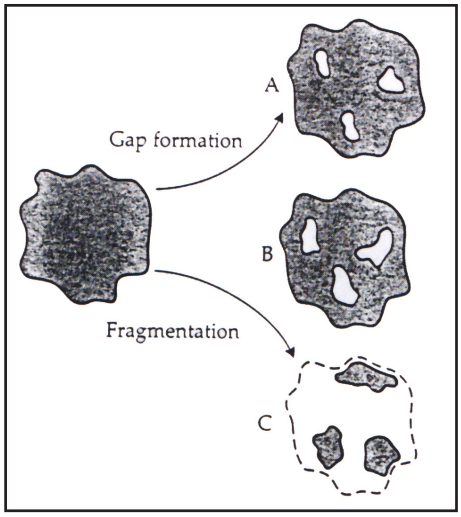

Figure 7.16. Fragmentation of the landscape. A fragmentation sequence begins with gap formation or perforation of the landscape (A). Gaps become bigger or more numerous (B), until the landscape matrix shifts from forest to anthropogenic habitat (C). (From Wiens, 1989.)

Figure 7.17. Wildlife fence. The fence along many thousands of kilometers of Swedish roads is there to protect the traffic from larger animals as moose and roe deer. Smaller animals, typically badger, hedgehog and sometimes fox, regularely passes and are killed by cars. (Photo: Lars Rydén.)

Case
Box 7.7

Wooded meadows

Wooded meadows are defined as sparse natural woods with a regularly mown herb layer. Tree canopy cover is usually in the range of 10-50%. Deciduous trees, such as birch and oak are typical. Several trees and shrub species are distributed in quite small irregular patches.

Wooded meadows are semi-natural ecosystems, occurring in the forest zone, representing a combination of a forest and a meadow. They remain only if mowed regularly. They have often been slightly grazed by sheep, horses, or cattle, but in the late summer after mowing.

Occurrence and history of wooded meadows

Wooded meadows are unusual. The main region of wooded meadows in the whole world is found around the Baltic Sea. Here they were widespread until the middle of the 20th century, especially abundant in areas with thin calcaceous soil: the islands of the Baltic Sea, western and northern Estonia, central and southern Sweden, south-western Finland, but also in flooded river valleys in southern Estonia, Latvia, and Lithuania. But we find wooded meadows all over Europe, especially in the Pyrenees, Alps, and Carpathians.

The history of wooded meadows goes back some thousands of years. Selective cutting of trees, collection of twigs for leafy fodder and grazing around settlements formed wooded meadow-like ecosystem already 4,000 years ago. About 2,000 years ago, hand mowing by scythe started and gave wooded meadows their typical form.

The distribution of wooded meadows in Estonia reached its maximum at the end of the 19th century, and stayed quite unchanged until the 1940s. At their peak wooded meadows covered 19% of Estonia's land area (Kukk and Kull, 1997). In western and northern Estonia and on the islands, patches of wooded meadows often covered large territories of several, even more than ten square kilometres, including meadows of a whole village.

Wooded meadows today

The area of wooded meadows decreased rapidly from the beginning of 20th century in Sweden and Finland and from the end of the 1950s in Estonia. The natural grasslands were replaced by cultivated grasslands. In 1995 - 1997, an inventory of wooded meadows of Estonia found that no more than 200 ha were still managed, 60 ha of this area was situated within the borders of state nature reserves. In addition, some 600 ha were in a quite a good condition. Several good examples of wooded meadows, especially in the western part of Estonia and on the islands have remained. In Sweden, they are nowadays distributed mostly on the island Gotland, and in Finland on Åland, and in the Slovak Republic.

Ecology of wooded meadows

The wooded meadows have a special ecology. The *tree canopy* is connected to the herbateous plants: if the canopy is too large, the herbs production drops because of a lack of light, and if too low (the tree canopy cover) herbs production drops because of a lack of mineral nutrients. The tree roots with rizosphere around them dissolve mineral nutrients from the parent rock, to make them available for herbs. After decomposition of the litter of trees, nitrogen enters the community through the activity of nitrogen-fixing microorganisms living in symbiosis with several trees and herb species (alder and leguminous plants). The trees and shrubs create stable humidity and temperature conditions, they weaken the wind, decrease diurnal temperature, and seasonal soil moisture fluctuations, and prevent soil erosion. The productivity of wooded meadows after a long-term management is higher than the productivity of open meadows in other similar conditions.

The richness of plant species of the wooded meadow is due firstly to the great variability of the herb layer's horizontal structure: shade and light, moist and dry, fertile and less fertile soil spots, which all depend on the distance to trees; and secondly on mowing which removes the bigger herb species and allows the smaller herb species to develop.

Biodiversity

According to T. Kukk and K. Kull (1997), the number of vascular plant species in a 1 x 1 m plot normally does not exceed 30 in natural meadows; in the richest alvar meadows it can be over 40; only in wooded meadows it has been found to exceed 50. The top five wooded meadows are in Estonia. They are: Vahenurme - maximum value 74 and an average of ten plots - 68 (western Estonia); Laelatu - maximum value 76 (western Estonia); Tagamõisa - 67 (island Saaremaa); Küdema - 65 (Saaremaa); Tärkma - 61 (island Hiiumaa) (data are from the years 1996 - 1997). Only two sites in the world are known where the small-scale species richness exceeds that of Estonian wooded meadows.

Existing published and manuscript flora of Estonian meadows includes 596 taxa, among them 55 protected species, that is about 40% of the whole number of the vascular plant species of the Estonian flora and 30% of all protected species.

The number of fungi species depends on the diversity of vascular plants, which in turn are important as fodder or dwelling places for insects, snails, and slugs. Vascular plants and invertebrates in turn have important roles in food chains, which very often terminate with birds or mammals.

Figure 7.18. A wooded meadow in Estonia. Wooded meadows have several charactersitic trees and bushes. On this meadow the juniper bush, *Juniper communis* (foreground), hazel, *Corydalus avellana*, and oak tree, *Quercus robur* (background). (Photo: Tiina Elvisto.)

Wooded meadows

Case
Box 7.7

Management of the meadows

The continuation of wooded meadows has been possible by regular management, which include: 1) picking of fallen branches (in spring), which hinder the mowing and are later burned; 2) mowing; 3) making sheaves from twigs, which are dried and used as fodder in winter; 4) chopping the brush; and 5) cutting of trees. The hay from wooded meadows is of high quality, rich in vitamins and minerals, free of chemicals, and is especially good for sheep. In addition to hay, leafy fodder, firewood and timber, cut for various purposes, hazelnuts, mushrooms, medical herbs, tea herbs, berries, wild apples, birch sap, material for wicker-work, flowers, etc., are collected from wooded meadows. Wooded meadows have been used for managing bees, having parties, hunting, etc.

The wooded meadows represent a perfect example of sustainable management, with very long-term and multi-functional landuse. They constitute rare examples of human activity that enriches a biological community. The wooded meadows should be protected to retain its rich communities and habitats, and a typical traditional culture of the Baltic Sea region, to promote green farming and eco-tourism, but also for scientific interest, for aesthetic reasons, etc.

In the course of time, the best has also often been the beautiful. In 1986, when an inventory was made of wooded meadows in Estonia, local elderly people were asked what was important when they took care of their meadows. They thought a bit and said simply: “The result has to be nice to look at.”

Tiina Elvisto

Figure 7.19. Managing the meadows. Traditionally the wooded meadows were kept open by mowing and chopping. In addition the green leaves from the trees were cut (lopped) and collected for winter fodder. (Photo: Heiki Luhamaa.)

Figure 7.20. A beautiful flora of hundreds of colourful plants is a characteristic of the wooded meadows all over Europe. Here *Vicia* and *Galium* species are seen. (Photo: Lars Rydén.)

Figure 7.21. Tatra National Park. The Baltic Sea region has many hundreds of national parks, some from the early part of the 20th century. Several of the more extraordinary parks are found in the mountains in the very far north and south. (Photo: Pawel Migula.)

PROTECTING THE LANDSCAPE

The conservation movement

As is clear from this chapter, there are no or very limited areas that are not at all influenced by man. In terms of biodiversity, the consequences of this is dramatic. In the cultivated forests, a whole series of species living in forests loses their biotopes, especially those which are dependent on old trees and old wood. There is a long list of insects, birds, plants, lichens, mosses, etc., on the World Conservation Union (IUCN) Red List of endangered species – species on the limit to extinction due, for example, to the fact that their natural habitat has been reduced and scattered.

There has long been concern for habitats and individual species losing ground. Such concern is the basis of the origin of the environmental or conservation movement. One part of the solution is to protect nature.

Even if the idea of nature conservation had its beginning in medieval times, the first national park was not established until 1872 in the United States, in the public interest, for the enjoyment of the scenery. The private interest, to economically exploit the area, was overridden.

The first national park in Europe was established by Sweden in 1909: the island and coastal habitat of the 168 ha small Ängsö National Park in the Stockholm Archipelago. It started the move towards protection of nature and wildlife in large areas. In northern Sweden, considerable areas in the mountains were made a national park in 1910. It was possible since a virgin area was considered worth conserving when the economic interests were not too large. Only the Saami were allowed to hunt and fish in the area. A real policy towards nature conservation began, however, only after World War II, starting from the protection of individual species through protection of their habitats. As a consequence a move towards integrated planning and management of natural environments developed and initiated efforts towards international co-operation, developing criteria and standards for active nature conservation to support biological diversity and sustainable development.

The majority of legislative regulations for nature conservation in the European countries, including those in the Baltic Sea basin, support goals such as:

- maintenance of ecological processes and ecosystem stability,
- conservation of biodiversity,
- conservation of geological heritage,
- conservation and long term survival of species and ecosystems,
- creation of proper human attitudes towards nature, and
- rehabilitation of resources and areas of nature to the proper stage.

Which areas should be protected? There is no or almost no areas that are "native" in the region, so "nativeness" is not a criterion for conservation. A habitat might rather be considered worth protection if only one or several of the factors needed for survival of threatened species are present. When an area is of marginal economic interest protection is not so controversial. But when nature conservation groups started to discuss areas with greater economic value it was more difficult to get support from governments. The interesting areas had to be owned or bought by the state to be turned into national parks or protected areas. It thus has become increasingly expensive to respond to these interests.

Protection and conservation of sites

The IUCN (1993) defines a protected area as "land and/or sea especially dedicated to the protection of biological diversity, and of natural and associated

cultural resources, and managed through legal or other effective means." Countries around the Baltic Sea understand this definition in different ways. The same name is used for different forms of protection. IUCN proposed therefore the use of various categories of protected areas based mainly on management objectives (see Table 7.6).

In Europe, more than 40,000 sites are protected. Some of these areas are very small, known as nature reserves. The majority represents the fifth category in the Table, however in some countries (e.g. Finland) more than 50% are in the first and second category.

Many protected areas are suffering from intensive agriculture, from air and water pollution, and a lack of sufficient sources for proper management, and also from intensive tourism.

A national park is defined as an area of at least 1,000 ha of specific and wilderness value with richness of diverse nature phenomena, nature monuments and beautiful, often primeval environment (see margin next page). Some established national parks do not conform to the IUCN definition and rather constitute a category of protected landscapes, partly privately owned, and where some use of resources is allowed. In Finland, for example, large such areas are in private hands and the government plans to assign another 250,000 hectares for conservation or other forms of protection. This is very costly, and much money has been spent on the purchase of land and compensation to landowners in conservation areas.

The number of national parks and the total area protected in various categories differs between countries of the Baltic Sea region. Protected land covers 9.8% area of Denmark, but true national parks are lacking. In Finland, 30 national parks (the majority established in the 1980s and 1990s) cover nearly 8,000 km^2. Some of them are quite small, less than 30 km^2. Other protected forms, such as nature reserves, protected forests, (including the 223 km^2 Friendship Park on the Russian-Finnish border designated to aid co-operation and research) nearly double this area. In Sweden, 23 national parks cover about 6,300 km^2. Some of them are unique, and the only "Arctic" national park within the European Union is found there. Additionally, about 1,400 established nature reserves (with areas designated for education and recreation) cover around 5.5% of the country. Nature reserves in Poland are divided into strictly protected and partially protected areas where certain kinds of human activity is allowed. Out of 1,200 sites 110 are strict reserves. The total area of protected reserves is

Figure 7.22. Slowinski National Park. Among the national parks on the Baltic Sea coast the dunes along the Polish and Kaliningrad coasts are a remarkable, dramatic landscape, with moving dunes, unusual flora and often resting places for migrating birds. The Slowinski Park is found west of Gdansk. (Photo: Pawel Migula.)

Table 7.6. Categorisation of important sites for conservation purposes. (Bromley, 1997.)

Category	Name	Description
A		
I	Strict Nature Reserve/Scientific Reserve	Protection of nature with minimised human activity
II	National Park	A large area where exploitation of resources is usually forbidden, available for public use under specific regulations
III	National Monument/National Landmark	Similar quality as II with less diversity
IV	Nature conservation Reserve/ Managed Nature Reserve Wildlife Sanctuary	Areas where habitat is managed to achieve conservation goals
V	Protected Landscape or Seascape	Primarily natural areas or landscapes with special aesthetic qualities managed for recreation and tourism
B		
VI	Resource reserve	Area awaiting evaluation for production and/or protection
VII	Anthropological Reserve/Natural Biotic Area	Natural area where inhabitants maintain traditional ways of life
VIII	Multiple Use Management Area/ Managed Resource Area	Area managed on a sustained yield basis for production and recreation
C		
IX	Biosphere Reserves	
X	World Heritage Sites	Natural or mixed with cultural sites

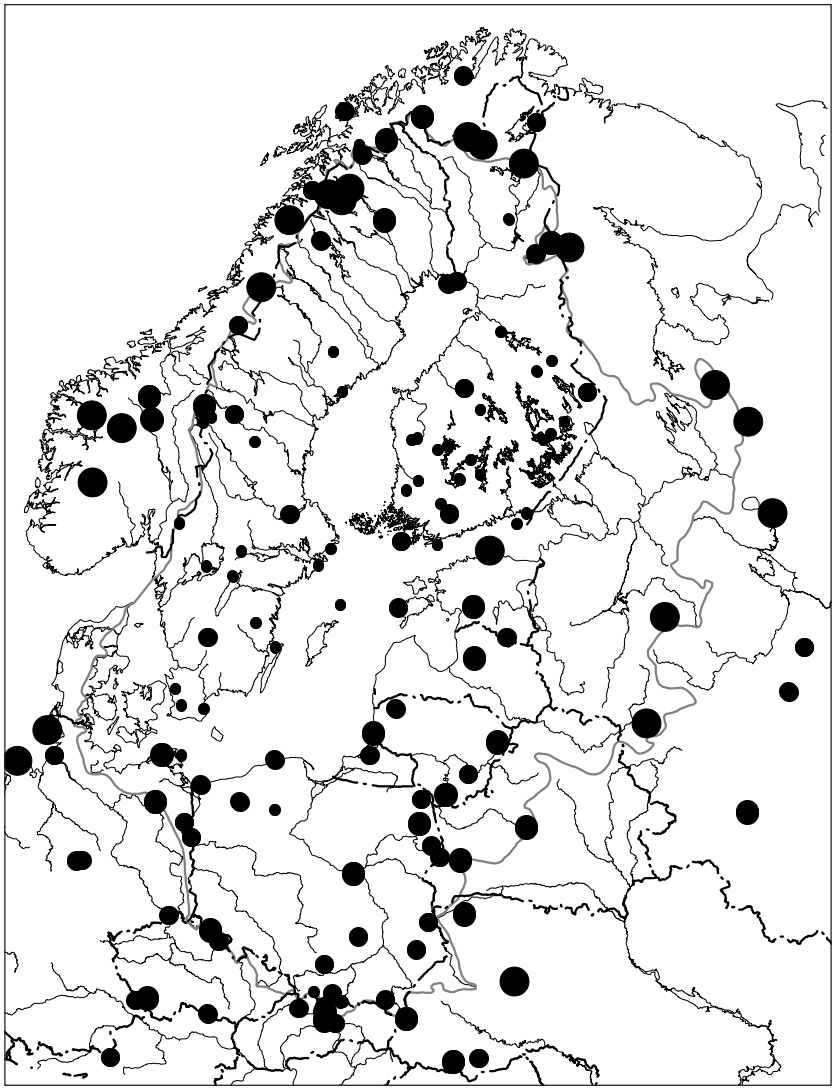

Figure 7.23. National Parks in the Baltic Sea region. Areas marked are those categorised as national parks in the statistics from each country. Most of them belong to category II in the IUCN classification, although in Germany the majority are in IUCN category V as do some of the larger parks in Sweden. The data up to and including 1998. (GIS map: Christian Andersson.)

about 120,000 ha. The 22 national parks cover an area three times larger. Thus, less than 1.5% of Polish land is under protection.

For a proper conservation strategy international co-operation and worked-out principles are necessary. National strategies have to be co-ordinated by international organisations such as IUCN. The *World Conservation Strategy*, launched in 1980 by IUCN, provides guidance for governmental and non-governmental organisations, covering data collection and analysis, sustainable development, conservation of habitat, education, and training.

Many European Union initiatives have been undertaken, such as *Natura 2000*, seeking the identification of a network for nature conservation across the Member States and beyond. In 1991, the European Ecological Network was established with the objective of conserving ecosystems, habitats, and species of European importance, and to enhance the ecological coherence of the continent. The European Environmental Bureau, a network of environmental groups representing various non-governmental organisations based in Brussels, took part in the development of conservation policies in the EU member countries. An overriding principle in this work was to integrate biodiversity and nature conservation efforts with national spatial planning as a whole. Another principle was to involve local authorities in the management of protected areas, and to control pollution that threatened ecosystems and species.

A National Park is: "a relatively large area (a) where one or several ecosystems are not materially altered by human exploitation and occupation, where plant and animal species, geomorphological sites and habitats are of specific scientific, educative and recreative interest or which contain a natural landscape of great beauty, and (b) where the highest competent authority of the country has taken steps to prevent or eliminate as soon as possible exploitation or occupation in the whole area ... where visitors are allowed to enter under specific conditions, for inspirational, cultural and recreation purposes (IUCN, 1975)."

Review
Box 7.8

International policies for landscape conservation

International co-operation

Europe, more so than any other continent, is a patchwork of relatively small countries. As a consequence, ecosystems and the processes that disrupt their functioning often extend across national boundaries. Isolated measures taken within a local, regional or national context will therefore in many cases be inadequate to deal with the problems. A series of international policies have been implemented for conservation and protection of landscapes in Europe as well as world-wide. Some of these will be commented below. References to all of them can be found in the list of Internet addresses.

Council of Europe and the Pan-European Biological and Landscape Diversity Strategy, PEBLDS

54 countries endorsed in 1995 the Pan-European Biological and Landscape Diversity Strategy. The Strategy establishes an international framework for co-operation for consolidating and extending existing schemes and programmes in the conservation field. The long-term objectives of the strategy are:

- establishing a Pan-European Ecological Network to conserve ecosystems, habitats, species and landscapes that are of European importance;
- sustainable management and use of Europe's biodiversity; integrating biodiversity conservation and sustainability into the activities of other sectors, such as agriculture, forestry, fisheries, industry, transport and tourism;
- improving information on and awareness of biodiversity and increasing public participation in conservation actions;
- improving our understanding of the state of Europe's biodiversity;
- assuring that adequate funds are made available to implement the strategy.

The Council of Europe and the United Nations Program for the Environment (UNEP) are responsible for the Strategy's Secretariat. (http://www.StrategyGuide.org/stralook.html.)

European Union Directives and the Natura 2000 network

EU Nature conservation policy is based on two main pieces of legislation, the Birds Directive and the Habitats Directive (http://europa.eu.int/comm/environment/nature/natura.htm). It benefits from a specific financial instrument, the LIFE-Nature fund. Its priorities are to create the European ecological network of special areas of conservation, called NATURA 2000, and to integrate nature protection requirements into other EU policies such as agriculture, regional development and transport.

Each member country should defined areas which will be part of the network and are obliged to keep these in a "good conservation status". This might be simply described as "the meadow should continue to be a meadow, and a virgin forest stay as forest, and species maintained in healthy populations". A total of more than 170 different nature types to be protected are listed in the directives. As an example Sweden has by January 2002 registered a total of 3,453 areas to Natura 2000 according to the Habitat Directive and 442 areas according to the Birds Directive, with a total area of 5,747,700 ha (57,477 km^2 Habitat), and 2,680, 000 ha (26,800 km^2) (Bird).

The Natura 2000 network is meant to be ready by 2004. In 2002 the Commission reports that nature and biodiversity still continue to decline in Europe and that the implementation of Natura 2000 is very much behind schedule. It is believed that this is partly due to local concerns that Natura 2000 designation will have negative impacts on local economic development. EU tries to to raise awareness of the potential benefits that Natura 2000 may bring to local communities, such as increased tourism incomes or greater access to EU funding sources.

The commission has published the guideline " Managing Natura 2000 sites " in accordance with article 6 in the Habitat Directive (Council Directive 92/43/EC 21 May 1992) (http://europa.eu.int/comm/environment/nature/habdir.htm.)

The European Landscape Convention

The convention is part of the Council of Europe's work on natural and cultural heritage, spatial planning, environment and local self-government. It sees the landscape as an essential consideration in striking a balance between preserving the natural and cultural heritage as a reflection of European identity and diversity, and using it as an economic resource (http://www.nature.coe.int/english/main/landscape/conv.htm.)

The convention was developed within the Conference of Regional and Local Authorities of Europe, CRLAE, and later adopted by the Council of Europe. The Committee of Ministers adopted the text of the convention on 19 July 2000 and opened it for signature on October 2000.

The landscape is important as a component of the environment and of people's surroundings in both town and country, whether it is ordinary or outstanding landscape. The public is accordingly encouraged to take an active part in landscape management and planning, and to feel it has responsibility for what happens to the landscape. It says that landscape must become a mainstream political concern, since it plays an important role in the well-being of Europeans who are no longer prepared to tolerate the alteration of their surroundings by technical and economic developments in which they have had no say.

Conservation of wetlands

The nature conservation value of wetlands got the highest recognition when the Convention of Wetlands of International Importance, especially as Habitats for Water Fowl, also known as the *Ramsar Convention*, was signed in 1971 in the Iranian city of Ramsar. By 1995, 70 nations had signed it, thus indicating their concern in resolving the environmental problems of wetlands in their countries. The signatories, the convention says, share a common belief in the value of wetlands as valuable and irreplaceable economic, cultural, scientific and recreational resources and commit themselves to proper management of

Figure 7.24. Białowieska Puszcza National Park, flooded in the spring on the Polish side. Białowieska is the largest national park in the area. It is situated both in Poland and Belarus. The forest in the park is considered to constitute the only remaining traces of the original large European forest. (Photo: Pawel Migula.)

Pearls in Nature
Necklace of Belarus

Belovezhskaya Pushtcha National Park

The beloved Belarusan poet V.S. Korotkevich called Belarus "the land under white wings" because of the abundance of white storks and said, "I don't need to write about other countries; I find the jungle here". And he was absolutely right. One can rarely find so many forests and marshes as in Belarus. But the real pearl of nature, which is world known, is, of course, Belovezhskaya Pushtcha.

Belovezhskaya Pushtcha covers an area of close to 25,000 km^2, about half in Poland and half in Belarus. The park has a long history. The first records of Belovezhskaya Pushtcha as a thick virgin forest (*pushtcha*, dense forest) with wild animals is from Ipatyevski's Chronicles dated 983. Belovezhskaya derives from the name of the watch tower (vezha), which was built in 1276 by Vladimir Volinsky on river Lesnaya. The forest was the favorite hunting place of Lithuanian, Polish, and Russian kings and high-ranking persons during the Soviet period.

Polish kings and Russian tsars protected their forest, especially the bison, to keep it to themselves. The Belarusan part was made a reservation in 1939, but in 1957 the status was changed and during 37 years it was a reservation for hunting. In 1991 it was reorganized as the National Park it is today. In 1993 the UNESCO gave it status of biosphere reservation, and added it to its list of world heritage of mankind.

In Belovezhskaya Pushtcha we can still find the last residues of the originally vast forests of Europe with relict plants, animals, territorial complexes and ecosystems; there is also a variety of biokoinos or small territory ecoystems; The park is situated on the biographic, climatic, hydrologic and natural-historic border between Central and Eastern Europe.

Not far away from the Belovezhskaya Pushtcha there are several other parks in Belarus of large protection value. These include Buslovka in the Brest region. Buslovka houses about 20 kinds of animals and plants redlisted in Belarus. The reservation has forest corridors in north-west direction which are connected with Belovezhskaya Pushtcha allowing migration between the protected territories.

Nikolai V. Mikhalchuk

wetlands for the present and future benefit of their people. With signing the Ramsar convention the countries will have to focus on four undertakings. First, they have to designate at least one wetland of international importance (see Figure 7.23). Second, they have to promote the sustainable use of wetlands. Third, they will consult one another on the implementation of the convention, especially when the water systems influence other countries. Fourth, they establish nature reserves on wetlands. There are three main ways of taking action. The Convention monitors the situation of wetland sites in the contracting countries and helps to prevent deterioration of destruction of wetlands. It also co-ordinates the "Rational Use of Wetlands Project," that advises governments how to make rational use of natural resources of the wetlands. Finally, the Convention set up the Ramsar Fund for wetland conservation in developing countries.

In addition to protection of wetlands, some countries have made great efforts to restore the once lost wetlands. Examples can be found in many countries. One of the most valuable bird protection areas of the Netherlands, Oostwaardersplassen, is situated in the polder of Flevoland that emerged from the waves of the Ijsselmeer only in 1963. There birds were quick enough to occupy the territory meant for industrial development and the authorities were wise enough to let this situation continue.

Artificial wetlands play an increasing role in wastewater management, as a cheaper alternative to clean water. The wetland is created, so it is isolated from groundwater, plants like alder, cattail, reeds, *Lemna*, iris, etc., are introduced, and a connection to the wastewater treatment plant is constructed. The wetland receiving partly treated wastewater and storm-water retains nitrogen and phosphorus and maintain denitrification. If not overloaded the wetland systems may take the nutrient contents of the water back to the natural background level.

Habitat conservation and project work

A traditional manure-driven agriculture survived in the whole region into the early 19th century, when a transition took place making natural hay-meadows and grazing areas unimportant. Already around 1900 much of the species rich habitats were gone in the southern more fertile areas, as in eastern Denmark and Scania in Sweden.

The shore meadows are totally dependent upon mowing or grazing to be preserved in a manner that provides a good habitat for a number of plants and

Case
Box 7.9

Wetland restoration in Sweden and Denmark

Lake restoration – Sweden

Sweden has seen several spectacular restoration projects the last few years. Lake Hornborga (Hertzman & Larsson, 1999), had up to the mid-1900s experienced five consecutive drainage operations. Water level had then dropped by 2 meters. Large parts of the previous lake area was colonized by bushes and extensive reedbeds. The results of the scheme had certainly been more farmland but also that groundwater levels had fallen and the costs for maintenance of drainage schemes rose. Farmers joined the conservationists, who wanted to restore the lake for its value as bird habitat, to develop various restoration options. The scheme that eventually became the object for a parliamentary decision in 1989 increased the wetland area with 7 km^2, and opened up considerable new open water surfaces, at a total cost of 80 million Swedish Crowns (about 10 million USD). The methods and machinery developed in this project has been used in several others. Other restoration efforts, again often quite costly, concern rivers, where meanders have been put back and channelling removed, to increase landscape values and improve cleaning capacities and fish habitats.

Mols peninsula, Denmark

This land in central Jutland was for thousands years open and unforested and grazed by sheep and cattle. A decrease of use of grazing areas for production activated strong succession rates towards forest. This process forced some action in order to keep the biodiversity of the land. Among other measures, throughout the year a stock of sheep is kept only for grazing, and even Scottish cattle, which are outdoors all the time, were introduced for this purpose.

Figure 7.25. The restoration of Lake Hornborga. To the left the lake in August 1987 and to the right the same view in June 1995. The open water surface has increased considerably, by a total of 7 km^2, while meadows and areas for grazing have increased by some 600 ha. Figures for improved biodiversity are very good. (Photo: Jan Johansson.)

for most of the wetland bird species. As grazing has ceased in many shore meadows during the last decades, the population size of many of these species has declined. A sufficient number of grazing cows, sheep, or horses are thus needed in those areas to preserve a high biodiversity. Changing conditions for agriculture in the three Baltic republics have aggravated the situation as traditions are abandoned.

Two kinds of projects have been the result of this change. In one kind of project, the agricultural landscape with its meadows, were, either actively or passively, transferred to forest. In Sweden, one of the first countries where reforestation started on a large scale, this development has more or less ceased. In Lithuania, for example, where the process started later, we find large areas with very young trees, which to a part constitute a natural succession. In Denmark, on the other hand, a very active tree plantation is ongoing on abandoned farmland, and then the new forest is not of much value for species richness. Much biodiversity is especially lost if the new forest is planted on earlier traditional grazing areas.

However, there are also projects where the old meadows are conserved by continuing the old traditions with the explicit objective to conserve the

old habitat. A number of projects have been started to try to find ways for grazing and mowing those meadows again. Especially significant is a restoration of the important bird area Matsalu bay in Estonia. Wet meadows along inland waters are in the same situation. Species threatened because of this include the great snipe, a bird nowadays extinct from all its earlier habitats in the southern parts of the region. An important locality is still Biebrza National Park in Poland, although the meadows there also do not function very well any more. To save the rich bird life mowing and grazing must come back in a full scale.

The best opportunities for a species-rich agriculture to survive seem to exist in areas of intermediate agricultural value. In some special circumstances a very different development has helped the biodiversity-rich, agricultural habitats survive to today. Thus, the special geology, rich in chalk, in combination with some remoteness, have saved many species-rich areas on the Baltic Sea islands of Öland and Gotland in Sweden, and Hiumaa and Saremaa in Estonia. Political circumstances and the negative economic treatment of private farmers in eastern Poland kept the agriculture of this regions for a long period in a traditional and economically less developed stage. However, this was very positive for the biodiversity.

Draining of wetlands are in a similar situation as aforestation of unused agricultural meadows. The drainage operations have abated in most countries since there is no more governmental support available for drainage or land reclamation. Attention is rather paid to maintenance of existing drainage systems, as there are farmers dependent on these systems and sometimes even valuable landscapes have been formed on these formerly drained areas. Still, in Estonia, farmers may get loans to finance up to 60% of the costs of creating new drainage systems.

However, the negative consequences of draining wetlands have been obvious. In some countries, e.g. in Denmark and Sweden, during the 1990s wetlands have been restored and are now taken care of by interest groups. New artificial wetlands have also been constructed (see below). The objectives are to fight eutrophication, increase biodiversity, and increase landscape values.

Managing the landscape

In the last few years the role of the farmer and the forester has partially changed. Earlier it was focused on the production of food or wood. Now the landscape in itself is considered of considerable value and the farmers are those who take care of it, manage the landscape. We know that a classical meadow with a beautiful variety of flowers and bushes and deciduous trees requires animals that are grazing, farmers that harvest the leaves and grass, and cut invading trees to keep a light meadow landscape. The work of farmers is required to open up the areas that were formerly used for sheep and goats. One component of the system of subsidies to agriculture used, e.g. by the European Union, is that the farmer is paid for these services to the rest of the population of the country.

The interest in protecting landscapes with much biodiversity, much aesthetic value, and much biological value is today large enough to expect an increasing support for such policy. The time when the deep forest was dark, threatening, and the home for robbers and thieves is long gone. Forests are today considered as good as they probably were for the original hunter and gatherer who came to this part of the world some 10,000 years ago to settle in the then paradisical landscape.

Review questions

1. Summarise the main reasons for deforestation.
2. Describe the forms of afforestation activities that have been done, if any, in your region; and explain the role of society in this field.
3. Describe why wetlands are important biotopes.
4. What are the consequences of draining wetlands? Comment on a relevant situation in your region.
5. Describe briefly the historical development of towns, and the main factors of their growth.
6. Characterise the role of transport in changing the land infrastructure.
7. Compare the ecological impacts of agriculture in the 18th and 19th centuries and recently.
8. Explain the term biodiversity. Give examples and compare various types of landscapes in term of biodiversity.
9. Analyse the examples of landscape restoration projects, and explain why efforts in this field are so important.
10. Name all actors interested in landscape protection and their roles. What you would expect from their work and activities?

Literature and references

Anderberg, S. (1991). Historical Land Use Changes: Sweden. In: F.M. Brouwer, A.J. Thomas and M.J. Chadwick (eds.). *Land Use Changes in Europe. Processes of Change, Environmental Transformations and Future Patterns*. Dordrecht, the Netherlands: Kluwer Academic Publishers, pp. 403-426.

Bodin, B. (Eds.) and Ebbersten, S.(1997). *Food and fibres – sustainable agriculture, forestry and fishery*. (A Sustainable Baltic Region : 4) Uppsala: Uppsala University, The Baltic University Programme.

Breitfeld K. et al. (1992). *Das vereinte Deutschland. Eine kleine Geographie*. Institut für Länderkunde, Leipzig. (in German)

Broda, J. (1988). *History of the Forest Economy*. Warsaw: PWRiL.

Bromley, P. (1997). *Nature Conservation in Europe. Policy and Practice*. E & FN Spon.

European Commission (1995). *Europe's Environment: Statistical Compendium for the Dobris Assessment*. Compiled jointly by Eurostat, European Commission, UNECE, OECD and WHO. Brussels and Luxembourg, 455 pp.

Haeggström, C-A. (1983). Vegetation and Soil of the Wooded Meadows in Natö, *Åland.- Acta Bot. Fennica* 120, pp. 1-66.

Haeggström, C-A. (1988). Protection of Wooded Meadows in Åland - Problems, Methods and Perspectives. - *Oulanka Reports* 8. pp. 88-95.

Haeggström, C-A. (1990). The Influence of Sheep and Cattle Grazing on Wooded Meadows in Åland, SW Finland. - *Acta Bot. Fennica* 141. pp. 1-28.

Hertzman, T. and Larsson, T. (1999). *Hornborgasjön : från vasshav till fågelrike* (Lake Hornborga : from sea of reeds to bird haven). Stockholm: Swedish environmental protection agency. (in Swedish)

Information and Publishing Department (1996). *Environment in the Commonwealth of the Independent States*. Statistical Compendium. Moscow. 204 p. (in Russian)

IUCN (1975). *World Directory of National Parks and Other Protected Areas*. Geneva: IUCN.

IUCN (1993). *Action Plan for Protected Areas in Europe*. The World Conservation Union, IUCN, Gland.

John B. (1984). *Scandinavia. A New Geography*. London and New York: Longman.

Juske A., M. Sepp and Ü. Sihver (1991). Land Amelioration Activities between the Two World Wars. In: *Land Amelioration*. Estonian Ministry for Agriculture Information Centre, Tallinn.

Karavayeva, N.A., T.G. Nefedova and V.O. Targulian (1991). Historical Land Use Changes and Soil Degradation on the Russian Plain. In: F.M Brouwer, A.J. Thomas and M.J. Chadwick (eds.) *Land Use Changes in Europe. Processes of Change, Environmental Transformations and Future Patterns*. Dordrecht, the Netherlands: Kluwer Academic Publishers, pp. 351-378.

Kukk, T. and K. Kull (1997). Puisniidud/Wooded Meadows. *Estonia Maritima*, No. 2, 249 p. (in Estonian, with English summary)

Kull, K. and M. Zobel (1991). High Species Richness in an Estonian Wooded Meadow. - *J. Veget. Sci*. 2, pp. 711-714.

Kuusela, K. (1994). *Forest Resources Europe 1950-1990*. European Forest Institute Research Report 1. Cambridge University Press, 154 p.

Leck, C.F. (1979). *Avian Extinctions in an Isolated Tropical Wet Forest Oreserve, Equador*. Sunderland: Sinauer Association Inc., 600 p.

Lindgren, L. (2000). *Island Pastures*. (About the meadows of the southwest archipelago of Finland.)

Meffe, G.K and C.R Carroll (1994). *Principles of Conservation Biology*. Sunderland: Sinauer Association Inc., 600 p.

Noss, R.F. (1981). The Birds of Sugercreek, an Ohio Nature Reserve. *Ohio Journal of Science*, 81, pp. 29-40.

Pettersson, B. (1985). Extinction of an Isolated Population of the Middle Spotted Woodpecker *Dendrocopos Medius* (L.) in Sweden and its Relation to General Theories on Extinction. *Biol. Conservation*, 32, pp. 335-353.

Stanners, D. and P. Bourdeau (1995). *Europe's Environment*. EEA: Copenhagen. 676 p.

State year books and Ministry of Environmental Protection, Natural Resources and Forestry, Poland.

Statistical Compendium (1996). *Environment in Commonwealth of the Independent States*. Interstate Statistical Committee of the CIS. Moscow, 204 pp. (in Russian).

Wackernagel, M. and W. Rees, illustrations by P. Testemale (1996). *Our Ecological Footprint. Reducing human impact on the earth.* New society publishers.

Wiens, John, A. (1989) *The ecology of bird communities*. Cambridge: Cambridge studies in ecology.

World Resources Institute (1996). *World Resources 1996-97*. Database Diskette. Washington: World Resources Institute.

INTERNET RESOURCES

CBM - Swedish Biodiversity Centre
http://www.cbm.slu.se/

Center for Biodiversity
http://www.alco.dk/biodiverse/

CORINE - European Topic Centre om Land Cover
http://etc.satellus.se/

Council of Europe and the environment
http://www.nature.coe.int/Default.asp

European Landscape Convention
http://www.nature.coe.int/english/main/landscape/conv.htm

Eurowetlands
http://www.eurowetlands.com/euro/start.html

Food and Agriculture Organization of the UN
www.apps.fao.org

FAO - Food and Agriculture Organization of the UN
http://www.fao.org

Hornborgasjön
http://www.hornborga.com/

IENE - Infra Eco Network Europe
http://www.iene.org/

IUCN - The World Conservation Union
http://www.iucn.org/

MAB - UNESCO's Programme on Man and the Biosphere
http://www.unesco.org/mab/index.htm

Natura 2000 Network (European Commission)
http://europa.eu.int/comm/environment/nature/natura.htm

Pan-European Biological and Landscape Diversity Strategy
http://www.StrategyGuide.org/stralook.html

Polish National Parks
http://hum.amu.edu.pl/~zbzw/ph/pnp/pnp.htm

The Ramsar Convention on Wetlands
http://www.ramsar.org/

Road Ecology - Wildlife and Infrastructure
http://www-grimso.slu.se/research/infrastructure/

Society for Conservation Biology
http://conbio.net/scb/

UNEP - United Nations Environment Program
http://www.unep.ch/

UNESCO World Heritage
http://www.unesco.org/whc/nwhc/pages/home/pages/homepage.htm

Wetlands International
http://www.wetlands.org/

Wooded Meadows
http://www.zbi.ee/ecophys/wood.htm

World Conservation Monitoring Centre
http://www.wcmc.org.uk/

World Forest Institute
http://www.vpm.com/wfi/

World Wildlife Fund (WWF)
http://www.wwf.org/

Glossary

afforestation
planting of land with trees to create woodland, forest

Białowieska Puszcza/Belovezhskaya Pushtcha (Polish/Russian spelling)
National park on the border between Poland and Belarus (the Park consists formally of two parks, one Polish and one Belarusan; the oldest and one of the largest national parks in Europe, know since 12th century, and with the only remaining traces of the large deciduous forests originally covering all of Europe

bog
a wetland, mire, that receives water from surface water, often acidic and oligotrophic with a slow decomposition of plants where peat is developing

coniferous forest
forest of pine, spruce, and fir trees

conservation movement
popular and scientific movement for the preservation of landscapes and species

deciduous forest
forest of broad-leaved trees

deforestation
loss of forest by cutting down and clearing away trees

diking
building a physical barrier, a bank or dike, on a river or other water body

drainage
lowering the water level in a wetland, and thus drying it out, by digging a new outlet to the water, or the outlet itself

ecological footprint
the surface area in the landscape used for the ecological services for a person, a city or a country or activity; the footprint is commonly made up of six categories: agricultural land, forest land, energy land, waste sinks, land to absorb waste, e.g. carbon dioxide and nutrients and built or used land

fen
a wetland, mire, that receives water from groundwater flow

floodplain
the plain along a large area that undergoes seasonal flooding; floodplains have a special and often rich flora

habitat fragmentation or landscape fragmentation
the breaking or separation into fragments, process by which habitats are increasingly subdivided into smaller units, resulting in their increasing isolation as well as losses of total habitat area

hunting-gathering
way to support oneself before agriculture, hunting animals and gathering wild plants

industrialised farm landscape
large scale landscape based on inputs of fossil fuels and chemical fertilizers; a polarised raster of fields and forests, fulfilling the needs of modern farming

infrastructure
physical constructions in the landscape, such as railroads, roads, energy distribution networks, etc.

IUCN
The World Conservation Union (formerly The International Union for the Conservation of Nature); an international organization consisting of several hundred governmental and non-governmental members organizations

marsh
a wetland with partly open water surfaces

meadow
open or partly open area used for mowing

meander
a serpentine or coil-like stretch of a river; meandering rivers are wind through the landscape with several meanders

national park
an area of at least 1,000 ha of specific and wilderness value with richness of nature phenomena, nature monuments and beautiful, often primeval environment

oxbow lakes
lake close to a river; oxbow lakes are formed as a result of closing off a meander

peat
a formation of soil rich in organic deposits created during long-term, slow decomposition processes in anaerobic conditions

peatland
a wetland with no open water surface but moist nutrient-rich organic soil

protected area
a category of protected landscapes, where wilderness, a nature phenomenon or monument is protected, which may be partly privately owned and allow some use of resources

Ramsar Convention
The Convention of Wetlands of International Importance, Habitats for Water Fowl, signed in 1971 in the Iranian city of Ramsar

river delta
the area where a river enters the sea dividing itself into several river arms and often an extensive wetland

scattered farm landscape
a mosaic pattern of fields, pastures, woodland, hay meadows and forests typical in the Baltic Sea region up to about 50 years ago

shifting in agriculture
the process where the former system, where each field was divided among the farmers in a village, changed to a system where the fields themselves were divided; in this process villages were split as farmers moved out to their fields

slash-and-burn agriculture
agriculture where a section of a forest was burned down to allow crops to be cultivated in the area, taking advantage of the nutrient rich ash of the fire

urbanization
building and development of cities and towns

wetlands
areas of marsh, fen, peatland or water, natural or artificial, were the depth does not exceed six metres

virgin forest
forest untouched by man, characterized by a high proportion of very old trees, and much dead wood