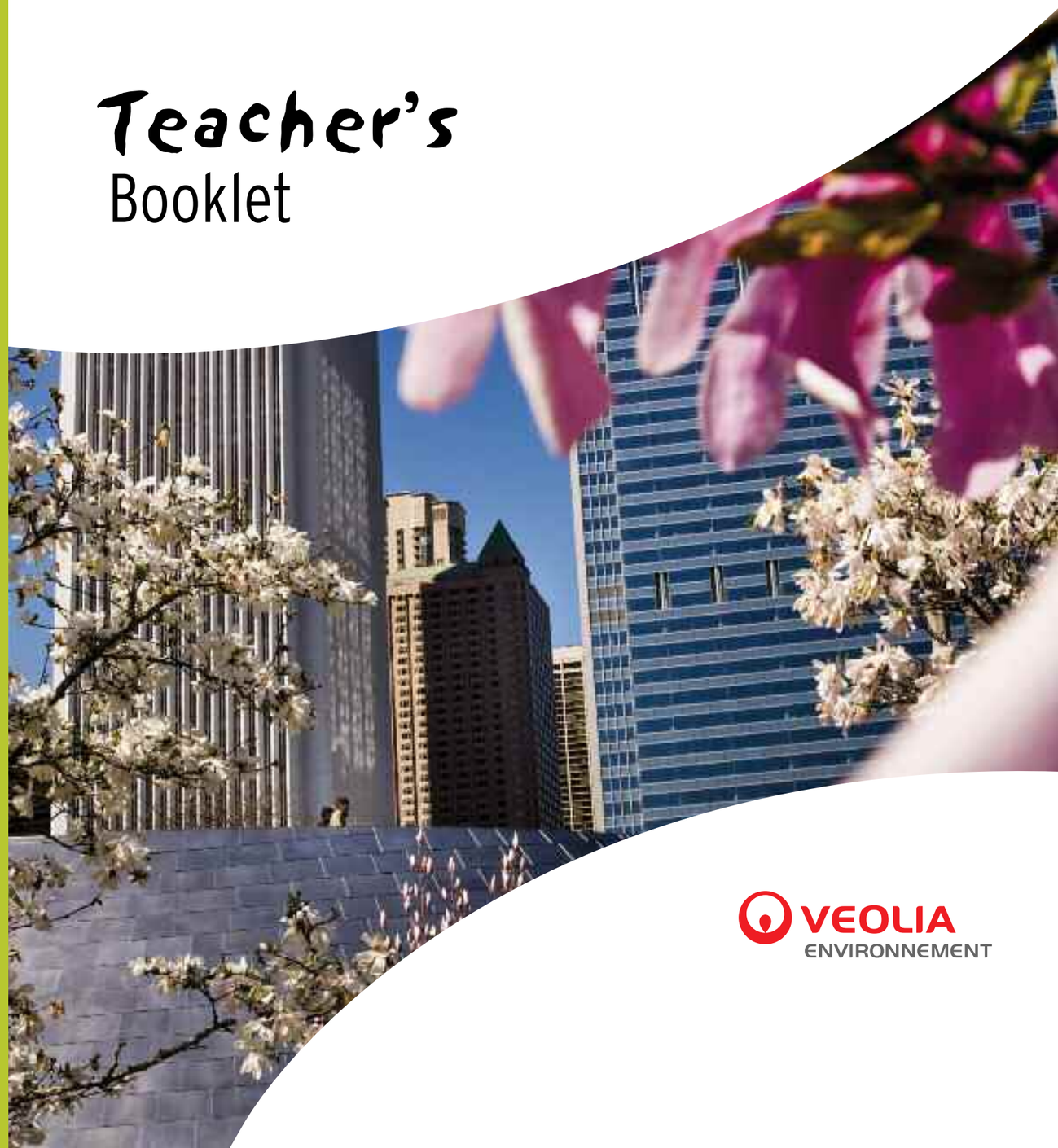
"When biodiversity brings my city to life!"

Teacher's Booklet



VEOLIA ENVIRONNEMENT

Contents

Would you like to download the "Pupils' Sheets" which accompany this document?
Visit www.veolia.com

Editorial

As we enter a new millennium, more than 50% of the world's population lives in cities. Cities are attractive and captivating. But how are they defined?

Not all countries agree on the definition. For some, it is a place with more than 2000 inhabitants, for others it is a question of density or proportion. What is certain is that cities fire the imagination. We think of them as dense, fast-paced, noisy and congested. They are artificial, the antithesis of natural.

And yet... cities are life!

When we imagine nature in towns and cities,

When we imagine nature in towns and cities, the first things we think of are parks, squares and private gardens. But let's just stop to think... Flowers potted planted, green walls, rooftop vegetable plots, gardens designed on roundabouts, tree-lined avenues, rivers, a blade of grass using a crack in the wall to reach daylight - these are all part of nature.

And... Wood, clay, limestone, sand and earth are all products of biodiversity resulting from the decomposition of living things. We realize that in fact nature can be concealed almost anywhere! Although humans consider cities to be artificial, animal and plant species have succeeded in taking advantage of the nature in cities. They have become their refuge, their haven of tranquility.
This biodiversity which develops in towns and cities and their surroundings is very beneficial to us. Biodiversity provides us with food, medicine, as well as fertilization of the soil, regulation of the water cycle, oxygenation of the atmosphere, relative stability of climates, flood control, etc. It takes care of human beings and ensures their well-being. In some ways biodiversity is life's own life insurance!

Geneviève Férone
Sustainable Development Director
Veolia Environnement

What is biodiversity?

A very recent word and concept

The word "biodiversity" is now used frequently. It is part of current affairs and day-to-day vocabulary. This is a great achievement as it only emerged very recently. The term was coined in 1986 from the words "biological" and "diversity" to be used as a title for an international forum on the concept of... "biological diversity" organized in the United States by the National Academy of Sciences and the Smithsonian Institution.

The term had the rare distinction of entering the vocabulary of most languages on the planet within a few months. In 1992, in Rio de Janeiro in Brazil, it was even the main theme of the famous "Earth Summit" which for the first time assembled the majority of heads of state to discuss the planet's environmental problems. A "Convention on biological diversity" was signed. Article 2 defines biodiversity as "the variability among living organisms from all sources, including, 'inter alia', terrestrial, marine, and other aquatic ecosystems, and the ecological complexes of which they are part: this includes diversity within species, between species and of ecosystems."

Richness and polymorphism

Biodiversity is the richness of life. Biodiversity is life!
It can easily be understood through contact with what is easiest to see: species – the various forms of life. In theory, the more species there are in a natural environment or landscape, the more biodiversity exists there.

In any given site, by counting the species year after year, scientists can say whether or not **the (inter-) specific diversity** is high, whether it is declining, whether it is increasing or remaining the same.

Another way of tackling biodiversity is to compare individuals from the same species with each other. How many different types are there? This is what is called **intra-specific diversity**. It is studied by looking at a population. The individuals which make up a single species can be different. This is called polymorphism.

The variety of genes within the same species contributes to general biodiversity. However, there are not many ways to encourage this, to avoid uniformity of individuals born from the combination of genes available within the species. The genes need to be shuffled like playing cards and dealt at each hand. This genetic diversity is ensured by sexual reproduction. This is the very essence of evolution: providing natural selection with the largest number of possibilities, so that the train of life can continue its course.

Interactions

The third level at which biodiversity can be characterized is the variety of natural environments (ecological diversity). This variety is fairly easy to understand since it is easy to grasp that a field of cereal crops is poorer in biodiversity than a forest.

That said, appearances can often be deceptive. As rich as it may seem, a forest can prove immensely poor if it is dominated by a single species. The study of ecological diversity therefore also depends on the study of each habitat's specific diversity. This involves analyzing the proportions of each species. A forest containing lots of species, one of which is present in far higher numbers than the others, is not as diverse as a forest with the same number of species in equivalent numbers. Scientists use very complex mathematical tools, called "indices", to calculate these proportions.

There is more to ecological diversity than that however. Above all, it is an exploration of the interactions between species, as well as between species and their environments. It is also relationships of cooperation, sharing, symbiosis and parasitism; food exchanges (predation, recycling) between species; relationships between the members of a single population; the way in which conditions in the natural environment (climate, soil, humidity, sunlight, etc.) influence species, and vice versa. This all forms the web which structures an environment, a biotope, an ecosystem or a landscape.

A close-knit web

Biodiversity is made up of "social networks". It is an immense tapestry in which each thread is a species. When a thread becomes loose, the whole tapestry is threatened. How many lose threads will it take for the whole thing to fall apart? Nobody knows. But what we do know is that an environment is more resilient to unexpected events (hurricanes, flooding, pollution, invasive species, urbanization etc.) if the tapestry is dense and thick. As a result of interactions, reproduction and mutations, biodiversity is constantly changing. There is not a single balance in nature – there can be several. The more an ecosystem is capable of drawing on a range of solutions when a problem arises, the more resilient it will be.

Total biodiversity on Earth is estimated at between three million and 100 million species (1.8 million have so far been identified). Over time it has formed a fine mesh covering our whole planet. A few dozen centimeters thick in the soil, 11km at sea and 15km in the sky, this biosphere is made more fragile each day through urbanization, intensive farming, pollution, poaching, over-fishing and the globalization of a few invasive species.
Why is this important? Because biodiversity means our fruit and vegetables, our meat, our fish, our cheeses and our alcoholic drinks. It also means many of the active ingredients in our drugs. It is also the fertility of the soil, regulation of the water cycle, oxygenation of the atmosphere, relative stability of climates, flood controls, etc. Biodiversity is a fundamental element of all of our cultures which are all the result of a particular concept of nature.
Despite its technology, our species cannot live without biodiversity. Biodiversity is life's own life insurance!

Useful info...

There is rarity and there is rarity!

Simply because a species is rare in a particular place you look for it, that does not mean it is... rare. For example, we think that predators are rare. Since most of the time their prey escapes, they need a lot of prey to be sure of catching something. They therefore hunt over vast areas. That is why it is more common to come across the prey than its predator.
Conversely, a species may be very abundant in its habitat, but extremely rare on a global scale.

Parent trap

A species is a range of living organisms whose offspring are capable of reproducing. A donkey and a horse can produce offspring, but the offspring will be sterile. So to belong to a species, you need to be able to be a grandfather or grandmother!

Home sweet home

A species which only exists in one particular habitat or in an isolated geographical location, such as an island, is called endemic: it cannot be found anywhere else in the world. Even if this species is abundant in its habitat, it is of vital importance on a global scale. It is rare in terms of heritage, even if its numbers in a given habitat are large. If its habitat were ever destroyed, its survival would be in danger.

Crisis or no crisis?

Biodiversity is not in good health, since species' habitats are being gradually diminished each day by urbanization and agriculture. For a little over a century, the biosphere has been subjected to pressure it had never experienced before. Biodiversity is facing faster erosion and continuous upheaval which nobody is capable of modeling.

Can cities be part of "nature"?

Dense, sometimes sprawling cities

For a long time cities were dense due to their need to spread out. The materials were available, it was just that a city too spread out would have required too much travelling which, until the oil revolution, was too expensive.

Cities were also limited by city walls whose purpose was to keep out invaders. Finally, these cities were dense for practical reasons. Building houses and apartment blocks next to each other, in narrow streets, was a practical way of insulating against the heat, cold and wind.
It provided easier availability of food and energy. Clearly, living on top of each other increased the risks of fire and infectious diseases. It also left little room for biodiversity, other than of domestic animals, rats and other detritivores that feed on our waste.

Parks and garden-cities

The situation changed in European and American cities when doctors realized the impact poor hygiene and cramped conditions had on deaths from infectious diseases.

Urban planning policies were implemented to clean up cities. These policies greatly transformed European cities, which were almost all organized into haphazard districts which sprang up during the Middle Ages. They introduced sunlight, which kills germs, into streets and homes. They encouraged the circulation of air, to blow away the unwholesome stench resulting from the cramped conditions.

The re-urbanization of European cities at the end of the 19th century introduced wide, straight, tree-lined avenues, coherent traffic plans linking the newly-accessible neighborhoods and the creation of large public parks and green spaces. In North America, immense urban parks were created at the initiative of the conservation movement.

The greening of cities continued into the first third of the 20th century, with the fashion for garden-cities and company towns: houses set side by side, each with its own garden, all looking onto a communal park. New garden-cities were then built vertically: tall high-rises surrounded by enormous parks to absorb the considerable rural exodus in the second half of the 20th century.

Urban sprawl, towers and artificial lakes

The late 20th century was characterized by two apparently contradictory trends. Firstly, **a rural exodus,** i.e. large movements of people which led to the massive, precipitous growth of old cities, to the detriment of urban planning designs and green spaces. These cities grew rapidly while becoming denser, forming haphazard megalopolises in which living conditions deteriorated. In some countries, however, the high cost of rents and real-estate, the noise and in some cases a lack of safety, led families to abandon cities in favor of the outskirts. **The creation of suburbs,** housing estates and commercial and business districts, linked by roads, destroyed farming land and fragmented natural environments. Cities tended to sprawl without becoming denser, wasting land and natural environments. In the 1980s, the creation of "greenbelts" containing large parks and artificial lakes, around metropolises and then their suburbs, marked the return of greenery to urban planning designs.

Despite this, for a little over a century more and more towers have sprung up in large cities. These symbols of power and might present a cold, artificial image, unconducive to wildlife.

Initially, demographic increases benefit towns and cities. In 20 years, more than 60% of the planet's inhabitants will live in cities. The lack of sufficient space in cities and in natural environments may prompt the question: where and how will biodiversity be sustained? The answer is... in cities! Just where it will be needed to improve the quality of life of the increasing numbers of city-dwellers.

Cities can be refuges

Cities owe their existence to nature. And they frequently allow it to flourish. For living species, cities have become clusters of landscapes which provide a fair approximation of natural habitats. Yet due to urban sprawl and the intensification of single-crop farming, cities have created vacuums around themselves, meaning they become refuges, little islands, even oases for some species. The flora and fauna which inhabit them encounter less pesticides and hunting than anywhere else. In cities they find water, food, shade, heat and coolness all year round. Some parts of the world, including in the richest countries and those which are most protective of their natural environment, the biodiversity in cities is higher than in the surrounding countryside. But we should not generalize. There are cities and there are cities! Construction and urbanization methods have an enormous influence on urban biodiversity.

Can cities be part of "nature"? Yes, if they agree to allow biodiversity to have some space.

Useful info...

Cities are natural constructions!?

In some ways, biodiversity has never left cities, as to some extent they are the product of it. Wood is part of biodiversity. It is used in construction and for heating and cooking. Although sand, limestone, sandstone and, to a lesser extent, clay and earth are composed of rock, they are still products of biodiversity, since they result from the decomposition of living things. However granite, iron, glass and concrete are nothing to do with biodiversity. And finally, the transformation and transportation of these materials consumes energy, mainly oil which is also entirely a result of biodiversity.

What is a city?

Every country has its own definition. In the Maldives, the city is Malé... the capital. In the United States and Mexico, a city has more than 2500 inhabitants. In France, it has at least 2000 inhabitants. The threshold is 100 in Peru, 200 in Norway, 1000 in Canada, 10,000 in Senegal and 50,000 in Japan. In China, a city is defined by its population density (at least 1500 inhabitants/km²) while in India, a population of at least 5000 inhabitants is required, at least three-quarters of whom are not farmers.

Nature in cities, but where?

Almost everywhere!

When we imagine nature in cities, the first things we think of are parks, squares and public gardens.

We also think of the many private gardens. But can we really talk of nature in such an artificial, inorganic environment? Although these spaces are certainly all green, they are organized, maintained, cut, mowed and pruned. They are anthropized, i.e. they only exist because of and for humans. However, although they may appear poor, these large surface areas can be very rich.

Wilson & Mac Arthur

Cities are refuges, because their green spaces are islands.

In 1967, in a publication which is now famous among ecologists (*The theory of island biogeography, Princeton University Press*) two American scientists, Edward Osborne Wilson (who coined the term "biodiversity") and Robert H. MacArthur, established an empirical link between the size of an island, its distance from the mainland and its biodiversity.

In general terms, the smaller an island and the more remote it is from the mainland, the less likely it is that naturalists will find a lot of species there. Conversely, an island with a large surface area which is not far from the nearest land mass will in theory be colonized by a lot of species, since they can easily reach it from the mainland and will have more space to live on the island. Although this relationship can be observed in situ, it is very difficult to represent in figures. The values given by the equation proposed by Wilson and MacArthur are simply indications, nothing more.

Most naturalists have confirmed in cities what the two researchers observed on islands. In a fragmented environment such as a city, a link can be observed between available surface area, distance from a source of species and biodiversity.

According to Wilson, a natural environment whose surface area is divided by 10 will see its number of species at least halved. But it can be much worse.

Green spaces, islands

Countryside subjected to single-crop farming and urban sprawl sees its biodiversity decline.

Some species which have lost their habitats find refuge in the city. This means we can compare the city to one of Wilson and MacArthur's islands. Urban green spaces like parks and public gardens are richer in species the bigger they are and the closer they are to a source of species, i.e. the natural environments of the surrounding countryside.

In this type of artificial environment, the area/species ratio provides us with four pieces of information. Firstly, green spaces (islands) are necessarily rich in biodiversity given the worrying state of natural environments (the mainland) around most cities in the world. The second piece of information is that there is more biodiversity in cities, which provide lots of islands to accommodate it. The third is that the link must be maintained between these islands and the natural environment (the mainland). Finally, the fourth piece of information is that this link cannot be maintained without wildlife corridors linking the islands to each other.

Islands and corridors

These wildlife corridors already exist in cities. They are the edges of rivers and canals, big trees planted along avenues, high-rises, buildings, tall street lamps, bell towers and minarets (which provide nesting places for birds, especially birds of prey), as well as private gardens, vegetable plots and, often overlooked, the verges of roads, tunnels and railroads.

These are all places nature moves into spontaneously. Cracks in walls, holes in sidewalks, spaces between paving stones, wastelands and abandoned plots – these corridors are all areas of the city which, left to their own devices, very quickly become covered in vegetation. Once this vegetation is left to grow, it ends up forming an ecosystem, i.e. a small island lost between two bigger islands.

Biodiversity is therefore omnipresent in cities. This "archipelago" of man-made islands (public and private green spaces) and spontaneous smaller islands is of crucial importance in many cities. Modern cities, as paradoxical as it may seem, are sometimes reserves of biodiversity.

And cities have a vital duty to maintain these green spaces and promote the spontaneity of life. It is therefore important to allow abandoned areas to be colonized by vegetation. It is important not to automatically spray herbicides on gardens and sidewalks. Industrial or commercial wastelands could be converted into natural parks by breaking up the concrete, opening buildings, bringing in earth, creating embankments, hollows and humps, etc. This all creates many more habitats and therefore opportunities for biodiversity.

Controlling opportunists

Controlled non-intervention is important, since although parks and gardens are "islands", they may have high specific diversity without actually having a high level of biodiversity. In many cases the distribution of species is disproportionate.

The abundance of food and advantageous living conditions in cities above all benefit opportunist species. Biodiversity is dominated by a few species. To correct that, cities must create a lot of habitats, diversify them and encourage wildlife corridors. The important thing is to avoid a few species getting a head-start over all the others.

Useful info...

Parks or gardens?

The bigger the overall green space in the city, the more species there will be. This does not mean that only rich cities can be home to high specific diversity due to their large city parks. A city where greenery is everywhere, where there are many private gardens, flower borders and tree-lined streets can also provide a much larger surface area for biodiversity than some large city parks.
It is obviously better if the city has parks AND gardens!

Water, water

Water is the fundamental element. Without water there can be no life and therefore no biodiversity. A city must have fountains, canals and ponds for its inhabitants, as well as for its flora and fauna. This is important since, as we will see later, biodiversity maintains the water cycle.

Diversity within diversity

A city is never so welcoming to biodiversity as when it offers a wide range of possible habitats. From this perspective, an immaculately manicured city park is not ideal. But this can change – by thinning the trees and shrubs to obtain various different heights, we can create many new opportunities for birds to nest and perch.

They are invasive!

There is no invasion without humans

The conditions of life in the urban environment are fairly unusual.

The abundance of food, the relatively low level of predators, heat and cold, a permanent water supply, urban lighting, noise and pollution – all this disturbs wild species. A lot of species are used to it however. Some, including rates and mice, have thrived. These species, which have fairly meagre ecological requirements, have been able to take advantage of urban waste to multiply, to such an extent that they have become invasive for humans. In cities, these species have developed a certain dependency on human activities. Humans provide them with a favorable living environment.

From pigeons to polar bears

Our waste attracts them...

Beds abound in bugs and dust mites. Pets allow fleas to multiply. When their larvae fall on the floor, they develop and metamorphosize by feeding on waste around the house. Mites, meanwhile, feed on your clothes or flour.

Buildings with wooden frameworks are a fantastic haven for other insects such as wood-eating beetles. In every city in the world, these animals bore tunnels in the wood, plaster, cement and mortar, and weaken the structure of buildings.

Some birds have become invasive. Benefiting from our waste means they can find food. Pigeons, gulls, seagulls and kites are common residents of cities. They can be found around waste dumps, parks and ponds. These animals cause damage. Their droppings spread disease-carrying bacteria on buildings and vehicles. These bacteria represent a microbial biodiversity. Finally, although they are not invasive, foxes, jackals, bears and other predators attracted by our waste and, to a lesser extent, by our dogs and cats, can be a nuisance.

Globalization of invasive species

These invasive species vary between cities, but since big cities are often similar, the same families of animals are always found there. The globalization of communications and tastes has led to certain plant species becoming more widespread in certain regions of the world. That is why the same trees, such as ailanthus, and plants, such as creeping water primrose, are to be found in many cities. These plants, exotic species which benefit from the artificial expansion of their habitat and the higher temperature in cities, are often thought of as scourges. Why? Because they reproduce quickly, faster than local species, which can be threatened with extinction. Habitats may therefore face the danger of becoming uniform. Despite this, few species succeed in establishing themselves outside their original environment (one in 1000 on average). They usually establish themselves where they have no competition and where space is available, often on wastelands that local species have difficulty conquering. Generally, invasive species cause little disruption to urban ecosystems and wastelands again demonstrate their advantages, acting as an observatory for studying the arrival and development of incoming species.

Invasion, really?

But what actually is an invasive species? Obviously there are objective criteria for defining invasion, but the concept still remains vague. As far as humans are concerned, a species is invasive if it disrupts their usual environment too quickly and too radically.

But what "nature" are we referring to? We mean nature as humans see it. How should this be perceived in the artificial environment of cities? Do we want nature to be wild, well ordered, semi-ordered, gardened, or even landscaped? What strategy should be adopted to preserve and develop it and how far should be done? There are cultural assumptions behind the concept of an invasive species. City-dwellers tend to automatically reject any foreign species introduced, whether deliberately or not, for the reason that it is not "natural". They also tend to want to eradicate these species and return to what existed in the "past". But what is nature in cities if not artificial, both in its origin and its maintenance?

If it is meant that the objectively random development of certain species should be restricted, it is worth considering an incoming species as an addition to the city's biodiversity, provided it doesn't threaten another long-established species. Cities, as mentioned above, are a refuge, an artificial archipelago. They must therefore welcome species which will in any case establish themselves one way or another due to globalization. By accepting these species, city-dwellers will have access to another form of nature, an enhancement which will help change their outlook on biodiversity.

Predators or pests?

The subjectivity of the concept of an "invasive species" in cities can be seen by analyzing the population increase among certain predatory species in relation to their own natural environments.

Populations of predators, often in significant numbers, now nest on the rooftops of most cities which have a high number of skyscrapers or very high buildings (religious monuments, factory chimneys, television masts, artistic monuments, etc.). In some cases, the population of these birds is higher in cities than in the surrounding countryside, where pesticides, hunting and the destruction of habitats may have decimated them. Falcons, kites, buzzards and eagles now frequently share the skies in many of the world's cities. They hunt the rats, mice, voles and pigeons which have themselves benefited from the city. Yet above a certain threshold, once they are clearly visible, the inhabitants consider them to be invasive and a pest. It is a good sign, however, if such high numbers of predators become established in cities, since being so high up in the food chain makes them excellent biological indicators.

Their success reflects the success of the city's biodiversity.

Useful info...

More nitrogen than fertilizer?

The warm welcome offered to nature by cities can also be explained by the high levels of nitrogen in their soils. Some of the nitrogen oxide released into the air by the combustion of fossil fuels, especially diesel engines, is transformed into nitrates and falls to the ground as rain. This provides the soil with natural fertilizer – nitrogen. The most astonishing thing is that in some very polluted cities, this air-borne contribution is higher than from the spreading of artificial fertilizers in the surrounding countryside. Such high levels of nitrogen encourage "nitrophilous" species which grow and reproduce very quickly when the soil contains nitrogen.

Dogs and cats

The most invasive species by far are dogs and cats. Pets are everywhere in cities. They can cause damage in terms of hygiene (dog mess on the sidewalk), health (hairs which carry numerous disease-carrying bacteria), botany (cat urine can kill shrubs) and the ecology (cats are known for snacking on birds and small mammals). This predation is worse with feral cats, cats that have returned to a wild state. And packs of stray dogs are often considered invasive because they frighten city-dwellers.

Not just for Christmas

A species need not exist in high numbers to be labeled invasive. A few crocodiles in a city's drains are sufficient. Released by collectors who don't know what to do with them, exotic species find themselves in an urban environment very different from their cage or terrarium. Some survive, such as crocodiles, turtles and snakes. Although these species may be frightening, they are not a significant ecological threat.

Encouraging biodiversity in cities!

Preserving the source... to preserve life

Cities are an archipelago.
To be visited by nature they need a nearby "source", a "mainland".

For plant and animal species to establish themselves spontaneously in cities or to adopt them when passing through, they need to be able to access them.
It is therefore essential that there is a "source" to supply the city with wild species. The source can dry up, however, if it is exhausted or cut off from the city. The source is the nature surrounding the city – wild nature, as well as nature controlled by agriculture. This nature is often threatened by suburbanization.
Suburbanization is the uncontrolled sprawl of a city outside its traditional boundaries. The city spreads when demographic pressure becomes too high due to new arrivals. Towns develop and spread in turn. Estates of detached houses and business parks spring up.
Sometimes this new suburb sprawls so far that it takes too long for the inhabitants to travel into the city.

An archipelago needs a mainland

This suburban area is strange, since it is neither completely urban, nor completely rural.

Vague and distant.

Although it appears green from the air, the greenery is actually interspersed with roads, parking lots and houses. It is often a monotonous green, composed of garden lawns and the leaves of intensively farmed crops. Suburbanization is a disaster for nature in cities, since it considerably reduces and separates species from their habitats. The smaller a population's numbers (because the population has been physically separated into numerous sub-populations), the less it reproduces and the more its numbers diminish – this is called the Allee effect. Below a certain number, an animal or plant population ends up declining. However, if this group comes back into contact with other populations of the same species, exchanges can be established. A male can find a female somewhere else apart from in its reduced group. Unfortunately, this communication is often made difficult. Urban sprawl and the spread of real-estate developments and single-crop farming create physical obstacles which are sometimes insurmountable for many species. Populations therefore find themselves isolated, physically and therefore genetically separated. Diversity and demographics decline.

The city is an archipelago provided we treat the surrounding countryside as a mainland which supplies the city with flora and fauna! The first thing to do to cultivate biodiversity in cities is to cultivate it outside cities, to maintain little islands of nature, not too far away from each other, if possible linked by wildlife corridors.

More habitats, more space

The important thing in cities is the number of habitats and the total surface area of the green spaces left to nature. These two factors are linked since, in addition to architecture and urban planning, vegetation itself acts as a support for "natural" habitats. The biodiversity in a city park comprising an immense area of lawn surrounded by a line of trees will be completely different to that in another, comprising meadows, lawns, copses, hedges, trees, shrubs, ponds, etc. City authorities must therefore ensure that they diversify their capacity to welcome biodiversity, by enhancing the strata (grass, flowers, shrubs, medium-sized trees and tall trees), the relief (hills, excavations, backfilling, hollows, etc.), living conditions (humid, dry, sunny, shady, etc.), and environments (meadows, hedges, wetlands, etc.). It is possible to diversify habitats without changing practices, or only a little. Because in fact allowing grass to grow, flowers to blossom, hedges to close in a little, water to occasionally overflow ponds, vegetation to grow over the edges of roads and at the foot of trees, and leaves to fall and decompose, means giving tamed nature a chance to live a little longer than usual. This increases the number of possible habitats and therefore encourages life.

The other way of cultivating biodiversity in cities is to increase the surface area available to it. Plants – whether in the soil or planted in pots, on balconies or on roofs, along the foot of a wall or on the wall, in a garden or a stairwell – are habitats and small islands in themselves. On the scale of a city, these plants take up a considerable surface area. Furthermore, each one contributes to these wildlife corridors allowing animals to move from one green space to the next.

Shadowy corridors

These corridors are of fundamental importance. They link the urban archipelago to the suburban archipelago, or the mainland, provided the surrounding countryside has not been tampered with too much. Within the urban archipelago, they link the larger and smaller islands to one another.

They often exist without us seeing them, e.g. rows of trees, the edges of rivers and roads, tunnels, sewers and the network of private green spaces. But in order for these corridors to be effective, they must be able to fulfill their communicating function. Plants should not be over-pruned, limit the use of chemical sprays, let vegetation grow in peace, arrange it so it can be home to several habitats. Humans should monitor it and restrain it, but under no circumstances prevent it from living! Corridors of lawns and trees pruned annually are not actually of any use!

The ideal is a dense city (to avoid suburbanism and improve its energy efficiency), crisscrossed by a few "green roads", with green tentacles of nature reaching into its center from the countryside, dotted with large urban parks and numerous private green spaces. Major cities like Tillburg in the Netherlands, Curitiba in Brazil and Montreal in Canada have succeeded in visibly integrating humans and nature.

Scientists do not yet have the full picture, however. At present nobody knows how to accurately model how wildlife corridors function. Nobody knows precisely how fauna uses them. Neither have the health and ecological risks of integrating nature into cities been fully identified. The question can therefore be raised of whether cultivating biodiversity in cities exposes humans to dangerous animals, facilitates the work of invasive species or introduces animals to dangers they are unable to tackle.

For the cultivation of biodiversity in cities, there are still a lot of recipes to be tried out!

Useful info...

Montreal

Montreal is an example of green urban planning. The city contains hundreds of parks. Twenty of them are very large, and 10 are left more or less in their natural state. The immense Mont Royal allows Montreal's inhabitants to ski in winter, a stone's throw from the business district and MacGill University. In addition to this are wildlife corridors and a real-estate policy which, since 2004, has saved about 8% of the city from property developersr.

Curitiba

In Brazil, despite the demographic explosion, the capital of Parana state is an example of successful green urban planning. The city has around 30 city parks, as well as forests and countless green spaces. Some parks are specifically dedicated to the preservation of local species. The city authorities are studying the possibility of transforming an urban expressway into a wildlife corridor.

Tilburg

This city, which is located in the industrial region around the Dutch capital, Amsterdam, "re-natured" the banks of the River Donge. This led to the creation of a wildlife corridor: a city park, a cycle path and a route for walkers were designed in the very center of a new residential district. The city also set aside five zones in which agriculture and urbanization are highly regulated. This protects both the residents' lifestyle and that of protected species.

Biodiversity in vegetable plots!

From balconies to communal gardens

Planting fruit and vegetables at home, on a balcony or in a garden, in a flower pot or a tub, is a common activity in every city in the world.

Whether you are male or female, rich or poor, from one country or another, vegetable plots are universal. They undoubtedly respond to a deep need in humans. Growing a plant provides the joy of seeing something grow out of "nothing". Harvesting a fruit or a vegetable provides the even greater joy of eating something you have sown. This joy is a necessity in many countries, however. The increased cost of fresh produce makes it less and less accessible to people. If they have access to a garden, whether private or communal, inhabitants can hope to reduce their food budget by growing their own fruit and vegetables. In some countries, city authorities and governments encourage the creation of family plots, either rented or loaned for free, based on working-class allotments established during the 19th century.

Soil, water, sun and... hard work

Growing food is possible in cities.

It may be difficult to grow fruit – a fruit bush or tree takes up space, which is often hard to find. Vegetables do not require much space, however. They only need three things: soil, water and looking after. Beans, tomatoes and sweet potatoes will grow as long as water is available.

Even a small vegetable plot represents a certain amount of work. If you have a garden, firstly you need to work the soil. This is especially difficult since vegetable plants require a lot of light, in other words sunshine. Once most of the stones, scrap and roots have been removed from the soil, gardeners must sow according to the season. They must also take into account the biological needs of the vegetables they want to grow. For a few weeks their job is to observe: check that the growing plants have enough water and, on the contrary, that they are not being given too much water; check they are warm enough; check they aren't being attacked by parasites or smothered by weeds.

Weeds

Parasites on crops are unavoidable. All plants attract them, particularly if they are on their own and watered regularly. Weeds, meanwhile, are encouraged by working the soil. The soil is worked constantly. It is turned for planting several times a year. This permanent instability encourages any plant that is able to grow and reproduce quickly between the rows of vegetables.

So how can we get rid of these weeds? Is the solution perhaps to spray herbicides? Be careful! These chemicals contaminate the person spraying them. They stay on the surface of leaves, fruit and vegetables (but can be mostly removed by washing and peeling).

Combining certain plants can help gardeners – this is called companion planting. When planted alongside each other, certain varieties of vegetables can distract or eliminate each other's parasites. For example, the smell of a flower may repel a destructive insect or attract its predator. There is little that can be done, however, to stop fungus, which is attracted by humidity, or against weeds.

Natural fertilizers

Chemicals must be used restrictively for health and environmental reasons. Their molecules do not biodegrade easily. They build up in the soil and in any living organisms they come into contact with, from their prey to predators.

The impact on nature is less significant if the fertilizers used come from the natural environment. Synthetic fertilizers can be avoided if gardeners have access to compost, grape pomace from a vine or cattle manure. Compost can be made from some weeds, vegetables, fruit and kitchen waste. Compost can also be obtained from municipal composters or waste recycling centers.

Market gardening in cities

Despite their demographic explosion, most major cities in the world have retained large areas of food production on their outskirts.

The more a town grows, the more complex its logistics. Given the state of transport networks and the space they take up, cities which face procurement difficulties have encouraged market gardening on their immediate outskirts, in their center or in some of their green spaces. This need will be shared by most cities in the world as transportation costs increase. That is the case in Kinshasa (Democratic Republic of Congo).

This new production approach throws into question regional planning, which always concentrates on urban sprawl – sprawl that is a major consumer of energy and agricultural land.

Useful info...

Integrated culture

Chemical fertilizers and pesticides cause pollution. When it is impossible to do without them, it would be better to use them curatively (when the problem occurs), rather than preventatively (involving systematic treatment), thereby saving money and reducing the health and environmental risks. Judicious association of certain plants makes their use redundant. Crops' parasites can also be avoided by breeding or introducing their natural predators.

Flowers for the bees

Three-quarters of agricultural crops depend to some extent on pollination, mainly by honeybees or other animals such as bats and bumblebees. Although it is not a requirement of wheat, corn and rice, most fruit and vegetables, oil and protein plants (e.g. soya and lentils), nuts and spices, need animal pollinators. Cocoa and vanilla both rely on pollination. Yet these pollinators' numbers are falling due to the intensification of agriculture and urban spread which have reduced their natural environments. This has resulted in crops in some regions finding it difficult to become properly pollinated. Increasing the number of vegetable plots and orchards is one effective remedy. These offer honeybees and bumblebees the variety of flowers they need to survive.

Biodiversity and our waste!

Individual composters

Making compost in a corner of the playground or on the balcony of a small apartment makes a difference.

Peelings and other food leftovers make up a large part of our waste. Placing them in a composter is a simple and economical way of recycling them. In most cities in the world, citizens are encouraged to separate this waste from the rest so that it can be recycled. Where? In special plants which transform them into compost or gas. But this recycling system is still fairly rare in many countries. This means that organic waste is buried, sometimes with other waste, or sent to incineration plants. This means their potential as fertilizer or energy is not realized.

Waste from green spaces

For organic waste to be recycled, it must be correctly sorted before being sent for a specific type of recycling.

This approach is vital, especially for "green" cities which have embraced and encouraged biodiversity, since a huge amount of waste is produced by the upkeep of green spaces (mowing and pruning).

This waste is easy to recover as it is localized and there is a significant volume. When you sort organic waste at home it is important to follow the instructions. Sometimes packaging or plastic bags are found amongst it after it has been sent to treatment plants. This forces the managers of these plants to carry out a second sorting, which makes the recycling process longer and more costly.

Producing energy and fertilizer

In cities which have established a special "green" industry, "green" waste is collected, mixed, pulverized and placed in reactors. These are closed containers which are lightproof and airproof, in which the organic waste ferments for about three weeks. During this process, micro-organisms break it down and transform it.

The product is then stored for three weeks at 60°C in a container it which becomes compost and methane. The compost is then refined before being sent to farmers, departments responsible for maintaining public parks, or private individuals. It can be used as natural fertilizer to enhance the soil. Meanwhile carbon dioxide and water are removed from the methane. There are then three possible places it can be sent. It can be used as fuel for buses which run on natural gas, be fed into the town gas network, or be injected into a turbine to be transformed into power.

Biodiversity is not all-powerful

The "recycling" service provided by microbial biodiversity has a very strong educational and symbolic value – biodiversity provides fertility and energy.

This service provided to us by biodiversity is effective, useful and necessary. Nevertheless, it would be fanciful to think that all our waste could be "digested" by this particular biodiversity. That is only possible for a small quantity of the biodegradable and fermentable waste. Believing that biodiversity is all-powerful means paying no attention to what we consume and throw out. The important thing to focus on is obviously recycling. To avoid cities suffocating under their waste, it is important firstly to consume better, and secondly to follow sorting instructions. Because some of our waste can be recycled: paper, card, some plastic, aluminum, etc. We can give them a second life!

Phytorehabilitation

Biodiversity can help to tackle pollution – in a process called phytorehabilitation – on contaminated land, industrial soil, mine pitheads, disused commercial sites, etc.

Plants grow spontaneously. They use up pollutants, such as heavy metals and pesticides, or else store them in their fibers. Pollution can be removed from land by clearing it regularly. By regrowing, the plants continue the task. Other plants appear when the ground is free of pollution. A natural environment gradually takes over land that appeared to be permanently condemned.

Humans can speed up this process by planting strains such as poplar.

But what can be done with the clearance waste? If it is left to rot, the stored up pollution will be released again. Nothing will have been achieved! It must therefore be considered as hazardous waste, meaning waste which must not under any circumstances be placed in a composter. It should be placed in a special storage center.

Useful info...

Dumping and biodiversity

Dumped waste is a haven for biodiversity. It attracts rats, dogs, cats, birds, primates and bears, as well as numerous disease-carrying micro-organisms. Is this the kind of diversity city-dwellers want to encourage? Waste is above all a matter of public sanitation. Collecting it and concentrating it is the least a city's authorities can do.

Roots and bacteria

Certain plants naturally clean pollution from soils. Just over 300 "hyperaccumulators" have been identified around the world. Specialists have divided them up into several categories: plants capable of accumulating heavy metals in their tissues, plants capable of accumulating zinc, plants capable of accumulating radioactivity and plants capable of accumulating hydrocarbons and organic solvents.
These plants owe their development to the quality of the soil, to micro-organisms and to the biodiversity of which they are composed. A sterile polluted soil would remain polluted for a long time. Soil which is still rich can develop, even in a very polluted area.

Biodiversity, going with the flow!

Transpiration of plants

As everybody knows, water is life.
What fewer people realize is that water also depends on life.

Biodiversity breathes. It releases carbon dioxide and water, as plants transpire, in a process called "transpiration". This transpiration obviously does not release as much water into the atmosphere as the evaporation from oceans. However, at a regional level, this water defines the level of the air's humidity and the intensity of rainfall. In a region without any trees, rain is impossible. ÀThe effect is even more apparent on the scale of a city. Thanks to vegetation, a city feels less heat. This is because transpiration is a physical process which consumes energy. By transpiring, parks, gardens, green spaces and even the smallest potted plant consume heat from the atmosphere. This cools it as the vegetation gives it its water - the humidity which will later be transformed into rain.
Biodiversity is therefore responsible for rain and sunny weather. It has a major influence over the water cycle.

Soil slaking and biodiversity

Soil reacts in one of two ways when water falls on it.

If it hits soil growing vegetation, it will be immediately "drunk" by the cracks in the soil. If it lands on soil without any vegetation growing, the water droplet will send up a plume of dust. When it falls, this dust will seal the cracks in the soil. It will then form a thick "slaking crust" which the next lot of rain will run off as if it were a road surface.

Slaking is even quicker if the soil is dry and rains are heavy and sudden. Slaking is almost impossible on soil without any vegetation but which is rich in humus (decomposed organic matter).

Slaking considerably accelerates the process of run-off. The soil becomes waterproof and can no longer absorb water which lands on it from the sky or from an overflowing river. This additional water runs off the soil and increases the risk of flooding. It is therefore clear why it is in cities' interest to ensure the land upstream from them is well planted with vegetation: it is a form of natural insurance against flooding.

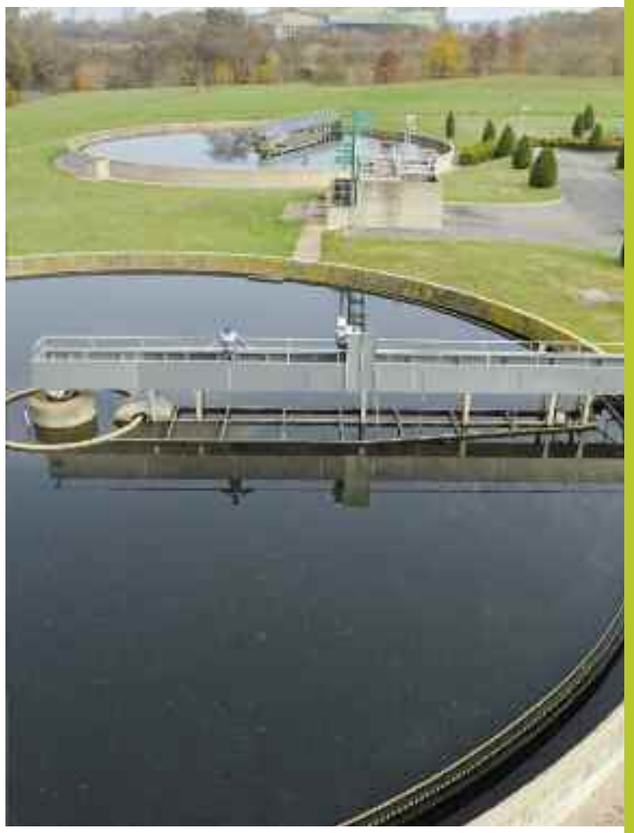
But there is vegetation and there is vegetation! A meadow and a forest do not have the same effect against run-off as a field of wheat. What matters is the density and depth of the roots and the biodiversity concealed in the soil. Tunnels, holes and permanent cross-fertilization of seeds put air into the soil and improve its structure as well as its ability to retain water. So when there is a lot of rain, a lawn is just as effective as a tarmacked avenue. To avoid flooding and landslides, a city must preserve the natural system of water flow as much as possible: the line of rivers, the distribution of wetlands and riverside vegetation.

Water reserves

Wetlands located upstream of cities have another advantage – they store water. These types of environment act like sponges.

Since water passes through them very slowly and they have a considerable capacity, wetlands remain engorged with water when the rivers which supply them have run out. For the cities downstream, they are like a retention dam regulating the flow.

Nature certainly provides a range of services which can assist human intervention.



Useful info...

Wastewater treatment plants

The essential function nowadays of a wastewater treatment plant is to remove pollution from water to make it clean. At the end of treatment, the water is divided into cleaned water which returns to the natural environment (sea, river, etc.) and sludge which needs to be disposed of. Some of this sludge is rich in nutrients and can be spread on the soil as fertilizer.
By 2020-2025, wastewater treatment plants will not only produce clean water, but also bioenergy and biomaterials. Rather than wastewater being considered as water that needs cleaning, it will be considered as a recoverable resource.
The wastewater treatment plants of the future will be able to prepare various qualities of water for different uses: water for irrigation, water for cleaning and water for cooling. And there will be two recovery sectors: energy and green chemicals.
Energy can be produced from the carbon contained in wastewater. And the sugar, grease and proteins will be sent to a reactor to produce biogas. This biogas will enable the wastewater treatment plants to be energy independent. The rest of the organic material will be used to make green chemicals. Manufacturers of bioplastics can recover biopolymer balls which can be used to make a wide range of products: packaging, pens, computer mice, vehicle bumpers, etc.
The water will no longer simply be treated, it will be transformed and recovered.

Pollution of rivers

When it rains, water runs off roads and roofs. As it circulates, it gathers numerous pollutants. Unless it is treated, this water flows into rivers which it then contaminates. Very little is required to reduce this pollution, however. For example, we can plant rows of very hydrophilic trees, such as willows and poplars. If these trees are planted close to rivers, they literally absorb certain pollutants such as nitrates.
This is how biodiversity can protect us from some water pollution.

Mow!

Plants transpire and refresh the air in cities. But they are especially effective when they cross-pollinate. In other words, meadows which have reached maturity need to be mown for transpiration to continue.

"When biodiversity brings my city to life!"

Biodiversity cools cities!

Leafy trees to give cities shade

Trees and plants cool the atmosphere when they transpire. When they have room to spread their branches, trees provide city-dwellers with shade.

Yet in many cities, trees have been planted too close to each other. They are pruned too frequently. While gardeners in the past planted for the future, favoring the tree, nowadays they plant for the visual appeal, favoring esthetics.
This practice is neither far-sighted nor particularly effective. This is because by being cramped, trees seriously lack space. And they suffer as a result. They have neither sufficient space to spread their branches and their roots nor enough air to respire. In cities, trees suffer from the heat and successive pruning changes their shape and encourages attacks from parasites such as fungus.
In cities, trees survive for a much shorter time than in the countryside. Their metabolism is affected and their lifecycle is accelerated. After 50 to 100 years, they need to be cut down and replaced.
According to botanists and urban planners specializing in encouraging greenery in cities, half to two-thirds of trees planted along streets and waterways are redundant. If we cut down these excessive individuals, the ones left would end up filling the gaps with their foliage which could finally develop. This would provide better shade.

Heat islands

The more inhabitants a city has and the more spread out it is, the denser the traffic and the more heat it releases. There are two reasons for this.

The first is related to urban planning. In geometric cities, organized around big avenues and giant squares, the sun's rays hit the ground. A better relationship between the width of roads and the height of buildings corrects this problem: a building which is higher than the width of the road creates shade and coolness. However, air has difficulty escaping if buildings are too high. This is because hot air, which rises, becomes trapped. Road surfaces and sidewalks also release heat. Under the effect of the sun's rays, road surfaces tend to soften or even melt. When shade arrives and the air temperature falls, the surfaces cool and return the previously stored heat to the atmosphere. The atmosphere therefore heats up just when you would least expect it – when night falls.

The second reason is that in cities, industry, vehicles and homes release a lot of heat. Let's take the example of cars. The main job done by a combustion engine is not moving the car forward, but heating the atmosphere. This is because 80% of the energy stored in a given amount of gasoline is transformed into heat during combustion.

To avoid generating so much heat in cities, it is better to use public transport to travel. Homes and offices also produce heat – and waste a lot when they are poorly insulated. What about air-conditioning? This removes heat from inside and expels it outside. Of course, it must be accepted as a necessity in confined spaces, to keep the temperature bearable.

Vegetation – a thermal insulator...

Wherever they are located, in summer modern cities create a "heat island". It is therefore vital to encourage shade. With large trees and ample foliage, cities can reduce heating of their road surfaces. They also produce coolness, since trees transpire, absorbing heat from the atmosphere and cooling the city.

Offices and homes also benefit by having a lot of vegetation. Climbing plants, trees on patios and potted plants behind glass windows provide some shade. If well designed, green walls can act as good thermal insulators, both in summer and winter. But there is something even better: green roofs. The temperature of roofs can be halved by insulating them from the sun's rays using plants. This reduces the temperature of the upper floors and also protects the roof. There is less of an effect in the opposite direction, however. In winter green roofs cannot prevent heat escaping from the inside to the outside.

...and an excellent particle filter

When planted in thick, dense hedges at the foot of a wall, vegetation plays another role. It slows down the wind which sucks heat from homes. Less wind also means much less pollution for humans and animals. The wind flow created by hedges and tall trees reduces pollution. Fine particles, mainly released by engines and chimneys, hit the leaves and remain on them or fall to the foot of the tree. Even a small hedge can be effective. A height of 1.50m along streets is generally enough to significantly reduce the number of particles in the air.

Useful info...

Snow

Snow is the best way of illustrating all the effects of vegetation on the air, its speed and its contents. A building with a high, wide hedge a few meters away becomes much less snowbound than a bare building. The wind deposits the snow behind the hedge, so there is much less snow on the building. A very dense hedge tends to retain snow, while a hedge of medium density scatters it uniformly behind it – sometimes up to 25 times its height!

Conifer or deciduous?

Should you plant conifer or deciduous trees? Like all species whose leaves are a complex shape, conifers are more effective at filtering pollution. They are also more effective at providing thermal insulation and shade. However, conifers are not particularly good as windbreaks since their needles have a very low volume. Deciduous trees are better at protecting a home from the wind. Remember to take into consideration the seasons when trees shed their leaves!
The choice of species is essential depending on the region in which you live.

Less noise?

It is commonly accepted that vegetation along a wall or in front of a window does not insulate against noise. A hedge at least 1m thick is needed to reduce the noise level by even a single decibel.

Zoos and museums, guardians of biodiversity!

From cages to islands

Zoos, menageries and zoological parks had a very bad reputation for a long time. Until the early 1980s, they were considered to be sad places where you would see sick animals which people thought were badly treated.

Whether or not it was true, this reputation did a lot of harm to these establishments and stirred up public hostility to them at the time. Things are now very different. Zoos and menageries have won back the public by improving their facilities and the animals' living conditions. They have also become vital to scientific research and the protection of endangered species.

Zoos have changed the way in which they present animals. Species are now given larger and higher spaces. Animals in captivity enjoy good living conditions: an environment reconstructing each one's habitat or ecosystem and permanent care.

Finally, traditional boundaries between the public and the animals (meshes, concrete walls, etc.) have disappeared or been reduced. Observation has also been improved, particularly through the transformation of cages into "islands", with the living environment separated from visitors by a double fence or a moat filled with water.

Observing animals

These types of improvements have been made possible by an improved knowledge of animals' needs.

Nowadays, the living conditions of animals in captivity are close enough to those in the natural environment for the observations made to be considered scientifically valid.

The African hunting dog is a good example of the fundamental role played by zoos and zoological parks in the protection of species. It was trials in captivity which provided an explanation as to why the usual vaccination against the terrible disease canine distemper generated so many side-effects in that species. As a result, other forms of vaccine and vaccination methods were developed. Only a confined environment like a zoo provides biologists with the appropriate conditions for studying diseases specific to certain zoological groups or species.

page 20

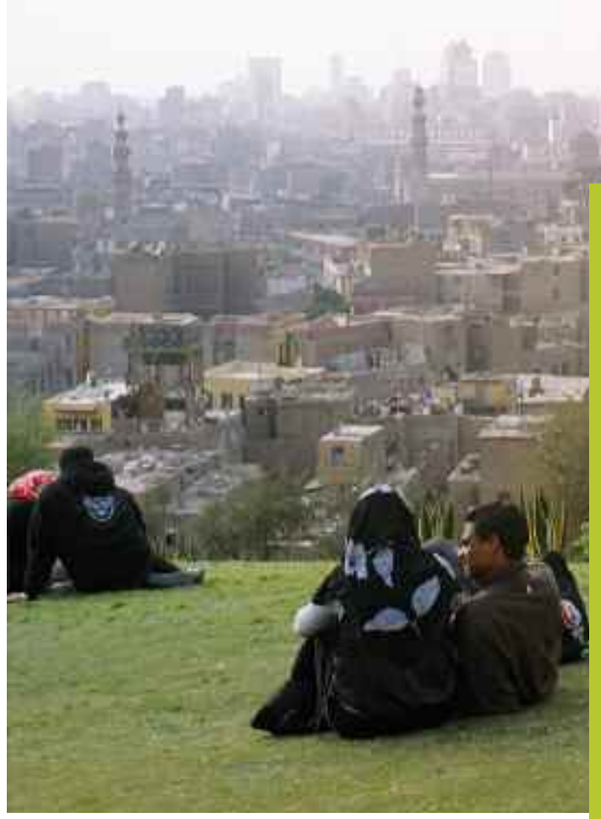
Reproducing species

Genetic disorders can be caused by captivity. Or, to be precise, reproduction in captivity. Since there are few individuals in captivity, there is a high risk of their genetic heritage becoming weaker (inbreeding) and that increases the risk of deformity, disease, etc. Studies into the genealogy of captive individuals have nevertheless made it possible to prevent this danger. International programs, in which almost all establishments on the planet participate, have managed to establish animals' history.

This history is recorded in "stud books". There is one for each species whose reproduction in captivity is deemed to be vital. These are most often species which are seriously endangered in their natural environment.

What do these stud books contain? The same information as stud books used by breeders of race horses. The following is listed for each individual: provenance (natural environment or zoo of origin), date of birth (if in captivity), place of birth, parents, any transfers, and date, place and cause of death.

Armed with this information, the person responsible for the species' stud book can decide which female from which zoo a particular male should mate with or which young can be transferred.



Stud book

Zoos around the world have become reproduction centers for endangered species. They exchange and lend each other animals based on the information recorded in stud books. Species are not traded, since transfers are free of charge. The recipient establishment pays only for the transportation cost. But not just anyone can be a recipient. For an animal to be transferred from one zoo to another, it must be able to provide suitable conditions. For some species, zoos also exchange straws of semen or implant embryos. This is often how tigers are reproduced in captivity.

Tame?

The objective of zoos is to safeguard endangered species. Individuals are regularly released into their natural environment. Reintegration is sometimes difficult. Animals which have been born in captivity are mostly unfamiliar with life in the wild. Before being reintegrated, they must be taught to hunt for their food, to teach their young to recognize inedible plants and to avoid dangers they have never encountered before. Vets' main concern is actually animals becoming tame in captivity. Zoologists have advanced the theory that after several generations of reproduction in a confined space, animals have become mutants which no longer bear any relation to their wild cousins. However, others believe that with proper re-education, any animal will be able to adapt to life in the wild if it is reintroduced.

Useful info...

Reintroduction into the natural environment

Some wild species have only survived because of the zoos which housed them. In 1987, San Diego and Los Angeles zoos (United States) collected from the wild 27 Californian condors which were finding survival difficult. To avoid inbreeding, this small population needed to be significantly increased. Condor eggs were therefore collected to raise them from the nest and ensure their reproduction. Five years later, demographic success seemed to be in sight. It was decided to reintroduce 13 condors into Colorado's Grand Canyon. Unfortunately, five of them died quickly, because they did not know how to recognize human obstacles (high-voltage wires, for example). The surviving condors were rounded up and trained how to live in the wild. Now, just over 70 condors live in the south-eastern United States. But they are not completely out of danger yet. The condors that eat carcasses abandoned by hunters absorb lead, which then poisons them.

Muséum d'Histoire Naturelle

The Muséum National d'Histoire Naturelle is dedicated to knowledge, conservation of biodiversity and the relationship between humans and nature. It is responsible for major scientific discoveries in the natural sciences. It is a reference center for the study and preservation of biodiversity. It is also a research center. Its educational work as well as various initiatives to promote the transmission of knowledge – through its galleries, its zoological parks and its botanical gardens – make it one of the leading public institutions for informing and raising awareness about protection of our environment.

Nature reserves

Zoos and zoological parks are not in opposition to nature reserves. On the contrary! They fund programs to maintain the natural environment, as well as programs to promote the reproduction of species for which they are responsible. The important thing is for reintroduction to be carried out under the best possible conditions: in a preserved habitat and in a genetically diverse population.

Aquariums

Large public aquariums meet the same requirements as zoos and zoological parks. They also have a conservation role in relation to pinnipeds (seals and sea lions) and scientific monitoring (for cetaceans, i.e. whales, dolphins, and porpoises).

Two obligations

The Washington Convention of 1979 prohibits the removal of endangered species from their habitat. This is why zoos and zoological parks are obliged to breed and exchange their specimens. The 1992 Convention on Biological Diversity also stipulated that "in situ conservation" must "respect, preserve and maintain knowledge, innovations and practices of indigenous and local communities embodying traditional lifestyles relevant for the conservation and sustainable use of biological diversity and promote their wider application with the approval and involvement of the holders of such knowledge, innovations and practices and encourage the equitable sharing of the benefits arising from the utilization of such knowledge, innovations and practices."

Your ideas!

Your ideas!

Your ideas!

September 2010 / Document produced by
Veolia Environnement's Communications Department.
Editorial coordination: Julie Chavaribeyre /
Copywriting: Frédéric Denhez /
Illustrations (design and production): SLR /
Illustrations: Laure Duquesne, Gilles Hureau /
Graphic design: Valérie Charlanne, Téo Löhrer -
Damien Lagier | COMAMA. Translation and layout: TagLine.

Veolia Environnement sincerely thanks the Muséum National d'Histoire Naturelle for its participation and advice, particularly Delphine Nahon and Hugo Plumel. Thanks also to Adrien Rozès for sharing her insights into this package with us as well as all those who contributed to enriching this document: Valérie Charlanne, Chantal Chavaribeyre, Pauline Danel, Geneviève Férone, Julien Juge, Philippe Langénieux-Villard, Johann Lasserre and Mathieu Tolian.

Photo credits / VEOLIA media library: Christophe Majani d'Inguimbert, Rodolphe Escher, Olivier Guerrin, Richard Mas, Jean Philippe Mesguen, Jean-Francois Pelegry, Manolo Mylonas, Jean-Marie Ramès, LE SQUARE / F. Benausse / A. Desvaux / W. Crozes, Alexis Duclos, Philippe Eranian, Chien-Min Chung – Polaris/interlinks Image, Denis Dailleux / Agence VU, Stéphane Lavoué / MYOP, Chris Maluszynski / Agence VU, Justin Sutcliffe - Polaris / interlinks Image. MNHN - L. Bessol, B. Faye, P. Lafaite, E. Gonthier, C. Lemzaouda. Matton images: Blend Images, fStop Images, Imagebroker, Moodboard, OEM Images, OJO Images, Radius Images. Julie Chavaribeyre, Fred Christophorides.