

Exhibition Forest. Berlin. Climate.

Main entrance

12.01. Großes Infoschild

Welcome, friends of the forest!

Dive into a different world just a few kilometres away from the city centre. No annoying noise, no high-speed society, just fresh air and the twittering of birds - pure nature.

Experience the unique exhibition »*Wald.Berlin.Klima.*«.

You will find 11 info stations, our so-called »*forest lounges*«, scattered along a 4 km trail, which describe how Berlin's forests have adapted to a changing climate. Look forward to enjoying special installations, wooden runways and platforms, which will give you a new point-of-view on the significance of the forest for our capital, Berlin. Discover forest landscapes and natural scenery, bodies of water and mires, and find out about how important it is for all of us to preserve the urban forest. Get an impression of the measures necessary to preserve this landscape.

Watch closely! Dive in! Take a deep breath!

Relax and become a fan of »*Wald.Berlin.Klima.*«!

Grunewald forest is a protected landscape

The Grunewald is a forest area covering about 3,000 hectares in the western part of Berlin. It gives people the chance to get away from the city and also to enjoy the impressive buildings such as the Grunewaldturm or the Nikolskoer Landpartie, which are part of the world cultural heritage »*Potsdamer Schlösser- und Seenlandschaft*«.

The Grunewald is part of the Landschaft Teltow, which originated about 20,000 years ago during the Weichselian ice age. In the late 19th Century, Berlin residents established the Grunewald as a recreational area, which it remains today.

- The Grunewald produces around 20,000 tons of oxygen and removes more than 150,000 tons of dust from the air every year
- It is home to numerous endangered animal and plant species as well as microorganisms
- Every year, 20,000 m³ of timber are harvested
- Large proportions of Berlin's drinking water are gathered in the forests
- For a growing metropolis, the forest is an important recreational site

The Grunewald forestry office and its six associated district forestries manage and maintain the forest and, in addition, a further 3,000 hectares of forest in Brandenburg. The forestry office ensures the numerous demands on the forest in balance. As a result of their hard work, the Grunewald was awarded the Waldgebiet des Jahres ("Forest Area of the Year") in 2015 by the German Forestry Association.

Climate-neutral Berlin 2050

Berlin contributes to climate protection: the Berlin Senate is pursuing the long-term goal of developing Berlin into a climate-neutral city by the year 2050. For that purpose, the emission of the Greenhouse gas carbon dioxide has to be reduced by at least 85% compared to 1990. The emission of greenhouse gases is the main cause of human-induced climate change.

The Berlin Senate is planning a series of measures to achieve the goal of being a climate-neutral city. Above all, a largely renewable energy supply will be built and intelligent infrastructures (e.g. in the

power grid) created. In addition, people will be encouraged to be part of a responsible urban society, in which people can participate in climate protection and contribute their own ideas,.

The improvement of forests and the preservation of mires play an important role in Berlin's efforts to protect the climate.

Mixed forests for Berlin!

Something is going on here - Berlin's forests are being gradually converted.

In the past, mainly pine trees were planted, but now, mixed forests are being created. Why is this forest conversion urgently needed? How does it happen? How do people in Berlin benefit from it?

For centuries, the majority of trees planted in the forests around Berlin were pine trees. Today, the disadvantages of these pure pine plantations have become clear:

- Storms, prolonged dry spells, or insect infestations can cause severe damage
- Rainwater is not retained well
- Biodiversity is limited

These problems will become increasingly important in coming decades - as extreme weather conditions are likely to occur more frequently. , Mixed forests with a range of broad-leafed trees and conifers are being created where pure pine forests currently grow. They will be better equipped to cope with the conditions in the future than pine plantations. More than a third of Berlin 's forests have to be actively transformed by human hands. To achieve this goal, the Berlin Forestry Commission (Berliner Forsten) have developed an ambitious mixed forest program (Mischwaldprogramm). An investment in Berlin's future.

12.02. Kleines Infoschild

WALD.BERLIN.KLIMA.

A brief history of Berlin's forests

Long before Alexanderplatz and Ku'damm appeared, Slavs lived in small settlements on the banks of the river Spree, the river Havel and numerous other rivers, streams and lakes in and around modern Berlin. These settlements were surrounded by forest. Nothing else!

Then the colonization of the east of Germany began and new settlers speeded things up. Agricultural developments enabled these settlers to cultivate larger areas of arable land. Roughly two-thirds of the forest area gradually fell victim to this settlement.

After extensive clearances of species-rich mixed forest to obtain new arable land, only a few pine and oak stands were left on the less fertile sites.

In 1237, Berlin was founded - the growing settlement needed large quantities of construction timber, firewood, resin and charcoal. Oak bark was used for tanning animal fur and as plant litter in animal husbandry. More and more primary forests disappeared.

The remaining forests were increasingly used for timber production. Pines in particular were replanted. They are well suited as construction timber, since they grow straight and relatively quickly. In 1709, Berlin became a Prussian residence. The creation of hunting grounds and game drives for the royal hunt then imposed a further burden on Berlin's forest.

A metropolis secures its forests: the Permanent Forest Contract of 1915

In the 19th century, Berlin became a major city. It entirely lost its urban forests due to the construction of housing. The city was fortunately able to acquire peripheral forest areas such as in Tegel, Grunewald, Potsdam, Köpenick and Grünau, as well as through the incorporation of various forests areas. The population of Berlin increasingly disapproved of the conversion of forest areas to building land. The desire to preserve and protect the surrounding forests led the city of Berlin to obtain extensive forest lands in March 1915 and commit to preserving them as forests and not to sell them as building land. The Permanent Forest Contract ("Dauerwaldvertrag") of 1915 is still valid today! However, the intensive use of forestry and the preference of the fast-growing pine continued.

Reconstruction: Forests created by the hands of Women

Did you know? Most of today's Berlin forests were planted by »Kulturfrauen« ("Cultural women"). After the Second World War, wood was scarce. It was necessary for heating and cooking as well as for the reconstruction of the destroyed city. Additional areas were used for "Reparations lumbering" -in total 10% of the forest area in Germany was lost this way. The situation was further aggravated by the Berlin blockade. It was mainly women, who worked as seasonal workers in the forest districts, who carried out the reforestation at this time. The tree selected to cover the, often large, clearings was usually - again - the pine. As a pioneer species, it was best able to cover these areas and was available both as seed and as seedlings in large quantities.

...and what about today?

Pine forests - mainly created in the post-war years - still characterise the appearance of the Berlin forests. However, the development of these unstable pure pine stands into richly structured, near-natural mixed forests was started as early as the 1980s. With the "Mixed forest program" launched in 2012, this development has been stepped up. The new mixed forests are designed to have a similar composition of tree species as the "Berlin primary forest" and are better adapted to cope with the expected climate changes.

- Today, forests cover 18.2% of the city's area. That is as much as the area of the three city districts Mitte, Pankow and Friedrichshain-Kreuzberg taken together.
- Berlin's total forested area is 28,500 hectare, of which 40% are located outside the city in Brandenburg.

12.03. Haupteingangsmarker

Guided Tours:

Available by appointment.

Further information:

www.berlin.de/senuvk/forsten/wald-berlin-klima

Facebook: www.facebook.com/Wald.Berlin.Klima

Lots of interactive fun is waiting for you in our app "uRnature" (created by U-DATA). It offers exciting stories, challenges, secret missions, and lots more. Download the app in your app store and get started!

Side Entrance

13.01. Nebeneingangsmarker

Welcome to the **Wald.Berlin.Klima.** exhibition!

You will be able to experience 11 varied and exciting info islands on this 4-kilometer-long exhibition trail and discover how Berlin's forests are being made fit for the future.

Berlin's forests offer not only the chance to take a walk, but they give the city much more:

- Delicious drinking water
- Fresh air
- Biodiversity
- A great contribution to climate protection.

At the moment there are many pure pine forests in the forest in Berlin's forests. The pine monocultures, however, will not be able to cope with a changing climate in the future. Above all, the prolonged periods of dryness that are becoming ever more frequent. These areas are therefore being converted into mixed deciduous forests.

What do people in Berlin get out of these changes? What exactly is happening in the forestry and why will it take decades to complete?

Wald.Berlin.Klima. bringing the forest management alive for you. Here you can experience and discover the forest and its future with all your senses! Follow the markings and let yourself be surprised at what we have got to show you at the various info islands.

Info station 1

Caution, construction area!

Forest conversion

01.01. Inselmarker

Caution, construction area! Berlin's forests are being prepared for the future - but what exactly happens during a forest conversion? Why do we need this century-long task at all? And how do Berliners benefit from it? Here we are, right at the construction site. Take a look for yourself!

App station

Combine your nature experience with some interactive fun! This info station is linked to a game you can access via your uRnature app.

01.02. Bezugsschild

A view through the picture frame

Forest conversion is a project that will take many decades, not least due to the slow growth of trees. But how is it realised in detail? Take a look through the picture frame! You will see a fenced area - a portion of the " Forest construction area ". What impression do you get of the forest here? Which details do you notice when you take a closer look? And can you imagine, what kind of "construction work" is taking place here? Naturally, you are also welcome to take a souvenir photo using our picture frame as a backdrop.

01.03. Großes Infoschild

Forest conversion: How does it work?

Here you can see how a pine forest is being developed into a mixed deciduous forest. Pines dominated the forest until a few years ago. Black cherries (*Prunus serotina*) originating from North America were abundant in the undergrowth and hindered the growth of young native tree species. In the course of the forest conversion, some of the conifers were cut down and all the black cherry trees were removed. Native and typically broad-leaved tree species were planted in their place, for example Beeches, Oaks and Hornbeams. The seedlings are protected by fences, which stop them from being eaten by wild animals. Forest conversion is usually based on self-seeding and the natural rejuvenation of the broad-leaved trees with human support . However, this principle isn't effective everywhere: At some sites, the forest needs both support and active silvicultural measures. The forest conversion is carried out by Berliner Forsten (Berlin Forestry Commission) and financed by the Berlin Senate's Mixed Forest Program. The aim of this program is to provide a natural, multi-layered and richly structured mixed forest. The aim is to achieve the same composition of tree species as was naturally occurring in this region before human interference.

»Silviculture«

- The function of silviculture is the maintenance and rejuvenation of existing forests as well as the establishment of new forest stands with the aim of securing and improving the growth and stability of the tree population according to the principles of sustainability.

Look out for pines and black cherries along the whole trail - many areas have not yet been converted, as the forest conversion is a long-term project that takes several decades!

Climate change in Berlin: How good it is to have forests!

Even in their current state, the urban forests provide an important counterbalance to the densely populated city. Have a look around - what do you find in a healthy forest that you might miss in the city centre on a hot summer day? As a consequence of the climate change, the average climate in Berlin will become warmer and dryer in the future. Extreme weather phenomena are likely to occur more frequently. These are dangerous developments for pure pine stands, which will have to withstand dry spells and storms more frequently than today. Mixed forests are more stable and better suited to cope with these changing conditions. Forest conversion also contributes to climate protection: a mixed forest with a wide range of species and a mixed age structure can bind more CO₂, which is a major cause of climate change. There are two main reasons for this:

1. A mixture of tree species prevents a single pest from threatening the whole forest.
2. As a tree stand reaches grows older and starts to naturally decay, less and less CO₂ is bound. In a layered mixed forest, wood keeps growing in the younger layers and thus binding the climate-threatening gas.

Piktogramme

How do the people in Berlin benefit from forest conversion?

Take a look at the advantages of forest conversion. You will be able to find these symbols at several stations along the trail. They will explain the benefits and enhancements resulting from the silvicultural measures.

- On a hot day, it's especially relaxing to go hiking in the cool shade.
- Extensive forests produce cool air on hot summer days, and the resulting chimney-effect reduces the warming of the city as cool air is pulled into the city from the forest.
- More groundwater is created under deciduous forests than under coniferous forests. The reason: broad-leaved trees drop their leaves in autumn, which reduces evaporation.
- Mixed forests bind the greenhouse gas CO₂ more efficiently. Thus, forest conversion contributes to climate protection.
- As a result of forest conversion, numerous animal and plant habitats are secured and improved.
- Please respect the fences and barriers in the forest. They exist for a good reason! By doing so, you can help to protect the young oaks and beeches in their early life.

01.04. Infografikschild

Berlins forest are being prepared for a changing climate

How does climate change affect the forest? And how can the conversion of the forest help it to better cope with the effects of a changing climate? A tree's lifespan is long, and the trees planted today still need to be able to thrive under future climatic conditions. The best way to deal with the risks of climate change is to promote high diversity within the forests - a rich composition of tree species, multi-layered stands, and a mixed age structure.

Problems of monocultures:

- little resistance to the results of climate change such as changing precipitation, temperature, and wind speed.
- soil acidification
- instability against storms, dry spells, fire or insect attacks
- less groundwater formation and inferior water quality

Advantages of mixed forests:

- near-natural, multi-layered and richly structured
- greater resistance
- greater groundwater formation and retention
- securing and increasing biodiversity

01.05. Infografikschild

Forest conversion: a task for centuries

This map shows Berlin's forest areas. They include areas in Brandenburg, which belong to the city of Berlin and are being managed by Berlin Forests. You can see which areas still need to be converted and where work has already begun. This conversion needs to be speeded up as in investment into the future of following generations. That's why, in 2012, the Berlin Senate started the so-called "*Mischwaldprogramm*" (Mixed Forest Program).

Legende Infografik erklären!

Basic contents of the Mixed Forest Program:

- Currently, new forest conversions are initiated on an area of 100 hectare annually. That resembles an area of 140 soccer fields.
- The goal is to convert 300 hectare per year – an area of 420 soccer fields, or the area of Tempelhofer Feld.
- The Berlin Forestry Commission estimate that more than one third (or more accurately 10,000 of 28,500 hectare) of the Berlin forest area needs to be converted over the coming decades.

Info station 2

Back to the Future

02.01. Inselmarker

A forest often is a part of nature that's cultivated by humans: It cleans the air and water, is a valuable ecosystem, produces timber – and also, looks simply beautiful. To fulfil its numerous tasks, the forest needs care and attention.

What does this care look like? And what actually is a forest? Keep reading and find out!

02.02. Bezugsschild

Can you see the difference?

Not all forests are the same: Here, you can directly compare two quite different forest landscapes. Look through the window! On this side, you can see a rather monotonous conifer stand with a lot of undergrowth plants ("scrubs"), which may give you a feeling of narrowness. Keep these ideas in mind and compare your impression with the one you get while looking at the forest from the next level. What differences can you spot?

On this side, you can see a much brighter, more airy stand with different tree species and a mixed age structure. This is what the goal of the forest conversion looks like. Even if no large-scale forest conversion is required, the foresters invest a lot of time, money and commitment into the care of the forest. Silviculture is an important task, as almost one third of the area of Germany is covered by forest. Since the year 2000, the total forest area has stayed at 11.4 million hectares - 120 times the area of Berlin!

02.03. Großes Infoschild

One forest - many demands

There are no more primary forests, untouched by humans, in Germany: Our forests are protected and managed cultural forests. They are designed to fulfil three main tasks:

- Recreation: Provide relaxing surroundings for everyone to enjoy.
- Protection: Store water, protect us from flooding and keep the drinking water clean so that plants, animals and other living beings can form a precious ecosystem.
- Utilization: Supply timber - an essential resource, for example as building material and for energy production.

»Forest«

- A forest is a plant formation mainly consisting of trees that is large enough to develop its own characteristic climate. It includes smaller areas without trees, e.g. clearings. Tree nurseries and parks overgrown by trees are not considered to be forests.

The objective of contemporary sustainable silviculture is to reconcile these three tasks with each other. However, certain forests are especially designated as recreational forests or protective forests in order to focus on a specific function.

Forest Management

By tending the forest, foresters maintain and improve the growth and stability of the forest. A range tree species that suit the local conditions are selected and encouraged. The most important tending strategies, which are used are:

- Weeding: uprooting vegetation that blocks the light and shades saplings (e.g. ferns, grasses).
- Brushing: removing weaker competitors to promote strong young trees.
- Thinning: taking away ill, crippled, or dead standing trees.
- Rejuvenation: cutting of mature trees for logging and to support the natural rejuvenation. This creates space and light for the growth of new trees.

Who owns the German forest?

48% private owners

29% federal states

19% cities and municipalities

4% federal government

Managers of the forest

Foresters are responsible for the sustainable and profitable use of the forest. That involves a whole range of everyday tasks:

- Planning and realising silvicultural and tending measures (e.g. thinning)
- Protection of the ecological equilibrium (e.g. maintenance of a biotope, hunting)
- Managing logging, and processing and selling timber
- Conservation of the recreational areas and paths (e.g. construction of forest trails), offering guided tours
- Consulting for and supervising private forest owners.

The German stereotype of the traditional forester, as seen in classic "Heimatfilme" focused on rural outdoor life, is completely out-dated and instead a diverse profession has taken its place. You now need to study Forestry at a university or technical college if you want to become a forester.

Piktogramme

How do the people in Berlin benefit from forest conversion?

Take a look at the advantages of forest conversion. You will be able to find these symbols at several stations along the trail. They will explain the benefits and enhancements resulting from the silvicultural measures.

- The forest is a standing invitation for a nice walk!
- Forest air contains very little dust and is rich in essential oils!
- Forests feed Berlin's taps! Forest floors filter and retain precipitation.
- Trees bind the greenhouse gas CO₂ while growing.
- The forest forms a mosaic of precious habitats.

02.04. Infografikschild

Stratification

A forest is like a building with several floors: the vegetation forms definable layers, which are inhabited by different animal and plant communities. This is called stratification.

From the attic to the basement, the availability of light, water and nutrients vary. Can you spot the layers shown in the illustration in the surrounding forest?

Tree Layer

- Divided into Upper Tree Layer (Crown Layer) and Lower Tree Layer
- Crown Layer: forms a fully or partially closed leaf canopy

Shrub Layer

- Divided into High and Low Shrub Layer
- Partial and full-shade plants grow here, e.g. Blackberries and Spindle
- In addition to shrub species there are young trees which have not yet reached the height of the tree layer

Herbaceous Layer

- Herbaceous (non-woody) plants, e.g. grasses, herbs, and ferns
- Early flowering plants appear first before the canopy fills out, e.g. windflowers and Snowdrops
- Late flowering plants are adapted to low light conditions, e.g. Phlox and Foxglove. They are important for bees to fill their winter stocks of pollen and nectar.

Moss Layer

- Vegetation growing directly on the surface of the forest floor of up to 15 cm in height, e.g. lichens and mosses
- Bacteria, algae and fungi decompose dead organic material

Root Layer (Rhizosphere)

- Roots, tubers, bulbs and other below-ground plant parts
- Worms, insects, bacteria, algae and fungi decompose dead organic material, which generates a supply of nutrients in the forest floor.

02.05. Infografikschild

Tree species in Berlin's forests

Depending on the local conditions, different tree species thrive at certain sites. The climatic and soil conditions as well as the availability of light determine which species grow best. The illustration displays which trees are present in Berlin's forests. This composition is the result of a century-long forest use and management.

The Pine

The Scots Pine (*Pinus sylvestris*) is relatively undemanding. It therefore thrives under the widest variety of conditions and also colonises previously woodless areas, as a so-called

pioneer species. Its native habitats are low-nutrient sandy soils that are either especially moist or especially dry, since competition from other species is relatively low there. It forms taproots with which it can draw water from lower layers of the soil. That makes it a specialist at surviving in dry habitats.

The Oak

Both the English oak (*Quercus robur*) and the Sessile oak (*Quercus petraea*) are found in Berlin's forests. While the English oak prefers deep, nutrient rich moist soils, the Sessile oak likes rather dry, warm conditions. Both species, like the pine, require lots of light.

The Beech

The Common beech (*Fagus sylvatica*) is a shade-tolerant tree species, which favours deep and nutritious soils. Its leaf litter crucially contributes to improving the soil; the beech is therefore also known as "The Mother of the Forest".

Info station 3

Berlin joins in!

03.01. Inselmarker

The Earth's climate is changing, and the emission of carbon dioxide through human activities is the main cause. Carbon dioxide? That's what fizzes when you open a bottle of sparkling water, and at its natural concentration, it ensures comfortable temperatures on Earth. Too much carbon dioxide in the atmosphere, on the other hand, threatens our livelihood. The good news is that there are plenty great ideas and solutions to protect the climate while improving our quality of life. Look at the installation in front of you and explore where our carbon dioxide emissions come from, how much we have to reduce them, and which options we have to do so!

App station

Combine your nature experience with some interactive fun! This Info station is linked to a game you can access via your uRnature app.

03.02. Bezugsschild

Berlin's CO₂

Berlin contributes to global climate change mainly by emitting the greenhouse gas carbon dioxide (CO₂). It is produced when coal, oil and gas are burnt, for example in cars and power plants. Take a guess: How much CO₂ is emitted in Berlin per person each year? The installation gives you the answer: All the wooden posts represent the annual CO₂ emissions of an average Berlin resident. One cubic metre of wood roughly binds the carbon from one ton CO₂ and thus contains 250 kg of carbon. The color-coded wooden posts show you how much CO₂ would be left if the output were reduced to a third by 2050 to help avoid uncontrollable climate change. The small wooden post in the centre represents the 0.03 tons CO₂ that one person in the Democratic Republic of Congo produces per year.

03.03. Großes Infoschild

Climate change – a challenge for the human race

»Climate and climate change«

- Climate is the relatively stable state of the atmosphere in a certain area. Weather data over a period of at least 30 years needs to be analysed before an accurate picture of the climate in one area can be built. In general, the term "climate change" refers to a change in the climate on Earth. It is not important whether this climate change has natural or anthropogenic causes. Current global warming is a man-made climate change caused mainly by the emission of greenhouse gases and deforestation.

Since industrialisation started, the climate on earth has changed rapidly. The average global temperature has risen by 0.8°C since then. Human activities are the main cause. This is why

we speak of "anthropogenic climate change". It happens many times faster than the warming that occurred at the end of the last Ice Age, which had natural causes. This climate change is taking place suddenly and rapidly. If we continue as we have been, the average temperature on earth could rise by up to 5°C over the next 80 years. This may not sound like much, perhaps we could all enjoy a barbecue at the lakeside in January, but it would have dramatic consequences for life on our planet, for example:

- Most of the world's glaciers would melt. This would cause problems for cities whose drinking water supply is fed from glaciers, for example in the Andes.
- A rise in sea level would threaten densely populated coastal areas.

Yes, there are realistic solutions!

At the World Climate Conference in Paris in 2015, governments around the world agreed to limit the rise in global average temperature to a maximum of 2°C - if possible, even below 1.5°C.* To achieve this goal, the emission of greenhouse gases must be drastically reduced through: reduction of energy consumption; more efficient use of energy; expansion of renewable energies sources such as wind and solar energy; stopping deforestation and boosting reforestation; and protection of mires.

* The temperature targets refer to the climate around the year 1850.

What does climate change mean for Berlin?

In the Berlin/Brandenburg region, the average temperature has risen by 1.2°C over the last 170 years, which is more than the world average. What should we expect in the coming decades? Extremely hot days, "tropical nights" (where the temperature doesn't fall below 20°C during the night) and long-lasting heat waves will become more frequent. The precipitation will be distributed less evenly over the course of the year. The summers will become drier and the winters more humid, which is unfavorable for the flora. Extreme weather events such as hailstorms and heavy rainfall will occur more frequently.

Berlin's goal: becoming climate-neutral by 2050

Berlin has set itself a target of being a climate-neutral city by 2050. The annual emission of greenhouse gases must therefore be reduced to less than 2 tonnes per person. To achieve this goal, Berlin is aiming to establish a largely renewable energy supply, intelligent infrastructures, and to promote a responsible urban society. By 2050, Greenhouse Gas emissions should be 85% lower than in 1990. Obviously, this goal can only be achieved if everyone in Berlin participates!

Piktogramme

How do the people in Berlin benefit from forest conversion?

Take a look at the advantages of forest conversion. You will be able to find these symbols at several stations along the trail. They will explain the benefits and enhancements resulting from the silvicultural measures.

- A stable, species-rich mixed forest makes a major contribution to climate protection: It can bind CO₂ more efficiently than a pure pine stand.
- Take a look at the information board called "CO₂ emissions in Berlin: Where do they come from? How can we reduce them?". We have collected some ideas that help prevent climate change.

03.06. Sonderschild

The Greenhouse Effect and its causes

The greenhouse effect is a natural process. Without it, the earth would only be a large, hostile snowball with an average temperature of -18°C . Greenhouse gases in the atmosphere (like carbon dioxide) cause a warming of the atmosphere. As a result, the average temperature of the Earth's surface rises to a pleasant 15°C . However, more and more greenhouse gases are ending up in the atmosphere as a result of human activities and are causing additional warming. This is called the "anthropogenic greenhouse effect." It has been the main cause of climate change on Earth over the last 150 years. Since industrialisation started about 250 years ago, people have been using fossil fuels such as coal, oil and natural gas as energy sources to produce electricity, or to power motors in cars and airplanes. We mainly owe our current prosperity to fossil fuels. For some time, however, it has become increasingly clear that the use of these energy sources has serious environmental consequences.

What are the most important Greenhouse Gases worldwide?

76% Carbon dioxide (CO_2)

16% Methane (CH_4)

6% Nitrous oxide (N_2O)

2% Other

In total, the global Greenhouse Gas emission in 2010 was 49 billion tonnes or 7 tonnes per person (in order to form the sum, gases other than CO_2 are converted into CO_2 equivalents).

What are the most important Greenhouse Gases in Berlin?

98% Carbon dioxide (CO_2)

2% Other

In Berlin, CO_2 makes up 98% of total emissions. This is so high because the processes through which other greenhouse gases are produced (for example in agriculture) only play a minor role in Berlin. Every year, 5.6 tonnes of CO_2 (value from 2012) are generated in Berlin per capita.

CO_2 emissions in Berlin: Where do they come from? How can we decrease them?

S4: Private households

Berlin today:

2.3 tonnes of CO_2 emissions per year per inhabitant (41% of total emissions)

Main Problems:

- Old, inefficient heating and household appliances
- Trend towards more living space and single households

Ideas for reducing CO_2 emissions:

- Increased use of renewable energies
- When buying household appliances, choose appliances with low energy consumption and generally save energy.
- Socially responsible and affordable building restoration

- New higher density housing alternatives

Are you taking part?

- Do you already own switchable multiple socket-outlets which you can turn-off to avoid standby losses of household appliances?
- Do you go to the farmer's market? Home-made dishes from regionally produced ingredients are better for the climate than frozen foods – and are, more often than not, tastier.

S2: Trade - Commerce - Services sector

Berlin today:

1.6 tonnes of CO₂ emissions per year per inhabitant (28% of total emissions)

Main Problems:

- As customers, we often pay more attention to the price than to environmental standards

Ideas for reducing CO₂ emissions:

- Focus on regional products and short supply chains
- Pay attention to sustainable consumption and avoid disposable products

Are you taking part?

- Do you shop locally? Mail-order companies deliver directly to your home - which is convenient, but CO₂ is generated on the transport route. Many items are available at your local retailer.
- Do you run a website? There are hosting providers that run their servers with electricity from renewable energies.

S3: Traffic

Berlin today:

1.3 tonnes of CO₂ emissions per year per inhabitant (23% of total emissions)

Main Problems:

- Visiting friends, traveling to far-away countries, driving here and there by car: mobility is important to us - but also closely linked to the emission of CO₂
- Increasing air traffic

Ideas for reducing CO₂ emissions:

- "Compact City": facilitating shorter journeys between housing, work, shopping and recreational facilities
- Expanding public transport and infrastructure for pedestrians and cyclists
- Promoting electrically powered cars and other innovative concepts

Are you taking part?

- Do you walk or cycle? Perhaps you could pass on a car ride here or there?
- How often do you fly? Numerous airlines and climate protection companies offer

opportunities to compensate for the CO₂ emissions generated during the flight on a pro rata basis. Examples are tree sponsorships or donations that fund environmental projects.

S1: Industry

Berlin today:

0.4 tonnes of CO₂ emissions per year per inhabitant (8% of total emissions)

Main Problems:

- Outdated technologies
- The European Union Emissions Trading System, which is supposed to reduce CO₂ emissions in industry, has so far proved unsuccessful.

Ideas for reducing CO₂ emissions:

- Development of energy-efficient production processes
- Expanding the use of renewable energy
- Stricter legislation and control concerning emissions trading

Are you taking part?

- What do you look for when you shop? Our choice when shopping determines what companies produce. For example, you could choose to buy regional products. Ecolabels such as the "Blue Angel" or "FSC" indicate that the manufacturer produces its products in an environmentally friendly way.

Democratic Republic of the Congo (for comparison)

The Democratic Republic of the Congo is not only one of the world's poorest economies, but also has one of the lowest average CO₂ emission per capita. Even with the other greenhouse gases included, people in the Democratic Republic of the Congo affect global climate change considerably less than those in most European and North American countries.

Info station 4

The "Pechsee" mire – a stroke of luck

04.01. Inselmarker

What do you think of when you hear the word "mire"? Perhaps creepy movie scenes in a foggy moorland? Or croaking frogs and dancing dragonflies? No matter what image you had in mind so far: Get to know the mire properly and follow this runway to the lookout high above the "Pechsee" mire! There, you will also learn why we're so lucky to have it...

04.02. Bezugsschild

The "Pechsee" mire

In front of you, you can see the mire called "Pechsee". As it is in relatively good condition, the mire plays an important role in local biodiversity. There are certain bird, insect and amphibian species which only find a suitable habitat here. The mire is also paradise for numerous plants which require very moist habitats to survive and thrive. Many of the creatures around the Pechsee and in the water body itself are actually only to be found near mires.

In the course of the year, you will be able to make quite different observations: The greatest activity happens in spring and summer, the time when animals mate, nest, raise their young, and when flowers bloom. When it gets warmer, the Scarce large blue butterfly (*Phengaris teleius*) starts its first flights. Dragonflies like the White-faced darter (*Leucorrhinia dubia*) start wizzing through the air. It's a fascinating but vulnerable habitat. In order to preserve its rich diversity, a wetland nature reserve has been created around the "Pechsee" mire and the neighboring "Barssee" mire - you are already standing right in the middle of it. The fences serve to protect the particularly sensitive areas.

04.03. Großes Infoschild

A mire in the Grunewald

The Pechsee is located in a glacial valley. Around the year 1500, pitch was produced here and was widely used as a raw material for sealing. In German, "Pech" does not only mean "pitch/tar" - hence the name "Pechsee" but it also means "bad luck". Unfortunately, for a while the Pechsee really had bad luck: Wells were built for drinking water abstraction near the mire. As a result, the groundwater table dropped by 5 meters and the lake lost most of its open water surface. Until the 1950s, the Lake Pechsee was still a popular bathing freshwater, but it was becoming shallower and shallower as it silted up little by little.

Today, the Pechsee is the best preserved mire in the western Grunewald - a great stroke of luck for the rare plant and animal species adapted to the special conditions of a mire. In the early 1960s, the mire and its shores were fenced off to protect this extraordinary, sensitive ecosystem.

Though the adjacent Barssee is also a mire, it dried out much more than the Pechsee. It is slowly regenerating, but the differences are still clearly visible. You can also visit the Barssee at info station 6 and have a look for yourself!

»Mires«

- Mires (peat bogs and fens) are habitats that are permanently water-saturated and contain very little oxygen. (Marshes, on the other hand, are areas that fall dry temporarily). Due to the absence of oxygen caused by the water, organic materials such as dead plants can not be completely decomposed. Instead, it turns into peat.

Nature conservation area "Barssee and Pechsee"

The Pechsee and the Barssee are important spawning grounds for amphibians in Berlin. In their immediate vicinity, you can observe Common toads as well as Grass and Moor frogs during their migration to the spawning area. The endangered ground beetle *Pterostichus madidus* takes refuge here. The Pechsee has an especially species-rich dragonfly fauna. Both mires are enclosed by a floating mat, which is a layer of mostly mosses growing out from the shore across the surface of the lake.

Piktogramme

How do the people in Berlin benefit from forest conversion?

Take a look at the advantages of forest conversion. You will be able to find these symbols at several stations along the trail. They will explain the benefits and enhancements resulting from the silvicultural measures.

- Mires also benefit from forest conversion: The groundwater table rises due to the conversion to mixed deciduous forests, which provides more water for the mires.
- Mires are home to numerous rare plant and animal species specially adapted to this habitat.
- Nature conservation areas help to preserve nature and the landscape. Sometimes (as in this case) parts of the area are protected by fences. Please abide by these restrictions and stick to the paths, so that nature can develop undisturbed.

04.04. Infografikschild

How does a mire look from the inside?

In front of you, you can see a kettle-hole mire ("Kesselmoor"), a special type of mire. Most kettle-hole mires were formed during the last ice age, about 12,500 years ago. After the retreat of the glaciers, large isolated ice blocks remained in the landscape. The melting of these ice blocks often resulted in potholes in which the melt water accumulated - and mires started growing. The illustration shows the basic structure of a kettle-hole mire.

Peat

Peat is a defining characteristic of mires. It forms when organic material, e.g. plant matter, decomposes in the absence of air. Different types of peat form, depending on the degree of decomposition of the material and the decomposed plant species.

- Peat consists of more than 30% organic material, as well as water and minerals.

- The peat layer grows several millimeters per year. The famous Teufelsmoor ("Devil's moor") in Worpswede in Lower Saxony, for example, took 8,000 years to grow to its present size.
- Kettle-hole mires can produce a peat layer several metres thick over time.
- Dried peat has been used as fuel and building material since ancient times. People in some areas of the world still use it this way. Peat ash can also be used as a fertilizer in agriculture.

Sapropelic mud

- These sediments form at the bottom of marshes and waters which contain a high proportion of organic material. This material is then decomposed by anaerobic bacteria.

Water bodies

- Many mires have an open water surface, but they do not have to have one.

04.05. Infografikschild

What lives in the mire?

Plants, animals, and microorganisms have to cope with high levels of moisture, nutrient deficiencies and acidic soils to live here: the inhabitants of a mire are specially adapted to these conditions, and many of them are only found in mires. The nutrient content tends to decrease from the bank to the centre of most mires, while the water content increases. That is why we can find a wide variety of special habitats in a single mire. In the illustration, you can find some typical inhabitants of a mire and the conditions they prefer.

Plants

- They are adapted to the different moisture levels of the soils.
- Peat moss such as the Flat-topped bogmoss or the Blunt-leaved bogmoss can absorb up to 20 times their own weight of water.
- Bog-sedge, White beak-sedge, Common sundew, Bogbean, Purple marshlocks, Small cranberry can be found in very moist soils.

Amphibians

- Ponds and mires are the nurseries for their young: the larvae breathe with gills like fish.
- An identifying feature of the normally unimpressive Brown moor frog is the blue colour of the males during 2-3 days in spring.

Numerous species of insects

- Many insects are adapted to the humid environment.
- Spiders: Diving bell spider and Nursery web spider
- Butterflies: Scarce large blue, Small pearl-bordered fritillary
- Dragonflies: White-faced darter, Common hawk, Northern damselfly
- Did you know that dragonflies have two pairs of wings, which can also be moved independently? This allows the insects to hover motionlessly in the air and suddenly change direction.

Info station 5

An Explosion of Biodiversity

05.01. Inselmarker

Do you like diversity, for example on your plate? Or in your wardrobe? Nature loves diversity too. It is important that a wide range of animal and plant species populate the forest to ensure that it is stable. How does forest conversion contribute to the forest's biodiversity? Follow the runway to the shore of the *Himmelsauge* ("Sky's Eye") and learn more!

App station

Combine your nature experience with some interactive fun! This Info station is linked to a game you can access via your uRnature app.

05.02. Bezugsschild

Discover the diversity

With every step along the runway, you got closer to an important biotope in the Grunewald. In front of you, you can see a small water body with a very specific origin that is of great importance for numerous amphibian species. Here, you can hear water frogs croaking loudly and marvel at magnificent dragonflies. And if there is a faint scent of peppermint in the air, you have discovered the Water mint. There's more to a forest than Foxes and Wild boars: the lakes, streams and even the smallest water bodies along with their inhabitants play an important role in this ecosystem as well. What's your estimate: How many animal and plant species inhabit a complex structured Central European forest?

05.03. Großes Infoschild

Variety of life

Our forests are important for biodiversity. Countless animals and plants make their home in them:

- Roe and Red deer, Wild boars and Badgers mostly avoid humans, and if you are particularly lucky you might spot the rare Middle spotted woodpecker, the European pied flycatcher, and the European honey buzzard.
- Other birds, on the other hand, are easy to hear: You certainly know the sound of a Woodpecker and the calls of a Cuckoo and Robin.
- Spiders, insects, worms, snails, fungi and microorganisms use and decompose litter and other dead material. Thereby, nutrients are recycled and stay inside the food web.

In a Central European forest, up to 140 species of vertebrates, 6,500 species of insects and numerous microorganisms can be observed depending on the location and habitat structure. Furthermore around 80 tree species, 120 species of shrubs, 1,000 herbaceous species, hundreds of moss and lichen species as well as fungi can be seen. Different habitats make up the colourful mosaic of the forest. Lakes and ponds, like this one in front of you, form particularly precious habitats that contribute to the rich biodiversity in the forest.

The distinctive feature of this water body is its history and origin. In the mid 1980s, whilst clearing and disposing of ammunition and weaponry from this area, the parts were sorted and loaded into containers. The soil was so heavily compacted by the trucks transporting these containers that a barrier layer was formed, and the water running down from the surrounding slopes couldn't drain away.

The *Himmelaue* is an important spawning ground in the Grunewald forest. Spawning is the eggs and sperm released into water by aquatic animals. These include newts, water frogs, toads and other amphibians, but also dragonflies, water scavenger beetles, fish and water snails.

»Biodiversity«

- The term biodiversity or biological diversity describes the entire spectrum of life on earth. It includes not only the large number of naturally occurring and bred animal and plant species, microorganisms and fungi, but also the genetic diversity within each species.

Diversity in danger

Biodiversity is decreasing worldwide. Habitats and endangered species are permanently lost on a daily basis and this also has consequences for other habitats and species. The main causes are:

- Conversion of natural ecosystems into land for agricultural use, housing and infrastructure
- Introduction of non-native species into habitats
- Polluting water with excess nitrogen (e.g. by fertilising, from exhaust gases)
- Noticeable changes in temperature and precipitation. Many species cannot adapt quickly enough.

How can we promote diversity?

Berlin's forests have been used economically for centuries. For Berlin Forestry Commission, a near-natural management is more important than a large timber harvest. Near-natural forestry also helps biodiversity by

- promoting tree species which belong to the natural vegetation of the respective site,
- not using pesticides,
- preserving and protecting wetland habitats like the *Himmelsaue*.

Piktogramme

How do the people in Berlin benefit from forest conversion?

Take a look at the advantages of forest conversion. You will be able to find these symbols at several stations along the trail. They will explain the benefits and enhancements resulting from the silvicultural measures.

- By converting the forest, a species and structurally rich mixed forest is created - this contributes to the preservation and enhancement of biodiversity, from which humans can benefit too.
- In the spring, wild animals raise their offspring – please allow them to rest and avoid getting close to or touching infant animals!

05.04. Infografikschild

Ecological interplay in water bodies

All living beings in an ecosystem are interrelated not only with each other, but also with abiotic factors in their biotope. The illustration shows you a simplified drawing of the food web in a water body. It is an example of the interrelationships, which together form a dense network in which all species depend on each other.

Consumers

Microorganisms/protists (e.g., *Paramecium*), animals (e.g., fish, crustaceans, amphibians)

- need organic matter from other creatures and oxygen

Primary producers

Water plants (e.g., Yellow water-lily, Water lens, Water knotweed, waterweeds) and algae

- produce organic material and oxygen
- need inorganic nutrients

Decomposers

Fungi, bacteria

- decompose dead organic material into inorganic nutrients
- need oxygen

The community of all organisms in a certain habitat is also referred to as the biocoenosis. A Biocoenosis and a biotope form an ecosystem.

05.05. Infografikschild

What is the benefit of biodiversity?

Many ascribe a value to biodiversity completely independent of its purpose and use for us humans.

The illustration shows which concrete benefits biodiversity also has. Several directives are intended to ensure the protection of a rich environment through practical objectives and measures, in particular:

- The Convention on Biological Diversity of 1992
- The "National Biodiversity Strategy" of the German Federal Government.

Aesthetics and recreation

For most people, a diverse environment is simply "beautiful", and it has a great value for our well-being. Can you imagine a spring morning without birdsong? Going for a walk in a diverse forest is certainly more fun than in a monotonous pine plantation.

Stability

Higher biodiversity stabilizes an ecosystem and improves its ability to return to its original state after major disturbances (resilience).

For example:

- A storm or a pest infestation poses a greater threat to a pure pine stand than to a mixed forest.

Natural resources

Biological diversity ensures the natural resources for mankind.

For example:

- The forest stores and cleans rainwater and thus fills our water pipes (you can taste the water at info station 8).
- A healthy and species-rich forest is a reliable supplier of wood, an important raw material and energy source.
- Biodiversity offers a reservoir of possible active components for different medical uses.

Info station 6

Mires in jeopardy

06.01. Inselmarker

Intact mires are some of the biggest carbon stores on earth. This info station invites you to take a journey through time to explore the history of this mire called "Barssee".

You will learn how the extraction of ground water can endanger a mire, and what impact that has on the Greenhouse Effect.

App station

Combine your nature experience with some interactive fun! This Info station is linked to a game you can access via your uRnature app.

06.02. Bezugsschild

Look once, look twice, then take a third look!

In front of you, you can see the Barssee, a mire fed by ground water. At first sight, the surface appears to be an ordinary forest clearing. But the appearance is deceptive: a meter-thick layer of peat is located just beneath the surface. What you won't find, however, is an open water body like in the neighbouring Pechsee.

This was not always the case - mires develop. Take a look through the three viewers! You can see three views of a mire in different stages. Can you spot the differences? And do you know what the underlying causes are?

06.03. Großes Infoschild

A mire falls dry

The Barssee mire has shared the same fate as many other peri-urban mires: anthropogenic disturbance to its natural development. The lake completely fell dry in the 1970s due to drinking water extraction and the resulting fall in the ground water table.

From 1986, water was fed back to the moor via a drainage ditch. But this artificial irrigation was soon stopped again. The water contained too many dissolved nutrients. Plants and animals in the mire are, however, accustomed to low-nutrient conditions. This nutrient rich water supply therefore destabilised the ecological balance.

Today, the mire is cut off from the groundwater. Here you can observe how a mire slowly silts up at the end of its existence.

As a result of the increasingly drier conditions, the species composition also changes. Succession proceeds until the former mire is covered by forest and the species-rich habitat is finally lost. You can certainly see the differences to the neighbouring Pechsee (info station 4).

»Succession«

- Succession refers to the chronological sequence of different communities of different species living at one location at various different points in time. Developments are triggered by gradual changes in environmental conditions (e.g., changes in water balance) or acute events (e.g., forest fires). As a result, the species composition changes. A stable community (climax) is reached after a series of developmental stages.

The mire - an endangered climate protector

The plants in the mire extract the greenhouse gas carbon dioxide (CO₂) from the air. Dead plants are decomposed into peat. The carbon contained in the plants is stored in the peat. As long as the mire keeps growing, it removes carbon dioxide from the atmosphere and helps to mitigate the Greenhouse Effect: the mire is a natural climate protector!

Why do mires fall dry?

The three following developments are the main causes of mires drying-up:

- The mire is deliberately drained to use the area differently, e.g. for agriculture.
- The water supply of the mire is reduced. This happens primarily when drinking water is extracted in the surrounding area and the groundwater table drops as a result.
- Impact of climate change, especially higher evaporation due to warmer summers.

Protect the mires! But how?

When mires fall dry, large amounts of carbon dioxide is released into the atmosphere and the Greenhouse Effect intensifies, and a precious ecosystem with countless rare species is threatened.

The best way to protect the mires is to permanently restore their hydrological status, for example, by shifting the positions of wells for drinking water production. The renaturation of dried-up mires is an efficient, albeit complex, measure to protect biodiversity and to mitigate human impact on the greenhouse effect.

Piktogramme

How do the people in Berlin benefit from forest conversion?

Take a look at the advantages of forest conversion. You will be able to find these symbols at several stations along the trail. They will explain the benefits and enhancements resulting from the silvicultural measures.

- Forest conversion helps to improve groundwater formation, mainly due to lower evaporation from deciduous forests throughout the year. This helps preserve the mires, which are "natural climate protectors" as they bind the greenhouse gas CO₂.
- Mires are home to numerous rare plant and animal species adapted to these particular conditions.
- Over three million cubic meters of potting soil are sold annually in Germany, most of which consists of peat.

06.04. Infografikschild

The Greenhouse Gas balance of mires

Greenhouse gases are the main cause of anthropogenic climate change. Carbon dioxide (CO₂) is the most important and best-known Greenhouse gas. However, other gases also contribute to climate change, in particular methane (CH₄) and nitrous oxide (N₂O). Mires store large amounts of carbon. Have a look at the illustration to understand this process.

Plants bind CO₂ from the air and transform it into other carbon compounds that they use as building materials. When a plant dies, the organic material is decomposed. The carbon dioxide is usually released again through decomposition.

Healthy mires

In the mire, organic material decomposes in the absence of oxygen as the soil is saturated with water. As a result, a peat layer is formed. The carbon is stored in the peat over a thousand years. Although the mire releases small amounts of Methane, the overall effect on the climate is positive.

Mires drying up

If a mire falls dry, air reaches ground layers that have been "preserved" in water before. The peat begins to decompose, and carbon dioxide is released. In addition, nitrous oxide is released into the air, which contributes to the degradation of the Ozone layer.

06.05. Infografikschild

The water balance of mires

Whether a mire can grow or dries out depends decisively on its water balance, which is mainly influenced by the following factors:

- Precipitation and evaporation
- Vegetation in the mire, which buffers and stores the precipitation
- The topography affects the flow of water into the mire

You can see the causes and consequences of a change in the water balance in the illustration.

Healthy mire

- Water inflow causes the mire to grow
- Mire binds greenhouse gases

'Sick' Mire

- Mire dries up, e.g. due to sinking groundwater table or lower surface inflow
- Mire releases greenhouse gases

Possible causes for a drop of the groundwater table:

- Natural causes, for example changes of the topography by erosion.
- Direct human influence: drainage, ground water extraction from the area. In Berlin, drinking water extraction poses the most serious threat to the mires.
- Climate change causes higher temperatures and lower precipitation. A decrease in the amount of precipitation leads to further lowering of the groundwater table.

Info station 7

Whispering Woods

07.01. Inselmarker

The woods are teeming with life! Trees offer shelter and nutrition to countless insects, numerous birds and many mammals. But the trees also add to life beyond their own lifetime, as dead stems and branches become habitats for other species. What would these trees say about their lives if they had a voice?

07.02. Bezugsschild

Look who's talking!

Berlin's forests are places of relaxation for us humans. But they are far more:

- The trees remove the Greenhouse gas CO₂ from the air and store the carbon in their wood.
- Numerous - sometimes rare - animal and plant species find a home in the forest.
- Forests safeguard our drinking water - sustainably.
- In most Berlin forests, the valuable raw material timber is harvested as the foresters tend the forests.

What do you think a tree would tell us if it could talk? Which tree would you like to chat with? Let this fantasy come true! Turn the crank and listen to what the young birch, proud pine, and the dignified oak tree in this forest are chatting about!

07.03. Großes Infoschild

Matured stands and Dead wood - Sources of New Life

In the last phase of the life of a tree, single parts begin to decay and whole branches die: the so-called "mature stand" and "dead wood" are forming. The combination of thick and thin, standing and lying dead branches and trees is important.

Mature trees and dead wood become sources of new life and form some of the forest's most valuable habitats. Thus, they make a valuable contribution to biodiversity. The dead wood fulfils another important tasks for the ecosystem: it is the water and nutrient reservoir and also the forest's buffer.

Jiggling and wiggling

Numerous species live in old and dead trees, such as the tireless woodpeckers, which hammer their holes into old trees, or the rare Stag beetle. More than 6,000 species specifically depend on dead wood as a habitat and food source, including more than 1,200 beetle and 2,500 higher fungi species, as well as many birds.

Why isn't anybody cleaning up the floor?

Have you ever wondered why there are so many broken branches and fallen trees in the forest, as if the foresters do not clean up properly? The answer is: the seemingly "untidy" forest is intentional!

Twigs and branches are deliberately left in the forest, and trees suitable as "biotope trees" are not felled. Thus, the forest becomes a refuge for species that feel pretty comfortable in old and dead wood. In Germany's forests, there are around 93 million biotope trees and around 224 million m³ of dead wood.

»Biotope tree«

- A biotope tree is a tree that provides special habitats that most other trees in its environment do not have, not only nesting holes in the wood, in the bark or around the roots, but also strong dead branches. It is only in such microbiotopes that many smaller animals, plants and microorganisms find shelter and food. Therefore, the biotope trees are permanently excluded from forestry use.

Use the forest - protect nature:

Sustainable silviculture

Berlin's forests are used for forestry operations. The annual harvest of timber is about 110,000 solid cubic meters. And still, the principle of sustainability always applies - no more timber may be harvested than can grow back. However, timber production plays a minor role in Berlin's forests. The main objectives of the forest management are as follows:

- Cultivating the forest as a relaxing "counter-point" to the hustle and bustle of the city and preserving the beauty of a diverse forest landscape.
- Permanently preserving the forest ecosystem and its biodiversity.
- Developing stable forests for effective climate and water protection and pollution control.

About five to ten old trees per hectare are excluded from forestry use in the forests of Berlin. Mature stands and dead wood may therefore reduce timber yields in the short term, but they are essential to a near-natural, diverse and stable forest.

Piktogramme

How do the people in Berlin benefit from forest conversion?

Take a look at the advantages of forest conversion. You will be able to find these symbols at several stations along the trail. They will explain the benefits and enhancements resulting from the silvicultural measures.

- Dead wood serves as a temporary store for the greenhouse gas CO₂ – it is good for the climate!
- Dead wood offers a home to rare species. The mixed forests that are forming in Berlin have trees of different age classes and a high proportion of old and dead wood.
- Do you have a garden? You could simply create a pile of dead wood! If you're lucky, a hedgehog or lizard might come to visit.

07.04. Infografikschild

The role of old and dead wood in the ecosystem

Did you know that about one third of birds in the forest breed in holes, but only a few species can create one by themselves? No wonder the woodpeckers' breeding holes are quickly snatched up by the next tenants: tits and owls like the Tawny owl, mammals like bats and Edible dormice and insects like Wild bees or Wasps. This is just one of many examples of the important role that old and dead wood play in the ecosystem.

Biodiversity

Old and dead wood is home to many animal and plant species and microorganisms in a very confined space. Many of these species depend on the special conditions in these biotopes.

- Birds appreciate the well-stocked larder that the dead wood offers with a multitude of beetles and ants, their larvae, and countless other insects. A long-term guest in dead oaks is the Stag beetle: its larvae need up to seven years to develop into the adult form of the beetle.
- Which species can be found depends on the size and location of the site (age, degree of decomposition, temperature, moisture): lizards, slow worms and snakes prefer dry, sunny spots; toads and frogs prefer moist conditions.
- Mammals, for example Edible dormice and Shrews, also like dead wood.

Moisturizer

Old and dead wood stores large amounts of moisture over days to weeks and slowly releases it to the environment. This ensures a pleasantly humid microclimate.

Nutrient storage

Fungi and bacteria feed on dead wood as it is decomposed it into its components, which can take decades. Important nutrients are released and enter the forest soil, especially nitrogen compounds and minerals. From there, plants can take these nutrients up again. And, maybe, a respectable tree will grow out of this soil some day.

07.05. Infografikschild

Development of carbon storage in the wood

Young trees bind carbon when growing and store it as biomass. During the decomposition of dead parts of the plant, the carbon is released again. Take a look at the phases of this process in the illustration.

Growing carbon storage

- Trees synthesise carbon compounds through photosynthesis. During this process, they remove carbon dioxide (CO₂) from the air and release oxygen. Sunlight provides the energy necessary for these processes.
- In the course of their growth, trees store more and more carbon in their wood - they create a kind of carbon storage.

Carbon storage in equilibrium

Due to the afforestation activities following clear-cuttings during the Second World War, most of the trees in Berlin are around 60 to 100 years old. During this relatively early phase of a forest stand's development, its biomass and thus also its carbon stock still increase. It is

only in its mature stand phase, with a balanced age structure, that this increase in storage is slowly reduced until a stable equilibrium is reached.

Decreasing carbon storage

- Carbon remains in a dead trees' wood. It is then decomposed over decades by microorganisms and serves as a nutrient source for them and future generations.
- During decomposition, the CO₂ is released over a very long period of time.

Info station 8

It's going to get wet!

08.01. Inselmarker

Do you know who Berlin's biggest supplier of beverages is? - The forest! Most of Berlin's springs and wells are located in the forest. At this info station, you can rest, learn more about the forest as a beverage supplier and taste fresh drinking water. Well then, cheers!

08.02. Bezugsschild

Cheers!

Forests store water that falls to the ground as precipitation. The water re-emerges from the forest floor in springs and wells. You can usually drink this water without hesitation: the forest floor is also an excellent water filter. There is a drinking water fountain at the crossroads in front of the Forsthaus Alte Saubucht. You are welcome to taste the fresh »Berliner Waldquell«! If you want to top up your water supply for the rest of your journey or would simply like a nice souvenir: You can get a Wald.Berlin.Klima. glass bottle from the vending machine next to the well. The conversion of the Berlin forests into rich mixed forests improves the formation of drinking water in the forest: That is important, so we don't run out of our »Berliner Waldquell« in the future, even with the on-going climate change.

08.03. Großes Infoschild

Forest and drinking water

Berlin's residents use of 115 litres of water on average per head and day, only 6 litres of which is used directly for cooking, eating and drinking.

Where does the drinking water in Berlin come from? The Berliner Wasserbetriebe extracts all this drinking water from 650 groundwater wells, where it flows with excellent quality. Before the water is fed into the pipelines and becomes the delicious "Rohrperle", the water in the nine Berlin waterworks is simply charged with oxygen and thereby freed from iron and manganese in gravel filters. Unlike many other cities, Berlin is completely self-sufficient and doesn't require drinking water from outside sources.

»Drinking water«

- Drinking water is water with such a high degree of purity that it is suitable for human use, in particular for drinking, preparing food and personal hygiene. Drinking water must be of such quality that its consumption or use does not pose a risk to health.

Most groundwater wells are located in the forest. Thus, we owe the forest and forest floor a great deal of thanks for our clean drinking water!

Water extraction from wells: Not always a perfect solution

If more water is extracted from the groundwater store than can be replenished, the

groundwater table drops in the vicinity of the well. As a consequence, soil layers dry up and are compressed, and the vegetation in that area changes. We should therefore manage our drinking water supply sustainably and reasonably, so that the groundwater table is not affected more than necessary.

Why is the forest such an important provider of drinking water?

- The forest stores precipitation really well. The forest floor is loosened by the roots of the trees and innumerable soil inhabitants, thus storing the water like a huge sponge. One hectare of forest soil can store up to three million liters of water! You could fill over 20,000 bathtubs with this amount of water.
- The forest is especially important as a temporary water store, for example during a thunderstorm. An enormous amount of water falls from the sky over a short period of time. The absorbent forest floor ensures that a large part of the rainfall can actually seep away and fill up our groundwater.
- The forest floor filters and cleans the water as it seeps through the ground. There are far fewer pollutants in the forest ground water than for example in unfiltered water in built up areas.

Climate change has two main consequences for the water supply in Berlin:

- Higher temperatures mean that a greater proportion of the precipitation simply evaporates. Groundwater will become scarcer.
- Heavy precipitation events and dry spells will become more frequent – extreme weather conditions will increase. It is therefore becoming more and more important not only to collect and store as much of the precipitation as possible but also to use it sustainably!

Piktogramme

How do the people in Berlin benefit from forest conversion?

Take a look at the advantages of forest conversion. You will be able to find these symbols at several stations along the trail. They will explain the benefits and enhancements resulting from the silvicultural measures.

- The role of the forest as water storage will become increasingly important in the coming decades. Forest conversion ensures that Berlin's forests remain reliable suppliers of clean drinking water.
- Even with a few very simple changes, you can reduce your water consumption at home or make it more sustainable and save money:
 - Do you already have a water saving button for the flush on your toilet?
 - Try shortening your shower by one minute and lower the water temperature by only one degree Celsius.This way, an average two-person household using a flow-type water heater saves around 100 Euro per year!

08.04. Infografikschild

Round and round it goes - The eternal journey of water

Water is abundant on earth - after all, 71% of the Earth's surface is covered by oceans. But only a small part of the water (namely 3%) is fresh water. It forms the basis of life for most

animal and plant species. Where does our water come from? Where does it go? In this illustration, you can follow the water's journey and discover the "water cycle", as each drop moves through the cycle.

Precipitation: Water falls from the sky

- When the air is saturated with moisture, water droplets form and reach the ground in various forms (rain, snow, hail, mist).

Forest: A green buffer

- The trees in the forest catch the precipitation, slow it down and lead it to the ground. This causes the water to seep away more slowly.
- The porous forest floor acts as a large sponge and can absorb an enormous amount of water.
- As it seeps away, the water is filtered and replenishes the ground water.

Groundwater: Lakes in the ground

- The water seeps down and accumulates in the ground.
- Water comes up to the surface through wells and springs after being filtered by the ground, where we use it as drinking water.

Rivers: Natural aqueducts

- The ground water comes up to the surface through different sources and trickles into streams, which collect more and more water the longer they get. They slowly grow into rivers and finally flow into the sea.

Oceans: Make our planet blue

- More than 2/3 of the surface of our planet is covered by oceans. They are an unimaginably large water reserve.
- However, this is salt water, which can not be used as drinking water.
- The majority of evaporation occurs from the ocean surface.

Evaporation: Invisible water

- Liquid water can change to a gaseous state at the surface, it evaporates. This happens faster the warmer the water is.
- The salt remains in the liquid water after evaporation.
- As the amount of water molecules in the air increases, clouds are formed.

08.05. Infografikschild

Why does a mixed forest improve the water supply?

The role of forests as water storage will become more and more important as a result of climate change over the coming decades. In the forest, groundwater recharge is mainly determined by the composition of tree species. Groundwater can recharge faster in deciduous and mixed forests. In pine forests, the groundwater recharge is slower because conifers don't shed their foliage during the winter and water keeps evaporating from the pine trees. You can learn more in the illustration.

What happens to the rainfall in the forest?

Evaporation:

- Precipitation remains on branches, twigs and leaves (interception) and partly evaporates there. During photosynthesis, plants lose water through the stomata in their leaves (transpiration).
- Transpiration and interception occur all year round in pine stands, as opposed to in tree stands with a higher proportion of oak and beech, which only photosynthesise during the growing season.
- A leaf is larger than a needle, but the total surface of all broad leaves on a tree is smaller than the surface of all needles on a conifer. As a result, the total evaporation from broad-leafed trees is lower.

Trees' water usage:

- Every tree needs water to live. As broad-leafed trees - in contrast to most conifers - shed their leaves in the winter, they have a lower total demand for water.

Seepage:

- Due to the higher evaporation and the higher water demand by conifers, much less water seeps away. The seepage water amount and thus the groundwater recharge is about 20% lower in pine stands compared to oak stands and 35% lower compared to beech stands.

Infoinsel 9

Into the woods!

09.01. Inselmarker

Watch out! It's getting dark!

The desired development of the forest into a mixed forest does not happen on its own. Foresters have to put a lot of work and effort into achieving this goal. But why? Follow this footpath deeper into this part of the woods, where there have not been any measures taken to create a mixed forest yet.

09.04. Infografikschild

The opponents of the development into a natural mixed forest

Black cherry (*Prunus serotina*)

- Do you think, the sapling of a deciduous tree could thrive in this area?
- The late black cherry finds optimal nutrient supply and a favorable microclimate in the forests of Berlin. It often wins the competition with other plants for light, water and nutrients and replaces other plants.
- It forms a closed shrub cover that completely shades the forest floor. In this dark environment, saplings of other deciduous trees don't get enough sunlight to grow.

Browsing animals

- Damage by animals is caused by (mainly) deer feeding on seedlings, buds and shoots. It's perfectly natural, but the balance between animal density and food supply can be unsettled when there are not enough natural predators. Then, too many young trees suffer damage.
- The young trees are only safe when they have grown tall enough so the deer can't reach the terminal shoots anymore. This may, however, take more than 10 years.
- The leaves of the late black cherry contain hydrogen cyanide which makes them taste bitter. As a result, they are avoided by deer.

Young trees are thus pressured by two aspects:

Their fruits, buds and young shoots are very nutritious and are preferably eaten by deer. The black cherry can expand freely and take light, water and nutrients away from the other deciduous trees. Under these conditions, a species-rich mixed forest can not develop without outside support.

09.05. Infografikschild

How did the black cherry get to Berlin?

Black cherries are common in Central Europe nowadays and are giving the foresters a hard time in approximately one third of Berlin's forest area. Being native to North America, it is an

invasive species in this region. But how did *Prunus serotina* spread so far, from France to Lithuania?

»Invasive species«

- Species spreading into areas where they do not originate from are called invasive species or neobiota. Often, humans have introduced them to new areas, partly on purpose (e.g. farm animal species in America and Australia by European settlers), partly unintentionally (e.g. as stowaways in the ballast water of cargo ships).

17th Century

Travellers coming from the "New World" brought "*Prunus serotina*" over the Atlantic, as the tree was valued as an ornamental plant at the time.

19th Century

Wood and timber was getting scarce in Germany. Since the black cherry manages to grow on nutrient-poor dry soils and does not need elaborate protection against browsing, it was intensely planted. Quite soon more and more people started complaining about the shrubby crippled growth of this former prodigy. The danger of an uncontrolled spread of black cherry was, however, not foreseen - but this is exactly what happened.

From 1950s onwards

Prunus serotina spreads over Berlin's forests uncontrolled.

From 1980s onwards

Berlin Forests make great efforts to eliminate *Prunus serotina* from Berlin's forests. The native deer species still ignore the leaves.

09.06. Infografikschild

Ways of controlling the black cherry

Mechanical removal

- Removing the adult plants with horses, tractors, winches or excavators
- Pulling out the young plants by hand
- Removing sprouting shoots over several years

Simply felling or sawing them off is solution at all. If the black cherry treated this way, it demonstrates its toughness: new shoots regrow from the stumps and roots. They even grow faster and produce more fruits than the older adult specimens!

Biological control

- targeted use of the fungus *Chondrostereum purpureum*
- Cutting the trees and applying the fungus to the wood
- The metabolites of the fungus cause the epidermis to peel off the leaves, and the plant dies
- This method is in the testing phase

Chondrostereum purpureum is a so-called pioneer species which attacks the wood quickly. After about six months, the fungus is replaced by other, stronger, putrefactive pathogens. As a result, there is no risk that the fungus will spread uncontrollably and unbalance the forest ecosystem.

Chemical control

Use of plant protection products: They act as toxins in different cellular processes, causing the plant to die. Given the harmful effects on nature and humans, it has been a long term policy of Berlin forests to avoid using such products.

Info station 10

A strong climate protector

10.01. Inselmarker

Trees remove the greenhouse gas CO₂ from the air, and they do so particularly successfully in a mixed forest. Good for the climate! But how much forest area do we really need to extract as much CO₂ from the air as all Berliners produce?

10.02. Bezugsschild

Trees as storage

Humans and animals need oxygen to live and exhale the gas carbon dioxide (CO₂) - Plants absorb the carbon dioxide and release oxygen: This creates a cycle.

But through human activities, CO₂ from fossil sources is released into the air, e.g. by driving a car, which intensifies the Greenhouse Effect. Trees can absorb part of this CO₂ and store the carbon for several decades. This helps us to slow down climate change at least. What is your guess - how much forest area is needed to bind as much CO₂ as you generate in one year?

Take a look around! In order to give you an idea of the forest area and accordingly the number of trees that can neutralize the average annual per capita CO₂ emissions of the citizens of Berlin, we have painted the trees growing in the respective areas.

10.03. Großes Infoschild

In an endless cycle: Carbon and oxygen

The broad leaves and needles on trees are little green power plants: During photosynthesis, they synthesize substances the tree needs to live and grow. Additionally, they produce oxygen, using water.

»Photosynthesis«

- Photosynthesis is carried out by plants, algae and some bacteria and describes the generation of energy-rich compounds from low-energy substances powered by light energy. Plants, for example, bind the low-energy gas CO₂ from the air and convert it, using water and sunlight, into energy-rich carbon compounds and oxygen.

Humans and animals, as well as most microorganisms, inhale and use the oxygen produced by the plants and exhale CO₂. The forests are also involved in this cycle:

- Germany's forests produce about 25 to 38 million tonnes of oxygen per year. This is more than all people in Germany need to breathe.
- A single large tree can supply oxygen for up to ten people.
- There is up to one ton of carbon bound in a 120-year-old Beech. This equates to 3.5 tonnes of CO₂.

The forest: An important carbon sink

Large amounts of carbon are stored in the trees, and also in the forest floor. A tree is made of roughly 50% carbon. If the forest is left to its own devices, the wood of dead trees begins to decay. This process is taking place in living, very old trees in individual wounds or weakened spots. The stored carbon is then released into the air. The release of CO₂ through rotting and the binding of CO₂ through growth are in balance.

However, if additional CO₂ is released into the air through human activities, the forest can absorb part of it for a long period of time. The increase in the CO₂ content in the atmosphere is thereby slowed down.

- Most of the trees in Berlin are 60 to 100 years old. This means that they will continue to store carbon for many decades.
- Mixed forests with a broad age spectrum, and thus a continuous wood growth, store carbon particularly well.

If the growth of the trees is disturbed by forest fires or storm damage, the stored carbon is quickly released to the atmosphere. Mires that are intact and where the proportion of dead plants is increasing are carbon stores too. Have you visited the mires at Info stations 4 and 6?

Forests contribute to climate protection worldwide

All the world's forests store an unimaginable amount of carbon - 653 gigatons. However, many forests and the animal and plant species living there are threatened by deforestation. Often, the need for agricultural land and the demand for exotic hardwoods are driving this destruction. Around 20% of the world's CO₂ emissions are caused by the deforestation of forests. The protection and sustainable use of forests is therefore an effective means to reduce CO₂ emissions, as well as to preserve biodiversity.

Piktogramme

How do the people in Berlin benefit from forest conversion?

Take a look at the advantages of forest conversion. You will be able to find these symbols at several stations along the trail. They will explain the benefits and enhancements resulting from the silvicultural measures.

- The forests store carbon in their trees' wood. Mixed forests with multi-aged tree stands can bind carbon particularly well – good for the climate!
- An injury in the bark can be dangerous for a tree. Our tip: If you want to immortalise your trip through this forest, take a selfie in the picture frame on info station 1!

10.04. Infografikschild

Half a hectare of forest: your personal climate protection?

Half a hectare of forest binds as much CO₂ as each Berlin citizen produces on average per year. Although Berlin's forests can not absorb the total CO₂ emissions of a city of millions, they make a big contribution and therefore play an important role in Berlin's climate policy.

Saving energy and the extension of renewable energy are therefore still important targets.

- Every Berlin citizen is responsible for the release of an average of 6 tonnes CO₂ per year.
- Half a hectare of forest can bind about 6 tonnes of CO₂ per year.
- Every person in Berlin would therefore need about half a hectare of forest to compensate for their annual CO₂ emissions. This is 5,000 m², about two thirds of the area of football (soccer) field.
- All Berlin forests bind about 100,000 tonnes CO₂ per year.
- This is the CO₂ emission of about 16,000 people - while Berlin has 3.5 million inhabitants.

10.05. Infografikschild

How much carbon is in the forest?

- While broad-leaved trees shed their leaves every autumn, most conifers keep their needles throughout the winter.
- In deciduous forests, there are additional carbon stores in the litter (shed leaves), in dead wood and in the soil.
- The conversion of conifer stocks into mixed forests therefore increases long-term carbon storage.

The illustration shows how much carbon is in different the different forest layers.

- The forest stores carbon as above-ground and below-ground biomass (especially in the wood, roots, needles and leaves of the trees), but also in dead wood and various layers of the soil. For example, the litter (shed leaves and needles) is decomposed over several years and serves as a mineral nutrient source and carbon buffer.
- The entire storage in Berlin's forests has greatly increased from 1990 to 2012!

Info station 11

Saving wood

11.01. Inselmarker

Wood is an excellent building material and a modern energy supply - it is really multitasking, as it also helps us protect the climate: It replaces other building materials and energy carriers, which are more harmful to nature. Sustainable wood harvesting and use is a great thing! Find out more about it here.

App station

Combine your nature experience with some interactive fun! This Info station is linked to a game you can access via your uRnature app.

11.02. Bezugsschild

Wood as a raw material

Wood is a fantastic resource. For centuries, it went without saying that wood was used both as a fuel and to build wooden houses. Wood has been almost completely replaced as new building materials such as concrete and steel have been developed and new fuels such as coal, oil and natural gas used.

Currently, however, wood is making a bit of a comeback. Germany now uses 1.3 cubic meters of timber per capita annually - about 20 percent more than in 1997.

Explore the installation in front of you: How can we use wood? What other substances can we replace with wood? And how do nature and humans benefit from that?

However, one thing must be clear: for each tree we fell, at least one new one must grow. Do you want to help? Then you can act just like a Eurasian jay and spread acorns and beechnuts along the exhibition trail.

11.03. Großes Infoschild

Benefits of using wood

1. Wood and timber from sustainable silviculture has an excellent eco-balance, as the energy the trees need to grow comes from the sun, free of charge! If we use wood for building and heating, we save energy and precious resources.
2. If we use timber as a building material, we can keep the stored carbon and out of the atmosphere for decades.
3. Our forests are an important eco-friendly economic factor and create more than 1.3 million jobs in Germany, for example in forestry, wood trade and crafts. Rural or structurally weak regions also benefit - forests and wood processing industries exist (almost) everywhere.

»Wood«

- Wood is a porous and fibrous structural tissue found in the stems and roots of trees and other woody plants. It is an organic material, a natural composite of cellulose fibres that are strong under tension and embedded in a matrix of lignin that resists compression. Further compounds found in wood are waxes, fats, oils, sugar, starch as well as tannins, mineral compounds and pigments.

Wood: A fantastic material

The use of wood as a raw material has a long tradition and is even seen in other primates, such as chimpanzees and gorillas. They use wood very skillfully to build housing and to produce tools. The oldest evidence of wood used by humans reaches as far back as the Stone Age.

Wood is essential to our lives, as we use it every day:

- as a building material for houses and furniture,
- in a cozy wood-burning stove or in efficient wood heating with wood chips or pellets,
- as a raw material for the production of countless everyday items: the daily newspaper, beverage cartons, books, tissues and toilet paper.

By using wood sustainably, we can reduce CO₂ emissions in Germany by about 158 million tonnes a year, which is 17% of all greenhouse gas emissions. For example, the construction of a one-family house built with wood instead of concrete saves 80 tons of CO₂!

Using wood - sustainably!

Did you know that the principle of sustainability was invented in forestry? The Chief mining administrator of Saxony Hans Carl von Carlowitz recognized as early as 1713: We can only take as much wood from the forest as we can regrow.

Today, 76 million cubic meters of wood are harvested each year in Germany. However, consumption is still much higher (150 million cubic meters), therefore 50% of our wood is imported.

"Sustainability"

- The concept of sustainability describes the principle of using a resource in such a way that it can regenerate and is therefore equally available to future generations.

Sustainable management in Berlin's forests has been happening for a long time now – and it is regularly monitored: The Berlin Forestry Commission have been awarded the FSC and Naturland certificates since 2002 - a seal of approval for the highest standards of ecological, sustainable management.

Piktogramme

How do the people in Berlin benefit from forest conversion?

Take a look at the advantages of forest conversion. You will be able to find these symbols at several stations along the trail. They will explain the benefits and enhancements resulting from the silvicultural measures.

- Sustainable forest management and the sensible use of harvested wood saves energy and reduces the release of CO₂ into the atmosphere - an important contribution to climate protection in Berlin!
- For every tree we fell, at least one new one must grow. You are welcome to participate and help yourself at the Jaybird-box!

11.04. Infografikschild

What does »multiple use« mean?

The term multiple use means that a raw material is used several times, i.e. over several steps. The illustration shows a possible so-called »cascade use« (literal translation of the German term "Kaskadennutzung") of wood, starting with the wood harvesting.

At the end of this cascade, the wood can be processed into fuel and used energetically, for example as wood pellets. Such multiple use is not possible or is limited when using other materials such as concrete.

- Timber harvested in the forest is used to make solid wood products. Later, chipboard can be made from the disused timber. Both products can be used as building materials and replace concrete, for example.
- The carbon, which has been stored in the wood for decades, is released during combustion. But it is part of a balanced cycle and can be absorbed by plants as CO₂.

11.05. Infografikschild

Substitution: Wood can replace other materials

Producing building materials needs energy. Aluminium, for example, is produced in a very energy-intensive process.

The energy demand for the production of wood is low, however, since trees use sunlight to grow. Heating with wood only releases as much CO₂ as was absorbed from the atmosphere while the trees were growing. The overall balance is therefore almost even. It looks quite different when heating with oil and natural gas: CO₂ from fossil sources enters the atmosphere and intensifies climate change.

- During wood harvesting, 1% to 4% of the energy stored in the wood is needed. The transport distances are usually much shorter for wood than for steel and aluminium - especially when using regional wood.
- The more we cover our demand for wood with German forest products, the less has to be imported from other countries. Our silviculture therefore contributes to the protection of the world's forests.
- Wood is excellent for heating. CO₂ is released, but only as much as was bound as the wood was formed. The overall balance is almost even. Why only almost? Forest management and harvesting require energy, and small amounts of CO₂ are released.

- It looks quite different when heating with oil and natural gas: fossil CO₂, which has been extracted from the atmosphere millions of years ago, is released. This further intensifies climate change.

Waldsteckbriefe - Forest portraits

1) Tree protectors

- Tree protectors prevent wild animals from browsing on young trees (eating buds, leaves and twigs).
- They are an alternative to completely fencing off an area.
- Additional benefits include protection from late frost, stabilization of the plant and warming the plant as it acts like a mini greenhouse.
- Modern tree shelters are high-tech products: they offer favourable conditions to the young plants thanks to a ventilation system, UV-permeable material and dual walls. The material decomposes after its planned life span.
- In the Grunewald forest, tree protectors are being used mainly in plantings on the forest borders; in the centre, fences dominate as protection from browsing.

2) Fences in the forest

- Fenced areas in the forest are used to protect the young trees from game, especially Deer and Wild boar.
- The construction and maintenance of the fences is costly, but offer reliable protection over a large-area.
- The Berlin Mixed Forest Program (*Mischwaldprogramm*) finances a large part of the fence construction and thus helps to speed up the forest conversion from monotonous pine stands to a healthy and robust mixed forest.
- Please respect the fences and do not damage them. Even one single animal in these areas can cause a great deal of damage within a short time.
- Did you know...?
For Fallow and Roe deer, a fence height of 1.50 m is usually sufficient, but hungry Red deer can jump this high with ease.

3) Glacial relief formation

- This wavy relief was created as a terminal moraine formed during the Weichselian ice age 115,000 to 20,000 years ago.
- The sequence of terrain shapes created by the advancing ice pile are called the glacial series.
(A) Ground moraine: Material carried by the ice
(B) Terminal moraine: up to 100m high hills formed from deposits that were pushed ahead of the ice
(C) Sandur: Sand and gravel surfaces, deposits from meltwater
(D) Glacial meltwater valley: formed by meltwater flows

4) Nature of the year 2017

Wild animal of the year: Hazel dormouse (*Muscardinus avellanarius*)

Fish of the year: European flounder (*Platyctys flesus*)

Reptile of the year: Slow worm (*Anguis fragilis*)

Bird of the year: Brown owl (*Strix aluco*)

5) Nature of the year 2017

Tree of the year: Pine (*Picea abies*)

Fungus of the year: Jew's ear (*Auricularia auricula-judae*)

Flower of the year: Common poppy (*Papaver rhoeas*)

Visitor of the year: (*Visitator annum*)

6) Logging trails

- Nowadays, fully automatic machines (harvesters) are used for thinning. They fell, debranch and cut the trees in one step.

- Logging trails are necessary to allow the harvesting of trees and the transportation logs to a fortified forest road.
- The distance between two trails in the Grunewald is usually 40 m.
- Did you know...?
The outdated German term for a logging trail - *Holzweg* - led to the saying "*auf dem Holzweg sein*" (to be on the wrong track) since these trails do not connect two localities, but end in the forest.

7) Roe deer

Capreolus capreolus

- Roe deer is a closer relative to Reindeer and Moose than to Red and Fallow deer.
- Doe and roebuck are coloured brownish-red in the summer and gray in the winter. The fawn lose their typical white spots after one to two months.
- The antlers (horn) of roebuck are up to 20 cm long and are re-grown annually.
- They prefer eating buds, grasses, herbs and foliage.
- Large deer populations can endanger the natural rejuvenation of a forest.
- Did you know...?
When deer "make the bed," they paw the foliage aside and lie down on the bare ground to keep insects at bay.

8) Wild boar

Sus scrofa

- The European wild boar is the ancestor of the domestic pig.
- Male Wild boars are called Tuskers, females are called (wild) Sows and their young are called Piglets or Squeekers. One-year-old animals are called Juveniles.
- Wild boars reach their fully-grown size when they are around 5 years old and can be 180 cm long and weigh 200 kg.
- As omnivores, the boars rummage in the ground for roots, fungi, worms, snails and mice.
- Approximately 4,000 Wild boars live in the urban area of Berlin and about 10,000 in the surrounding area.
- Did you know...?
Gallop Wild boars can run as fast as 50 km/h and are thus faster than sprinters like Usain Bolt.

9) Hollow Trees

- Large holes in trunks are caused by minor injuries of the tree, which serve as portal of entry for wood-decomposing bacteria, fungi and insects, but also through the work of woodpeckers.
- The holes become larger over time, fill with duff (wood chipping, foliage, insect excrement etc.) and develop into to unique, moist habitats in the still living tree where many rare and protected species live.
- In Germany alone, more than 280 species of beetles rely on tree holes, along with a large number of birds, bats, edible dormice and other species.
- Did you know...?
The Hermit beetle (*Osmoderma eremita*), an endangered and strictly protected scarab beetle, often spends its whole lifetime in a single tree hollow. The larvae live on duff for up to four years, while they live for only a few weeks as beetles.

10) Scots Pine

Pinus sylvestris

- In Germany, natural pine stands rarely occur naturally. They are only seen in very specific regions with meagre soils, where competition is low.
- The pine can reach heights of up to 48 m and trunk diameters of up to 1 m.

- Their maximum age is about 600 years, but they are usually felled when 80-140 years old for timber.
- The fast-growing and sturdy timber is mainly used for building and construction purposes.
- Did you know...?
Pine honey does not consist of nectar, but of the excretion of sap-sucking aphids (plant lice) that are "harvested" by bees.

11) Oaks

Quercus spec.

- Two oak species are native to Germany: the English oak (*Quercus robur*) and the Sessile oak (*Quercus petraea*).
- Their maximum height is 20-40 m, trunk diameter up to 3 m, and age up to 1,000 years.
- Oaks require a lot of light and have a large open crown and a strong taproot, making them highly storm-proof.
- The sturdy timber is resistant to environmental conditions and moisture-tolerant.
- The oak is home to up to 350 insect species.
- Did you know...?
The oak called "*Dicke Marie*" (chubby Mary) is thought to be the oldest tree of Berlin. Johann Wolfgang von Goethe used to enjoy the shade of the currently 900-year-old English oak too.

12) Common beech

Fagus sylvatica

- Beeches can have a diameter of up to 2 m, grow up to 45 m high and can be as old as 300 years old. One crown can cast a 600 m²-shadow.
- (Mixed) beech forests are probably the potential natural vegetation in Germany and large parts of Central Europe.
- Beech litter decomposes within one to two years, thus it improves the soil because it quickly provides nutrients to other organisms.
- Did you know...?
One 100-year-old beech annually produces 4,600 kg of oxygen. That covers the demand of an adult for 13 years.

13) Silver birch

Betula pendula

- With its early shoots and sleek, elegant growth, delicate spring green and white bark, the Birch is a symbol of spring.
- Birches can grow as thick as 1 m in diameter and up to 25 m high. The rather delicate tree can be as old as 150 years old.
- The birch is a pioneer tree species, which demands a lot of light and is often replaced by more competitive species later on.
- To protect the bark from UV radiation, secondary plant compounds completely reflect the light, so that the bark appears white.
- Did you know...?
Birch tar was already produced in the Stone Age and was used as an adhesive.

14) A short history of silviculture

- Before 1850, Berlin was a small town surrounded by forests. This small town started growing rapidly over the course of industrial revolution as woodland areas were converted into building areas.
- In 1915, the city of Berlin bought ca. 10,000 ha forest area under the Act "*Dauerwaldkaufvertrag*" (Permanent Forest Contract) to ensure its preservation.

- During and after World War II, the forest suffered severely as a result of the extraction of large amounts of timber, which was needed as fuel and construction material.
- From the 1950s, large pine plantings were carried out to re-forest the area. These plantings still shape the landscape here and there.
- From 1979, the economical utilisation has taken a backseat. Today, Berlin Forests pursue near-natural forest management focusing on balancing and enriching the ecosystem.

15) Woodpeckers

Picidae

- With their strong bills, Woodpeckers are the carpenters of the forest.
- Their breeding holes in trunks and thick branches of trees are re-used by numerous other animals, e.g. Bats, Nuthatches, Wild bees, Squirrels and numerous other cavernicoles.
- The most common native representatives are the European green woodpecker (*Picus viridis*), Great spotted woodpecker (*Dendrocopos major*) and Black woodpecker (*Dryocopus martius*).
- Did you know?
Woodpeckers don't just drum not when building a hole, but also to communicate with each other.

16) Animal silviculture assistants

- Squirrels and Jays bury plenty of seeds and nuts during the warmer months for use during winter.
- Squirrels rely on their noses whereas Jays use terrain markers to locate the stashes.
- Stashes which are not recovered safely hibernate in the soil and the seeds can germinate in spring.
- Did you know?
When Squirrels and Jays feel like being watched when burying their food, they create empty stashes to mislead the watchers.