Nationalparkverwaltung
Bayerischer Wald

RESEARCH
IN THE NATIONAL PARK

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FOREWORD

The Bavarian Forest National Park has now been in existence for over half a century! For almost just as long, the natural environment here has been left to its own devices and safeguarded within the park's protected area. This sanctuary offers a wonderful opportunity to study the natural processes that take place here. In the 1970s, research work in the national park started with the recording of simple measurements related to water, air and soil pollution, which has gradually evolved into the wide-ranging research work currently undertaken here – from monitoring an array of animal species and biodiversity markers through to animal carcass decomposition. Over the decades, scientific work has become increasingly important in the national park. The results we have learnt from the research in the national park have become more and more internationally relevant. As a result, the National Park is a globally respected centre of scientific research. Scientists from all over the world welcome the opportunity to travel here and conduct projects on a large intact forest ecosystem. This research work is not only made possible by our excellently managed internal research team, but also through our strong network of national and international partners.

However, in addition to gaining global recognition for this work, two other points are also important to us in our research. Firstly, we want the research conducted here to be practical and offer applicable solutions, e.g. new approaches for managing commercial forests. Secondly, research should not be an end in itself. We want this work to be accessible and understandable for everyone. And that's why we've put this research brochure together. We hope that it inspires you to learn more about the fascinating scientific discoveries found in our national park.

Ursula Schuster
Head of the Bavarian Forest National Park Administration

CONTENT

Photo: Frank Bietau

Photo: Wolfgang Lorenz

Photo: Christoph Moning

Photo: Ruth Goldhahn

Photo: Heiko Bellmann

Photo: Lukas Haselberger

IF THE INSECTS ARE OKAY, EVERYTHING'S OKAY

The recovery of previous stream chemistry in the Bavarian Forest National Park has paved the way for the European bullhead to return to its original habitat. Photo: Rudolf Schmidt

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IF THE INSECTS ARE OKAY, EVERYTHING'S OKAY

In the early years of the national park, the humming and buzzing of small insects around the region's streams was still pretty rare. During this era, the acidification of the watercourses had taken its toll on these animals. The riverbanks were remarkably quite places. Fortunately, this trend has now changed.

Many years of research have shown that if the populations of insects and crustaceans in watercourses are healthy, stocks of fish and other animals that live in and around the water are healthy too – from the toad to the otter. Fifty years ago, the situation for these river-based communities was difficult. Man-made pollutants severely deteriorated the water quality of streams in the second half of the 20th century – even within the protected area of the Bavarian Forest. The disappearance of insects, crustaceans and fish was accelerating. Luckily, the tide has turned in the decades since. The Große Ohe is a remarkable case study – a river where local animal populations are proven to have substantially recovered in the intervening years.

WHEN THE ACID RAIN CAME

Substances like sulphur dioxide and nitrogen oxides were released into the air by fossil fuels and industrial processes up until the 1970s and early 1980s. In addition, a lot of ammonia was emitted by agriculture. All of these substances released strong acids into the atmosphere, which in turn reached remote areas as acid rain. This caused the soils and watercourses in the forest to acidify. Insects were among the major victims of this development, as their water-dwelling young are sensitive to acidic conditions. Due to the decline in these prey animals, fish, such as the brown trout and European bullhead, were deprived of part of their food base. In addition, these species themselves are not acid-tolerant either. As a result, during this era, many streams and rivers were completely fish-free, especially in the higher reaches of the Bavarian Forest.

BETTER ENVIRONMENTAL PROTECTION ENABLED NATURAL REGENERATION

The recovery began in the 1980s. Peoples learnt from past mistakes. Political measures and technological advancements for controlling air pollution ensured that fewer pollutants were emitted into the atmosphere. As a result, the amount of acid that reached the forests declined, allowing the watercourses to gradually recover. Data from Deggendorf Water Management Authority for the years 1983 to 2014 reveal how the composition of animal communities developed on the Große Ohe river below the Taferlruck gauging station. A new species has been observed in the Große Ohe river every two years on average since the peak water acidification in 1983. The total number of individual animals counted increased by 173 percent during this time.

FLIES AND MOSQUITOES BENEFIT FROM CLIMATE CHANGE

The diversification of watercourse-based communities has also been accelerated by climate change. The temperature of the water has risen by around 1.5 degrees Celsius compared to the 1980s. In addition, conditions have become brighter on the banks of the streams and rivers. Many trees perished due to bark beetle infestations and wind throw events, and the canopy opened up. There was a decline in the proportion of stone flies and caddis fly species – which are adapted to living around cold water. By contrast, the larvae of "true flies" such as flies and mosquitoes, which are better equipped to cope with warmer conditions, now dominate the waters of the Große Ohe. Without the water regaining its previous chemistry, this development could probably not have taken place. At the same time, European bullhead and brown trout have now also resettled in these ancestral habitats – after all, they feed on crayfish and similar creatures, which have themselves become more common again.

IN A NUTSHELL

- *Industry, transport and agriculture acidified the soils and watercourse until the 1980s.*
- *All groups of species living in and around the water were able to recover from acidification thanks to measures to curb air pollution.*
- *However, not all species groups in and around rivers and streams benefit from warmer water.*

Stonefly larva of the genus Perla.

Mayfly of the genus Rhitrogena.

Photos: Senckenberg Forschungsinstitut und Naturmuseum Frankfurt/M.

THE DEADER, THE BETTER

Dead wood is not only a habitat for a wide variety of insects, but also for an array of fungi.

Timber from trees can be used as furniture, rafters, chairs, paper or firewood. But trees like beech, spruce and the like also have other value – sometimes it's enough to let trees simply rot slowly but surely away.

If a forest is infested by bark beetles or suffers considerable damage in a storm, humans usually intervene. The damaged trees are felled for profit. However, this also takes away a future breeding ground for life in the forest. How can this be avoided? How many dead trees have to remain in the forest after this type of event to preserve at least a few native species? The first answers to these questions are now beginning to emerge.

Insect traps are being used to determine which species search for areas containing dead wood.

NATURAL DISTURBANCES – CATASTROPHE OR OPPORTUNITY?

Although natural disturbances in forests are viewed as a disaster by many people, these events actually create habitats for rare and endangered species. This is mainly due to the large supply of nutrient-rich dead wood and increased sunlight that these events produce. In commercial forests, disturbed areas are often managed with damaged trees being cut down and removed from the forest. The impacted areas are then replanted with young trees. This is a lost opportunity to provide a habitat for a wide variety of species.

NEW SOLUTIONS FOR COMMERCIAL FORESTS?

As a result, new approaches to deal with areas of disturbed forest are currently being sought, particularly for use in commercial forests. In the national park, where timber sourcing is not a primary goal, disturbance events in the natural zone are allowed to unfold completely without human intervention. In this part of the park, the development of various disturbed areas has been specifically monitored over a longer period of time in an effort to gain important insights into the development of biodiversity. Research was carried out in areas that had been partially or completely cleared after windthrow or bark beetle infestation, as well as those where the dead wood was left to rot in the forest.

HOW MUCH DISTURBED FOREST SHOULD BE LEFT TO ITS OWN DEVICES?

Long-term monitoring based on about 200 data sets from the National Park as well as from around the world – has revealed the following result: 90 percent of the occurring species can be preserved if 75 percent of the area is excluded from post-disturbance clearing. For the forest owner, this means that they would for the most part have to forego using the timber. But if half of the disturbed area is cleared, 25 percent of the resident species are lost. These calculations can therefore serve as a rule of thumb for the management of disturbed areas. The differences between cleared and untouched areas are particularly evident in the occurrence of rare species. They react very sensitively to the clearance of disturbed areas and cannot re-colonize cleared areas, even after more than ten years.

IN A NUTSHELL

- *If trees are removed from the forest after a storm or after bark beetle infestations, biodiversity is affected.*
- *The clearing of disturbed areas is particularly damaging to rare species.*
- *90 percent of the species are preserved if 75 percent of the disturbed area is excluded from clearing work.*

Taiwanese environmental statistician Anne Chao is supporting the National Park in its dead wood research. Photo: Simon Thorn

CAPERCAILLIES LOVE WELLNESS

The capercaillie population in the Bohemian Forest is stable. During mating season, these birds, which otherwise live lonesome lives, come together. Photo: Andreas Rückerl

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CAPERCAILLIES LOVE WELLNESS

The Bavarian Forest without the capercaillie? Unimaginable! Yet the bird adorning the region's coat of arms almost disappeared completely. There was quite simply a lack of sufficient wellness facilities for these creatures. Fortunately, that has now changed.

Capercaillies need a habitat rich in forest structures, with fallen trees as a sleeping place as well as open areas with a sufficient supply of food.
Photo: Andreas Rückerl

Today's Central European populations are the only remaining representatives from a formerly widespread forest bird species. The Bavarian Forest and Šumava National Parks as well as the Bavarian Forest Nature Park offer these birds – that can weigh up to four kilograms – a safe sanctuary in the coniferous forests higher than roughly 800 metres above sea level. They clearly feel perfectly at home here.

NOT SEEN, BUT STILL COUNTED

Capercaillies are real heavyweights among birds. They are poor flyers and feed on poorly digestible tree needles, especially in the winter months. These seem to be the main reasons why these animals like to avoid disturbances of any kind. As a result, it's very difficult to observe these animals in the wild. Nevertheless, the population in the Bavarian Forest has still been successfully counted. While there were only a few animals on the Bavarian side over the border in the 1980s, intensive field studies and research in 2010 revealed around 500 individuals now living on both sides of the border. Wondering how they were counted? Analyses of faeces samples made it possible to estimate the population size effectively using genetic fingerprinting. In a repeated study in 2017, the results revealed a slight increase to a mean estimated population of about 600 individuals within the study area. A somewhat reassuring insight from the point of view of conservation: This population growth indicates that the species is still considered capable of surviving in the region.

PLANTS AND INSECTS BENEFIT TOO

Researchers in the National Park have been monitoring this bird species for many years, as it's considered a target species for nature conservation. This bird's habitat requirements are so complex that the successful protection of this species can simultaneously protect many other species and, indeed, entire communities within the forest. These include sunny and dry areas for herbaceous plants and insects, dead wood as a breeding ground for fungi and rare beetles, and pioneer trees as important elements in forest renewal after catastrophic events, such as severe storms or massive insect infestations.

IN A NUTSHELL

- *Faeces analysis of capercaillies not only provides information about the population, but also about their stress levels.*
- *These rare animals are very sensitive to disturbances and steer clear of popular hiking trails.*
- *Managing visitor trails can be an effective measure to protect these forest birds during the breeding and mating seasons.*

PROTECTION THROUGH PEACE

An important finding of the research is that significantly fewer capercaillies live in habitats with a higher number of visitors, or that they may even be completely absent in these areas. Analyses of the stress hormones in the faecal samples found in these parts of the forest prove this idea – regular high volumes of human visitors stresses the animals. Such conditions could have ecologically fatal consequences for the population, for example by causing lower breeding success. The findings have therefore helped in establishing quiet zones for the capercaillie. Hiking trails can be opened for specific windows of time and temporarily closed during the breeding and mating season. And it is thanks to measures like this that the population in our region has been able to stabilize once again.

DEAD WOOD SAVES TREE SAPLINGS

In forests with a lot of dead wood, tree saplings are better protected from being eaten than in cleared forests.

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DEAD WOOD SAVES TREE SAPLINGS

Tidiness is a virtue. This certainly applies in children's rooms, the kitchen or the office. But what about in the forest? Does it really have to be tidy? Or is chaos and mess the better alternative? Roe deer, red deer and fir trees offer very differing perspectives on the matter.

The quintessence of research findings from the national park is as follows: Chaotic conditions can certainly help ensure that tidy processes take place! Take the rejuvenation of the forest, for instance. The more disorder there is from dead wood in a forest, the more difficult it is for roe deer to nibble on young fir trees.

DEAD WOOD PROVIDES NUTRIENTS AND WORKS AS A BARRIER

After the death of many old spruces in the National Park following bark beetle infestations in the 1990s, there was concern in the region that the forest would not be able to rejuvenate in affected areas rich in dead wood. However, after ten years it became clear that this assumption was wrong. In fact, the trees grew back faster than in the tidied wind-thrown areas, where trees were replanted. But why? The valuable nutrients and moisture that dead wood provides undoubtedly play an important role. But is this the only positive effect? Research in the National Park shows that dead wood also forms a natural barrier for deer.

IN A NUTSHELL

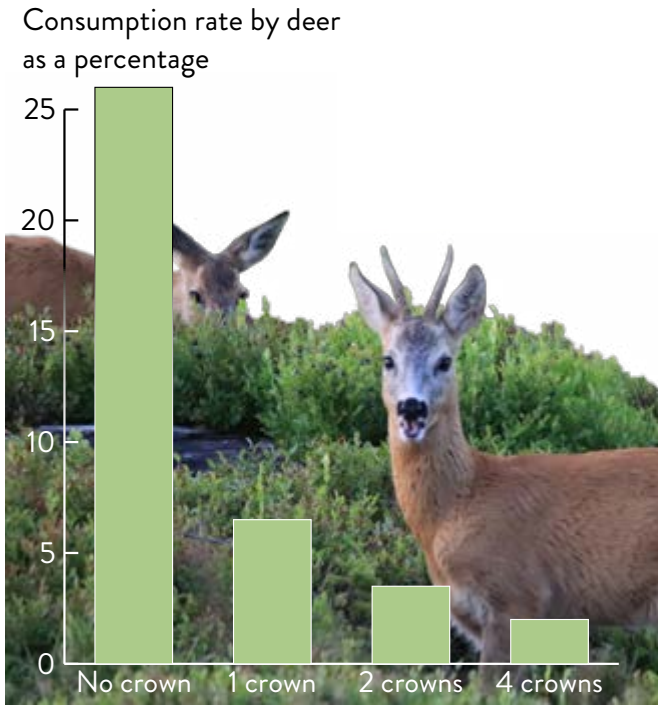
- *Dead wood provides the ideal nutrient base for future tree generations.*
- *Chaos and disorderliness ensures that roe deer leave behind significantly less damage on young firs.*
- *Red deer can deal well with large areas of disturbance.*

FIR TREES IN THE OPEN STAND LITTLE CHANCE

The experiment that yielded this finding was set up as follows: Dead wood in the form of treetops was laid out in varying quantities across 384 areas. A total of 20 to 40 cm pine seedlings were planted among these dead treetops on the ground and analysed in the following year. In order to draw a comparison, firs were also planted in areas without any dead wood surrounding it. The results were clear: If a fir sapling was left without protection in the forest, it had a 26 percent probability of being eaten by roe deer within the first year. However, if it is protected by a lot of dead wood, the probability was only two percent. This knowledge can also be of benefit to commercial forests: By leaving dead wood in the forest, it not only promotes biodiversity – forest rejuvenation can also be safeguarded in a natural and more cost-effective manner.

RED DEER BENEFITS FROM BARK BEETLES AND STORMS

But how do red deer react to disturbances in the forest caused by bark beetles and storms? In order to answer this question, telemetry data from animals equipped with transmitters were evaluated, as were timelines of satellite images. The findings: for red deer, habitat suitability in disturbed areas improves over a period of 25 years. This marks the latest point at which they return to these areas again as usual. If, on the other hand, forests are completely cleared after bark beetles and the like, red deer abandon these areas. Roe deer, on the other hand, are less demanding. They are also still found in forest clearings. However, roe deer avoid naturally disturbed areas – especially in winter. But in the summer, they can be found there again.



This graph shows the percentage probability of consumption by deer in connection with the number of dead tree crowns added to each site.

THE DEATH OF A BARK BEETLE

In the 1990s, the areas in the Bavarian Forest that had been planted with spruce trees in the last century provided the bark beetle with a rich supply of food, resulting in the forests dying over a large area.

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THE DEATH OF A BARK BEETLE

The bark beetle – the mere name makes many forest owners shudder. In recent years, this small insect has been eating its way through vast swathes of spruce populations throughout Europe. And the Bavarian Forest National Park is no exception. But when will its advance run out of steam?

When we refer to bark beetles, the European spruce bark beetle is usually the insect in question. This is a subspecies that has the potential to cause the destruction of large areas of spruce forests. Will this devastation continue for hundreds of years? Can this tiny beetle continue to exert such a huge influence on the development of forests? Research has now revealed that the European spruce bark beetle will likely be a dying breed in the future.

SIMULATION MODEL LOOKS 600 YEARS INTO THE FUTURE

A crystal ball is not going to offer much in the way of reliable prognoses, which is why scientists have programmed a complex simulation model instead. This "iLand" software breaks down the entire forest ecosystem into individual puzzle pieces, from the development of external influences such as precipitation and temperature to the growth of plants, fungi and microorganisms. Each of these elements therefore simulates a building block within natural processes. The processes relating to the infestation of spruce trees by bark beetles are also simulated. In order to test the functionality of the program, data from the Rachel-Lusen area was used to simulate the recent past, i.e. the bark beetle infestation in the 1990s. The results showed that the calculations made by the software are very close to the reality that actually came to pass. The software therefore makes it possible to simulate the forest's development over the next 600 years.

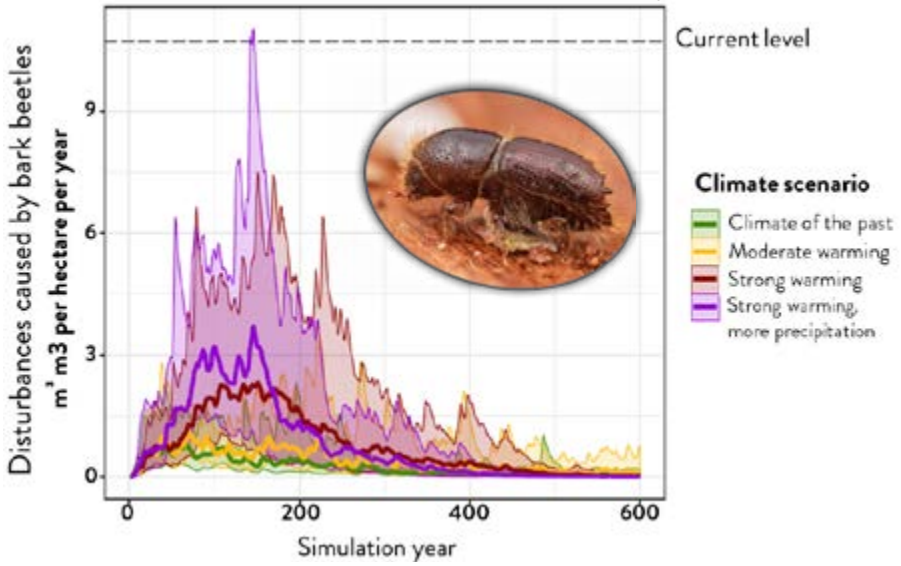
FROM MODERATE TO STRONGLY RISING TEMPERATURES

The simulation models four different climate scenarios: a control scenario in which external circumstances do not change, a moderate temperature rise, a strong temperature rise and a strong temperature rise combined with more rainfall. In all scenarios, there will continue to be further waves of bark beetles in the future, as well as large, intensive outbreaks in the event of strong global warming. However, the high levels recorded from the mid-1990s will no longer be reached. And what's more, after around 200 years, the activity of the European spruce bark beetle – in all simulations – declines significantly.

BEECH AND FIR BATTLE IT OUT AT HIGHER ALTITUDES

But why are conditions for the bark beetle deteriorating? There are two reasons. First, forestry usage is changing the structure of the forest. In the past, there were almost invariably spruce forests of the same age, but today these are increasingly developing into dynamic natural forests, where there are gaps in the population, with old trees growing alongside young trees. The bark beetle has less surface area to attack – even if it gets warmer due to climate change. Second, the ratio of different tree species. Due to the rising temperatures, the spruce will lose its role as the leading tree species in the future. Beech and fir will fight their way into higher altitudes bit by bit. In the two scenarios simulated by the computer program in which the temperature rises sharply, the spruce disappears almost entirely from the Bavarian Forest after 600 years. As a result, the European spruce bark beetle will quite simply lack sufficient food sources in the distant future.

The four climate scenarios show that the risk of infestation by bark beetles in 600 years is no longer significant. Graphic: Prof. Dr. Rupert Seidl, Photo: Lukas Haselberger



IN A NUTSHELL

- *In the near future, waves of bark beetle infestations will occur time and again in the National Park.*
- *Forests with diverse structures are less susceptible to large-scale disturbances.*
- *If temperatures rise sharply, spruce and the European spruce bark beetle will become a rarity in the long term.*

AN INTERNATIONAL LOVE STORY

In 2016, a camera trap in the National Park was able to photograph two wolves. The Polish and the Italian animals mated and in 2017 they gave birth to the first wolf offspring in Bavaria for 150 years.

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AN INTERNATIONAL LOVE STORY

A Polish female and an Italian male find each other after a long and arduous search. They settle down and start a family in the Bohemian Forest.

What makes this love story so unusual? Because after a long absence, this is how the wolf gained a foothold in the region once again.

Flashback to May 2015. The pictures taken by camera traps in the National Park are checked on a regular basis and in this particular month, the researchers discovered something of a sensation during their regular check. A wolf is spotted roaming the forests of the cross-border protected areas. This marks the beginning of the successful return of this strictly protected species.

A SUCCESSFUL RETURN WITHOUT HUMAN ASSISTANCE

The wolf has actually been a natural species in the Bohemian Forest for a long time. But the local people viewed it as a danger and ultimately exterminated the wolf from the region. The last animal was shot on the Bavarian side of the border in 1848. But unlike the lynx or Ural owl, which were actively reintroduced at the end of the 20th century after their disappearance, there were no such aspirations for the wolf. Luckily, the animals didn't need any help. They came back all by themselves. Just one year after the first sighting, a camera trap then captured a pair of wolves. Genetic analysis of faecal samples showed that the female immigrated from the Central European lowland population, i.e. from Poland. While her companion hailed from the Italian Alps. This is the first time that these two European sub-populations have come together and bred. Scientists from the Bavarian Forest and Šumava National Parks have now launched intensive monitoring work in close cooperation, because the wolves used both national parks as their core habitat.

FIRST CUBS FOR 150 YEARS

The wolves then began to reproduce. In the summer of 2017, an automatically triggered video camera documented four young wolves. These are the first wolf cubs in Bavaria in over 150 years. From then on, the small population has slowly grown. In 2020, a second pack established itself in the region. The foundations for this expansion were laid by a female from the first litter and another wolf, likely from Poland. Young cubs are regularly sighted. And these creatures can be quite eager to travel considerable distances in search of their own territories: a male was spotted in Central Thuringia in 2018, another male died in road traffic near Hamburg in the same year, after having previously visited its relatives in Saxony.

IN A NUTSHELL

- *Wolves returned to the Bohemian Forest on their own accord in 2015.*
- *A Polish female and an Italian male produced offspring for the first time.*
- *Nowadays, 26 wolves live in the region, and three animals have been fitted with GPS transmitters. No farm animals have been harmed in the Bavarian Forest National Park by wolves to date.*

TRANSMITTERS PROVIDE ACCURATE DATA

In order to learn more about the behaviour of wolves, Czech scientists began to catch individual animals at the end of 2020 in order to fit GPS collars to them. Three wolves have already revealed their movement patterns using these devices. One of the animals in question, a young wolf, roamed the Bavarian forests below Falkenstein and Rachel for a long time. Together with genetic samples and camera trap analyses, this data provides researchers with a very good basis for making assumptions about the rest of the population in the Bohemian Forest. In February 2022, the population consisted of four packs of at least five to six animals each, as well as two more couples for a total of 26 animals.

At the end of 2021, a female wolf with four cubs was spotted in the northern part of the National Park.

RADIANT RESIDENTS

Porcini mushrooms still contain radioactivity, even after more than 30 years. Photo: Peter Karasch

RADIANT RESIDENTS

Science thrives on making clear statements. But when it comes to the radioactive contamination of fungi, that's easier said than done. What may be easily digestible higher up in the Bavarian Forest can pose a long-term health risk a few kilometres further down.

Foraging for mushrooms is a hobby for many people, especially in the Bavarian Forest. But can these fruits of the forest also be consumed without hesitation given the still persistent caesium radiation in the soil? Research conducted by the National Park and the Goethe University Frankfurt can now provide a few answers: The health risk posed by the Chernobyl accident in April 1986 is still relevant today.

LEVELS LINKED TO TOPOGRAPHY

Previous measurements of contamination in fungi were not spatially standardized. Geography, soil, altitude and exposure were not taken into account either. But as part of a new National Park project not only the contamination of mushrooms was considered, but also that of the soil in relation to its topography. By linking these two components, meaningful data has now finally been obtained. For this purpose, 36 test areas with a size of 100 by 100 meters each were established in the protected area. Samples of porcini and bay bolete mushrooms as well as of the soil were taken. In order to obtain representative results, different altitudes as well as western and eastern slopes were used throughout the National Park area.

The highest radiation level, which was measured in a bay bolete mushroom, was 3100 becquerels. Photo: Peter Karasch

BAY BOLETE MUSHROOMS CONTAIN MORE RADIATION THAN PORCINI MUSHROOMS

Even the researchers were surprised by the results. Over the past 35 years, radioactivity has not fallen in the soil. The contamination is still at a similar level as it was directly after the reactor meltdown. As a result, the radiation within fungi is also correspondingly high. In general, the bay bolete mushrooms are more contaminated than porcini mushrooms, as they absorb more radioactivity due to their metabolism. The highest level, which was measured within bay bolete mushrooms, was 3100 becquerels per kilogram, whereas in the case of porcini mushroom it was just 601 becquerels per kilogram. For comparison: Anyone who wants to sell mushrooms commercially must dispose of any goods with values exceeding the 600 mark.

DIFFERING CONTAMINATION IN DIFFERENT AREAS

One surprising aspect of the findings is the differing contamination in different areas and altitudes. Between Lusen and Rachel, the soil is less contaminated than in the area around Großer Falkenstein. In the Lusen–Rachel region, fungi have a high level of radioactive contamination primarily at higher altitudes.

In the Falkenstein–Rachel area, on the other hand, the opposite is true. Fungi at lower levels are especially contaminated there. This shows that the contamination of fungi does not necessarily correspond with the contamination of the soil. In general, the contamination of one third of all fungi samples was above the permitted limit of 600 becquerels per kilogram. In other words – the risk is still present. Thanks to these research results, every forager can now determine for themselves which mushrooms from which areas they wish to consume, and how frequently.

IN A NUTSHELL

- *The radioactive contamination of the soil in the National Park is still similar to levels measured shortly after the Chernobyl accident.*
- *Bay bolete mushrooms have a significantly higher radioactivity than porcini mushrooms.*
- *One third of all samples were above the legal limit.*

THE SECRET OF RACHELSEE LAKE

The distribution of tree species over the past millennia can be traced using analysis of pollen taken from the depths of Lake Rachelsee. Photo: Steffen Krieger

When you think of a forest in our region, spruce trees most likely come to mind.

But this wasn't always the case. Looking back in time, there was used to be another queen of the forest: the pine.

Researchers are rightly questioning whether the pine, which used to feel right at home in the Bavarian Forest, could return to its previous levels at some point. Could that be part of the new look of the forest in these times of drought and climate change? Does a glimpse into the forest's past provide the solution to today's issues? Together with the University of Bern, the National Park decided to take a journey through time. Its focus: pollen that was hidden in various layers of bog in Rachelsee Lake, alter Rachelsee Lake and the Stangenfilz wetland.

TREE SPECIES OVER THE COURSE OF TIME

A temporal analysis of the extracted pollen shows that between 9500 and 8500 BC, i.e. already after the last ice age, there were forests in the Bavarian Forest which mainly consisted of pines and birches. These two species were then gradually displaced by spruce, oak, lime, elm and ash over the millennia. Beech trees grew here from 6500 BC. 2000 years later, the climate began to become wetter and milder, which greatly favoured beech trees and then later also firs.

IN A NUTSHELL

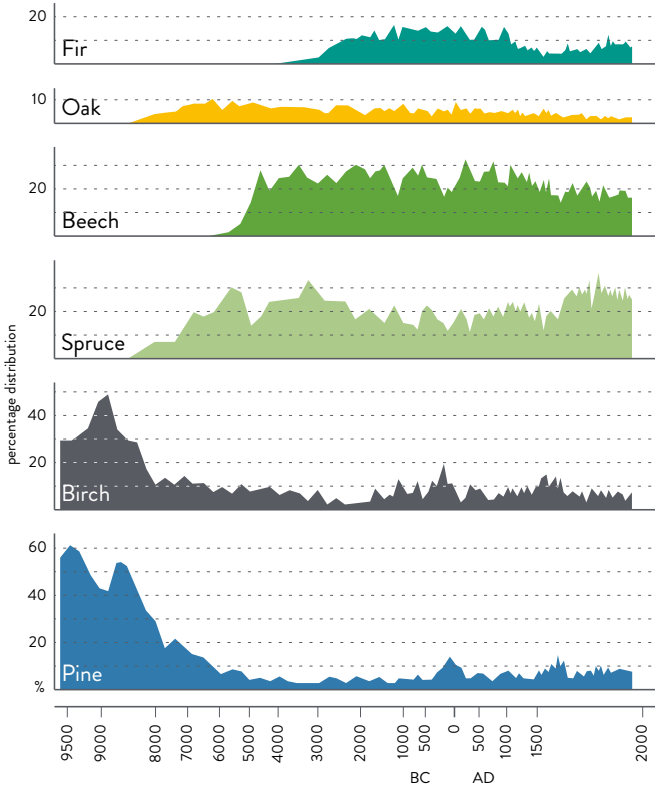
- *Pollen from sediment and bog layers reveals a lot about the tree species of the past 10,000 years.*
- *Since the last ice age, new tree species have succeeded in migrating into the region time and again.*
- *Forests are highly dynamic ecosystems when viewed over longer periods of time.*

HUMANS PROMOTED SPRUCE TREES EARLY

From 2000 BC onwards, human influence was also detectable. Hemp and cereal pollen are proof that grassland was created. In the forests, the fir population was still expanding. Only shortly before Christ's birth did their proportion of the overall tree population decrease, with birches and pines once again becoming more common, undoubtedly thanks to human activities such as the development of forest pastures. During the migration period after the breakup of the Roman Empire, these traces of human activity disappeared again from the Bavarian Forest. It was only in the early Middle Ages, i.e. between 800 and 1000 A.D., that people exerted more influence over the environment again. At that time, the proportion of open land was about 20 percent. Grazing favoured the growth of juniper and spruce, but disadvantaged the fir. In the following 600 years, the forest became lighter and lighter, with pastures now even extending up to the higher altitudes. The analyses show a sharp increase in coal residue, probably due to the increased production of charcoal. This is also likely the reason why beech and fir were in decline at that time. Human interventions were sometimes so substantial that entire fir and beech forests were converted into spruce forests. In the 19th century, the fir in particular was pushed further back over a wide area, paving the way for the spruce – which is still the most common tree species in the Bavarian Forest today.

FIR PROPORTION ROSE BY RACHELSEE LAKE

Between 1800 and 1900, intensive forest pasture grazing took place in the wetland Stangenfilz area below Großer Rachel, which led to the wetland being prevented from developing further. By Rachelsee Lake, on the other hand, the forests recovered during the same period, with the proportion of fir trees even increasing locally. But during this period, higher levels of industrial soot particles were also deposited. These deposits peaked in the 1970s and 1980s.



Distribution of tree species by Lake Rachelsee since 9500 BC.

LETTING THE FOREST BE FOREST

Saplings are just as much part of an intact forest as old and dead trees. Photo: Simon Thorn

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LETTING THE FOREST BE FOREST

Nursery, school, work and nursing home. The various stages of life that exist in humans can also be applied to the forest. And as with humans, all ages of the tree population have a role to play.

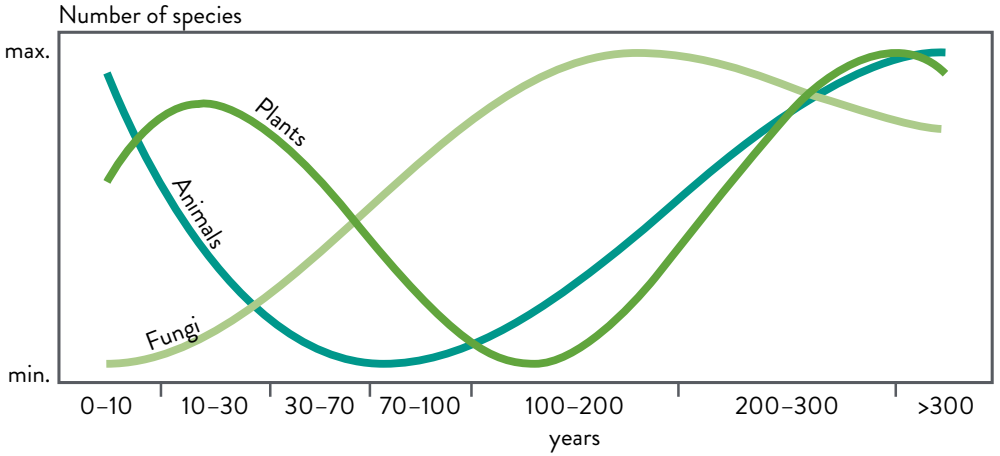
If humans do not intervene in the processes of the forest – as in the natural zones of the Bavarian Forest National Park – a cycle of growth and decay emerges, and a pattern of succession. How biodiversity develops throughout the course of these natural processes and which of the different stages of development in forests are particularly important for species conservation has now been analysed using a broad data set.

A CYCLE OF GROWTH AND DECAY

When trees die, gaps are created in the canopy and light reaches the forest floor. Seedlings then have the chance to germinate and grow into new trees. The canopy closes again and the cycle begins all over. At each stage of development, there is a specific biodiversity. For a long time, however, the focus was only on late forest development phases in international nature conservation: old forests with old trees were considered the epitome of the primeval forest and the target for forest conservation.

YOUNG FORESTS ARE JUST AS BIODIVERSE AS OLD FORESTS

Research conducted in the National Park now shows that this approach to increasing biodiversity may be lacking. As early as the 1990s, a chart of the biodiversity of animals and plants across all stages of succession in the forest was created. Over 20 years later, these charts were recalculated based on new data and supplemented by the diversity of fungus. All in all, these new calculations are based on more than 3000 species recorded in the National Park. The results provide important impulses regarding the composition of biodiverse forests. Early stages of development, which have long received little attention in research and nature conservation, represent an important habitat for many animal and plant species. In fact, young forests after disturbances, such as bark beetle infestation, are just as rich in species as old forests – especially in terms of plants and animals. Fungus, on the other hand, has the highest diversity in the dense forests typical within intermediate stages of development. Herbivores, green plants and species that break down dead biomass are common both at the beginning and at the end of the cycle.



Young and very old forests are rich in biodiversity.

WILL THE BIODIVERSITY OF THE NATIONAL PARK REMAIN INTACT?

In general, different compositions of biodiversity are found in each development phase, which in turn underlines how important all stages of development are for enabling high biodiversity within a landscape. In the Bavarian Forest National Park, the great variety of forest development phases in the former commercial forests has arisen without human intervention due to the natural disturbances in the last 30 years. At this point, we do not know if this diverse landscape will remain or whether denser and more homogeneous forests will become more dominant moving forward, and this will be a focus of research into the future. However, initial data analyses indicate that heterogeneous forest landscapes are likely to develop.

IN A NUTSHELL

- *Different compositions of species can be found at each stage of development.*
- *Not only old forests, but also early development phases have particularly high biodiversity.*
- *In order to increase biodiversity, trees have to exist in all stages of development.*

DEATH, WHICH SUPPORTS LIFE

Death is not the end. Many species, such as this blackbird, benefit from animal remains in the forest. Photo: Andreas Rückerl

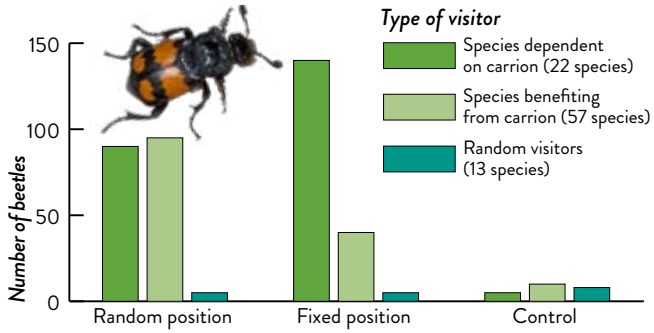
DEATH, WHICH SUPPORTS LIFE

Nature knows no waste. So even death is not in vain. Perished animals provide the basis for new life. Bacteria and fungi are capable of tremendous things – and in order to maintain this cycle of life, the smallest creatures are often the most important.

What happens to large animal carcasses in the forest? A new research project in the National Park is now providing answers to these questions. This is all the more important as the natural processes of carcass decomposition are almost non-existent in the Central European cultural landscape nowadays. Even in National Parks it is not customary to leave red deer, roe deer and similar sized animals lying in the forest after their death. Yet carcasses are a true hotspot for biodiversity. Beneficiaries include not only bacteria, fungi and large predators – but, above all, insects.

ROAD TRAFFIC VICTIMS FOR THE WILD FOREST

Animal carcasses are the most nutrient-rich form of dead organic matter. To put this into context – a decaying deer carcass on a small area corresponds to approximately the same resource value as 100 years of fertilization. The effect therefore has a high concentration, but a low spatial spread. The effects on biodiversity from dead biomass remaining in the forest have been investigated in detail in the Bavarian Forest National Park since 2018. To this end, carcasses were placed in random places within the forest as well as in permanently set-up carcass spots. The dead animals placed here were killed in road accidents or as part of wildlife population management measures. The results of this project demonstrated the role of carcasses as a crucial link within the ecosystem.



Many species depend on carrion for their survival. Photo: Heiko Bellmann

RED-LISTED SPECIES VISITED THE CARCASSES

An initial study revealed that 17 carnivorous vertebrates fed on the deer carcasses. These included the lynx, wild cat, tree marten, white-tailed eagle and red kite – all species that are on the endangered species list in Germany. The larger the carcass, the more often the animals came. In addition, an increased frequency of visits in the winter months was another significant finding of the project. And this shows that the availability of large carcasses in the cold season can specifically help promote vertebrate diversity.

DIVERSE INSECT POPULATIONS IN FIXED CARCASS SITES

While there were no difference in the diversity of vertebrates that visited the random positions and the fixed carcass sites, a further study showed that the diversity of insects is significantly higher in the areas where carrion was made repeatedly available. This is because decomposition liquids can accumulate permanently in the soil, enriching it. These nutritious islands serve as an important sanctuary for an array of creatures, especially for threatened red-listed species. Here is the only location where the beetle necrobia violacea was detected, for instance. Researchers also found the very rare primitive carrion beetle (Necrophilus subterraneus) and the Sphaerites glabratus in these areas. These two species are each the only members of their respective genera in Europe and, together with numerous other carcass-visiting beetles, they are essential within the complex chain of decomposition of carrion. Their existence underlines the importance of carrion for the conservation of insect biodiversity.

Spectacular species, such as the sea eagle, also came to the carcasses laid out.

IN A NUTSHELL

- *Carrion is a crucial link in the forest ecosystem.*
- *Lynx, wildcats and co. use carcasses as a source of food, especially in winter.*
- *In the summer months, carcass-feeding beetles assume an important job within the decomposition chain.*

THE TWO SIDES OF THE SAME COIN

The dead wood study was designed in the Bavarian Forest National Park. Photo: Sebastian Seibold

THE TWO SIDES OF THE SAME COIN

"Dead wood is good for biodiversity," some say. "Dead wood releases carbon dioxide and is bad for the climate," others counter.

So which is true? Researchers from the Bavarian Forest National Park have now focused on getting to the bottom of this once and for all.

How can both climate change and the extinction of many species be slowed down? These are some of the most pressing questions of our time. In order to get answers, we need data on the structure of the carbon cycle, in which locations carbon dioxide is stored and released, and it what quantity. There are already numerous international models for forests, oceans and soils. However, there is a dearth of knowledge when it comes to dead wood and insects. Thanks to the Besenstiel-Projekt ("Broomstick Project"), climate researchers are now somewhat smarter.

55 RESEARCH AREAS ACROSS ALL CONTINENTS

In order to obtain meaningful international results in this area as well, the National Park established a total of 55 research areas on all continents. Every forest type in the most diverse climate zones was represented. At each location, three local types of wood were laid out as well as a broomstick made of beech wood from the Bavarian Forest – in order to be able to draw accurate comparisons. In the end, 142 different tree species were used across all research areas worldwide – from spruce to pandanus palms to rubber trees. Half of the wood was accessible to insects, the other was not – this helped determine the role insects play in the degradation of dead wood. Over the course of three years, researchers observed at these locations at what speeds the different woods rotted.

The same experimental setup as in the Bavarian Forest was also found in Madagascar. Photo: Sebastian Seibold

HOW MUCH CARBON DOES DEAD WOOD RELEASE?

As part of the study, researchers found that dead wood releases a considerable amount of carbon dioxide (CO_2) annually during decomposition – about 25 percent of what is released from soils. Dead wood therefore plays a climate-relevant role in the global carbon cycle. However, it should be noted that 93 percent of this annual natural release of carbon comes from tropical forests. One third of this carbon release is due to insects. Because especially in warmer areas, insects decompose dead wood faster. In colder regions, the trend can actually go in a different direction. Here, for example, some bark beetles carry fungi with them, which are bad wood decomposers. This causes the degradation process to slow down. It is clear that both global warming and the loss of biodiversity of insects have the potential to affect carbon and nutrient cycles worldwide, and to influence climate change.

A variety of beetles, such as the click beetle (elateridae, left) and bess beetle (passalidae, right), were found in the dead wood logs. Photo: Annika Busse

COOPERATION

The Bavarian Forest National Park was able to attract many collaborators for this research project. Berchtesgaden National Park, the Julius Maximilian University of Würzburg and the Technical University of Munich were key partners, along with more than 30 cooperating research groups from all over the world.

CO_2 measurements are also carried out in the National Park using the research tower at Lackaberg. Photo: Rainer Steinbrecher

A CONTRADICTION BETWEEN SPECIES AND CLIMATE PROTECTION?

Dead wood therefore releases a remarkable amount of CO_2. Does this negative effect on the climate stand in contradiction with species protection? After all, dead wood, as numerous international studies have shown, is of paramount importance for the preservation of biodiversity.

In order to answer this question, a study was carried out in the Bavarian Forest National Park on an abandoned windthrown tree at Lackaberg near Großer Falkenstein after Hurricane Cyril to determine the consequences of dead wood on the climate. Two questions initially arose: What amounts of CO_2 are released into the atmosphere from the forest ecosystem after the disruption? And how many years will it take for the vegetation layer, i.e. grasses, herbs and tree rejuvenation, to store more biomass carbon in the forest ecosystem than it releases into the atmosphere as CO_2?

Since 2009, continuous, high-quality measurements of CO_2 and meteorological variables such as temperature, radiation and wind have been carried out by the Institute of Meteorology and Climate Research (KIT/IMK-IFU) at Lackaberg. With suitable biophysical models, it is not only possible to determine the absorption of CO_2 into the biomass, divided into tree rejuvenation and lower vegetation, it is also possible to calculate the release of CO_2 into the atmosphere by vegetation and soil, including dead wood.

ON THE GROUND OR UPRIGHT: CO_2 RELEASE IN THE SPRUCE FOREST REMAINS THE SAME

The research revealed that the annual release of CO_2 from dead wood and soil humus is 7 tons of carbon per hectare (with slight fluctuations). This corresponds to the amount that a living spruce forest releases. Natural forests rich in dead wood are therefore not major carbon dioxide outputters.

Preliminary calculations show that at Lackaberg, the annual binding of CO_2 by photosynthesis in the rejuvenating forest population since 2017, with an average of 7.7 tons of carbon per hectare, is slightly greater than the release, with tree rejuvenation becoming increasingly important compared to grasses and ferns. Just ten years after Hurricane Cyril, this storm-affected forest ecosystem is now a net CO_2 store once again.

These results show that in forest areas at moderate latitudes, such as the Bavarian Forest, even large quantities of dead wood do not become an excessive and permanent source of CO_2 release after disruption events, and there is therefore no contradiction between species and climate protection in this case. As a result, demands to remove dead wood from the forest for climate protection reasons are unfounded.

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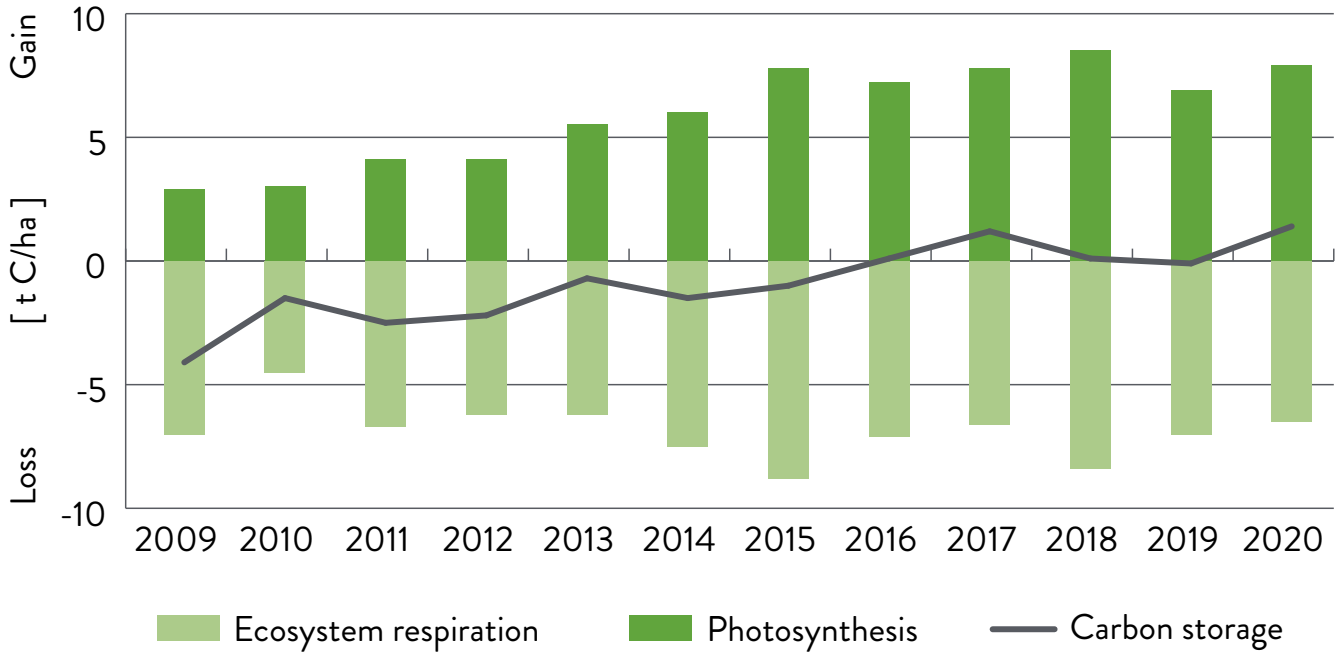
THE TWO SIDES OF THE SAME COIN

Windthrown area at Lackaberg photographed from approximately the same angle. The photos were taken in 2008 (left) and 2017 (right). Photos: Rainer Steinbrecher, Wilhelm Breit

After just a few years, areas of dead wood develop into carbon stores.



IN A NUTSHELL

- *Dead trees are of paramount importance for biodiversity.*
- *The decaying of dead wood releases large amounts of carbon – especially in the tropics.*
- *Insects play an important role in the decomposition of dead wood.*
- *Consequently, the loss of biodiversity can affect carbon cycles.*
- *In forests of temperate latitudes, large-scale disturbances do not lead to increased CO_2 emissions.*
- *The positive effect of dead wood on biodiversity does not adversely affect climate protection.*

A WELCOME RETURN
AFTER OVER 100 YEARS

For the first time in over 100 years, the beetle Peltis grossa was detected in the Bavarian Forest National Park in 2019. Photo: Lukas Haselberger

A WELCOME RETURN AFTER OVER 100 YEARS

If you are looking for a needle in a haystack, the chances of success are greater if lots of people help. This is a good analogy for the project aimed at detecting the Peltis grossa beetle, a relic of the primeval forest, which has not been observed since 1906. Ultimately, the effort was rewarded with success.

Measuring up to two centimetres in length, *Peltis grossa* is not very small and not particularly easy to miss. But if the habitat for this endangered beetle does not exist, the beetle itself will be nowhere to be seen. And so it was for over 100 years. With the increasing commercial usage of the forest in the 20th century, more and more natural forests were lost. Thick dead wood, which peltis grossa relies on, no longer remained in the forest and the species disappeared.

FIRST FIND IN A BARK BEETLE TRAP

In 2018, one specimen landed by chance in a bark beetle trap in the Šumava National Park. One year later, P*eltis grossa* was also detected on the Bavarian side of the border. This triggered a wide-scale, cross-border monitoring program in the Bavarian Forest and Šumava National Parks in 2020. 36 volunteers, from children to pensioners, searched for this rare insect across 104 areas. Care had to be taken to identify suitable conditions. The beetle is especially active on warm nights above 19 degrees and can then be found on red-banded bracket fungus or on the bark of dead spruce trees.

Ultimately, the search was particularly successful on the Czech side: While on the Bavarian side only one beetle and three boreholes were found, on the other side of the border a total of 115 sightings of this rare species were recorded. The main population is located within a radius of ten kilometres around Plöckenstein Mountain.

REPOPULATION THANKS TO FEWER SURVIVORS

But how can the resurgence of *Peltis grossa* be explained? Windthrow and bark beetle infestation events over the past two decades have provided sufficient dead wood in both national parks. However, the first “wave of dead wood” in the 1990s was not enough for re-settlement. It took 30 years for suitable habitat conditions to emerge for this long-lost beetle. Its return was ultimately only possible because there was still a small remaining population in the region, i.e. the last survivors of the primeval forest relic species. According to the findings of the monitoring study, this must have remained in the area around Plöckenstein.

LETTING NATURE BE NATURAL – THE BEST PREREQUISITE

The study shows that species that were considered extinct over a large area can still spread out again – but that this process takes a very long time. The remaining population first needs time to recover and grow. Only then can it spread to the surrounding area – and this only works if there are suitable habitats available. Since the two national parks of the Bavarian Forest and Šumava are the largest contiguous protected forest in Central Europe and the philosophy of “letting nature be nature” applies everywhere here, Peltis grossa has promising chances of continuing its spread. Its home is fully furnished, now it’s time to move in.

36 volunteers helped during the 2020 cross-border monitoring program. Only with the help of “citizen science”, i.e. the participation of the public in research, could large areas be studied in both national parks.

IN A NUTSHELL

- *Species believed to be extinct can return once again.*
- *A handful of survivors and a suitable habitat are necessary for this.*
- *As populations grow slowly, nature conservation concepts must be designed with the long term in mind.*

BETTER VALUE AND ACCURACY FROM ABOVE

Counting trees from the air is significantly more efficient and easier than on the ground.

Sometimes you can't see the forest for the trees. So how are you supposed to count them properly? This is precisely the problem that researchers face when taking an inventory of the forest. Luckily, nowadays technology can also lend a hand.

Progress does not stop at counting trees either. What in the past used to involve trudging through the forest and counting trees by hand, is today much easier. From the air, the work is done in no time – and it's cheaper.

AT ONE TIME EVERY TREE HAD TO BE COUNTED BY HAND

Traditionally, forest inventories have always been very time-consuming and personnel-intensive. Costs of over one million euros were incurred in the National Park every ten years for this very purpose. At a total of around 5,800 inventory points, all trees had to be recorded according to type, height and diameter on a test area of 500 square meters, with forest populations also recorded cartographically. And this work, which lasted several months, ultimately only yielded information on sample areas.

THANKS TO LASERS, ONLY ONE-FIFTH OF THE COSTS ARE NOW INCURRED

Research conducted by the National Park has shown that this work does not necessarily have to be done from the ground, but can also be carried out from the air. A Laser technology has proved to be a particularly powerful tool in this regard. This laser scans the terrain from an airplane using short pulses, creating a three-dimensional elevation profile of the forest in the process. With this method, up to 300,000 measurements per second can be carried out, which results in up to 50 measurement points per square meter. The results are very accurate – at least as good as the measurements made from the ground. In addition, the necessary work can be carried out within just a few days at about one-fifth of the cost.

The data obtained shows that the national park is changing rapidly. In 1989, more than half of the area was still covered by coniferous forests. A good 28 years later, this figure was just over 20 percent. In contrast, the proportion of deciduous forests has increased from under ten to over 30 percent – and mixed forests have also become more numerous. This is evidenced in the composition of tree species in rejuvenating open areas. While there was still a 70.2 percent share of spruce in 2008, this figure dropped to 60.6 percent by 2021. In the same period, beech rose from 22.2 percent to 27.6 percent, while fir increased from 3.1 percent to 5.4 percent.

DETAILED EVALUATIONS DOWN THE YEARS

In addition, laser technology offers a further advantage: the collected data is not only important for the current management efforts, but also allows for detailed evaluations of various issues across multiple years. For example, it is possible to obtain information on the growth behaviour of the trees or on the structural diversity of areas, which was not previously possible. Therefore, the use of laser scanning methods is clearly an important tool in nature conservation and the management of natural resources.

IN A NUTSHELL

- *Laser scanning of the forest is cheaper and provides better data.*
- *This method provides a continuous source of data on the entire national park area.*
- *Firs and beech trees are on the rise, and the spruce is on the decline.*

With the help of laser scanning technology, it is now not only possible to determine the number of trees, but also whether they are deciduous, coniferous or dead.

ZEBRA CROSSINGS FOR MOOSE

The moose population can only grow with the help of protective measures. Photo: Thies Hinrichsen

ZEBRA CROSSINGS FOR MOOSE

Would zebra crossings for moose make sense? If these animals knew how to use them properly, it would certainly be.

Why? Because road traffic is the greatest threat to this animal's survival.

In recent years, fewer and fewer ***moose*** have been sighted in the Bohemian Forest. The decline of this already small population, which is currently estimated at ten to 20 animals, was difficult to explain at first. But now cross-border research has shed some light on the matter.

DATA SETS FROM THREE COUNTRIES COMPILED AND EVALUATED

In Germany, Austria and the Czech Republic, moose sightings from the years 1958 to 2019 were first collated and inputted into a database with a total of 771 sightings. Based on this data, three key questions could then be answered: How have the sightings and the area of distribution of these sighting developed over time? What are the main causes of the animals' deaths? And how many habitats suitable for moose are available?

FOR 50 YEARS THE MOOSE POPULATION GREW STRONGLY

The results show a strong increase in moose sightings after 1958, with peaks in the 1990s and around 2010. But after 2013, there was a sharp decline in sightings. But what was the reason for this development? Are there not enough habitats available for these animals?

Moose prefer to live in higher altitudes between 700 and 1000 meters with wetlands, forests and natural grassland. They tend to avoid steep slopes and areas of human activity. Based on this, suitable areas are in fact available outside of their current area of activity. Habitat is therefore unlikely to be the limiting factor preventing the growth of moose populations. Ultimately, evaluation of the data showed that moose are primarily killed by human activities: 13 fell victim to accidents, while four animals were killed intentionally.

IN A NUTSHELL

- *The moose population has declined sharply over the past ten years.*
- *Traffic accidents and intentional killings are the most common causes of death.*
- *Once suitable habitats are available, the population can grow again with the help of protective measures.*

PROTECTIVE MEASURES ACROSS BORDERS

In order to preserve the moose population, immediate cross-border protection measures are necessary. First and foremost, efforts must be made to prevent wildlife accidents and to tackle illegal killings systematically. Mooses`s habitat requirements must also be taken more into account when planning infrastructure and development measures.

INFO

The border region between Austria, the Czech Republic and Germany is home to the most southwestern population of moose in continental Europe. The population originated in Poland, where moose never died out, migrated from the former Soviet Union or were resettled after the Second World War.

In isolated cases, moose sometimes roam into the Bavarian Forest National Park, as documented by several photo traps, such as this one from 2015.

LESS AND LESS WATER

Up to 30 percent less water reaches the valleys via streams compared to 20 years ago. Photo: Thies Hinrichsen

LESS AND LESS WATER

Do you think climate change is something that happens in other places? Think again! This worldwide phenomenon is also noticeable on our own doorstep.

Changes can be observed in the Bavarian Forest National Park, some of which are more serious than the global average.

For decades, the protected area has been keeping a close eye on the key variables of the climate. This means that temperature, precipitation, solar radiation and the like are recorded in detail. Numerous research facilities, such as the Waldhäuser weather station and the Taferlruck water level station, are dedicated to precisely this. Evaluation of the data clearly shows that climate change also affects the Bavarian Forest.

MORE SUNSHINE IN THE FOREST

The most obvious effect: in the mid altitudes it is now almost 2 degrees Celsius warmer – in summer as well as in winter. Along with this, the total sunshine duration has increased by almost 300 hours annually. Both changes only began at the beginning of the 1980s. Until then, the release of sulphur dioxide emitted from combustion processes in industry, transport and co. led to the formation of aerosols, i.e. the finest particles in the atmosphere, which swallowed solar radiation or reflected it back into space. As a result, warming due to the release of climate gases such as carbon dioxide and methane was not able to take place. The rapid rise in temperature only came about due to successful air pollution control measures in the northern hemisphere.

Employees of the National Park Administration have been taking water samples at the Taferlruck research station since the 1970s.

LESS RAIN, LESS RUN-OFF

The opposite was the case with precipitation. Since the turn of the millennium, this has declined by 257 litres per square metre, mainly during winter. The consequences for the water cycle are enormous and alarming at the same time. Not only the amount if fresh snow has decreased – by 41 percent – but the period of time in which there is an intact snow cover is also decreasing steadily. In turn, the plant world is now emerging earlier in spring. All of this results in less groundwater building up. Especially in the recent past, there have been many years of low precipitation, which has led to a significant drop in groundwater levels. The total storage volume underground is comparatively small – and it would ideally be replenished annually by precipitation.

But not only does less water reach the Bavarian Forest from above nowadays, less is also flowing out of it. For example, the surface runoff of streams in the central Bohemian Forest declined by around seven percent between 1978 and 2013. This was due to the general warming of the climate and, as a result, the increased evaporation of water. During this period, 5 and 19 percent less water flowed into the valley in the Große Ohe and the Große Regen at the Schoenberg and Zwiesel water level stations respectively. Only seven years later, following the low precipitation years after 2010 were even more dramatic: Compared to 1978, the decline in the outflow is now already 30 and 28 percent respectively.

BARK BEETLES DELAY CLIMATE CHANGE CONSEQUENCES

Because tree populations in areas severely affected by bark beetles do not require as much water to grow for a period after infestations, the increase in evaporation caused by climate change was temporarily compensated. However, due to the progressive rejuvenation of the forests, this effect only exists in the 10 to 20 years after a bark beetle infestation. As a result, the impacts of climate change are only now having a full impact on the interior of the National Park. To date, the above-average amount of precipitation in the National Park compared to other regions ensured that serious ecological, forestry and agricultural droughts did not occur here – and this despite the decline in precipitation. What the likely warmer future will bring, whether more or less precipitation, in summer, in winter or both, is unclear at this point.

IN A NUTSHELL

- *The temperature rose by almost 2 degrees Celsius within 40 years.*
- *The groundwater level in the region has been falling steadily since the 2000s.*
- *Streams carry up to 30 percent less water into the valley.*

BIODIVERSITY ENGINEERS

Through their construction measures, beavers create a species-rich habitat for wagtails and co. Photos: Andreas Ebert/ Andreas Rückerl

Some study for years to learn effective engineering, others just have it in their blood. Beavers definitely belong to the latter.

As skilful landscape engineers, they actively reshape their habitat – and promote biodiversity in the process.

As recently as the 19th century, beavers were on the verge of extinction. Only strict protection and resettlement projects brought these animals back to many regions. As was the case in the Bavarian Forest. In the National Park alone, more than 100 animals now live in 22 active territories – as of 2020. The effects of these water-loving rodents, which have even settled in the mountain forest ecosystems, have now been extensively investigated by researchers for the first time.

COMPARISON OF BEAVER PONDS, RIVERS AND FOREST

Freshwater ecosystems are among the most threatened habitats in the world. This makes it all the more important to understand the complex processes that take place there. For example, it is not yet fully known what impacts the activities of beavers have on biodiversity in mountain forests. To investigate this, scientists created 33 research areas across the National Park – eleven respectively on beaver ponds, on sections of river not populated by beavers and in the forest, as control areas. The biodiversity of different species groups was analysed in these areas, from insects to beetles and birds to land mammals. A total of 1,188 species were ultimately detected during the project.

196 SPECIES EXCLUSIVELY LIVE TOGETHER WITH THE BEAVER

In-depth analysis of the data shows in some cases considerable differences between the habitats. For example, the diversity of birds and bats at beaver ponds is highest. In general, the sheer number of birds here is also significantly higher than the level in the river areas. When looking at so-called specialists, 196 species were found exclusively on beaver ponds, i.e. species that only find a habitat in the National Park alongside the beaver. A little less – 192 species – were exclusively found by researchers in the river areas uninhabited by beaves. In the forest, on the other hand, there were only 156 species that showed up exclusively here. Keystone species, i.e. species that are particularly characteristic for a habitat, were not identified in the forest or on the river. However, eight keystone species could be identified on the beaver ponds, such as Bechstein's bat, the common pipistrelle and the grey wagtail. Overall, the communities in beaver territories and river areas not populated by these rodents differ significantly in three species groups – namely birds, beetles and insects. In a comparison between the forest and beaver pond, researchers even found significant differences in seven of the eight species groups studied.

As the graphic shows, there are specialists in each habitat that are only found there

BIRCH MICE BENEFIT FROM RODENTS

Overall, we can see that beavers, as habitat engineers, transform entire ecosystems. They can therefore become drivers of regional biodiversity hotspots. From the point of view of nature conservation, active promotion of the beaver populations is therefore definitely desirable. These large rodents not only benefit entire species groups, but also some particularly protected species. Take the birch mouse (Sicista betulina) for instance, it was also found in a beaver pond during research in the National Park.

IN A NUTSHELL

- *Detailed analyses of the effects of beavers on biodiversity in mountain forest ecosystems were previously lacking.*
- *Birds and bats in particular benefit from the structures that beavers create.*
- *On a regional level, beavers can become drivers of habitat diversity and biodiversity.*

This aerial photograph shows how beavers can impressively transform the landscape. Photo: Berndt Fischer

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The European Diploma (since 1986),

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an important building block in the European Natura 2000 network,

membership to the “Nationale Naturlandschhaften e.V.”, the umbrella association for large nature protection sites in Germany

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