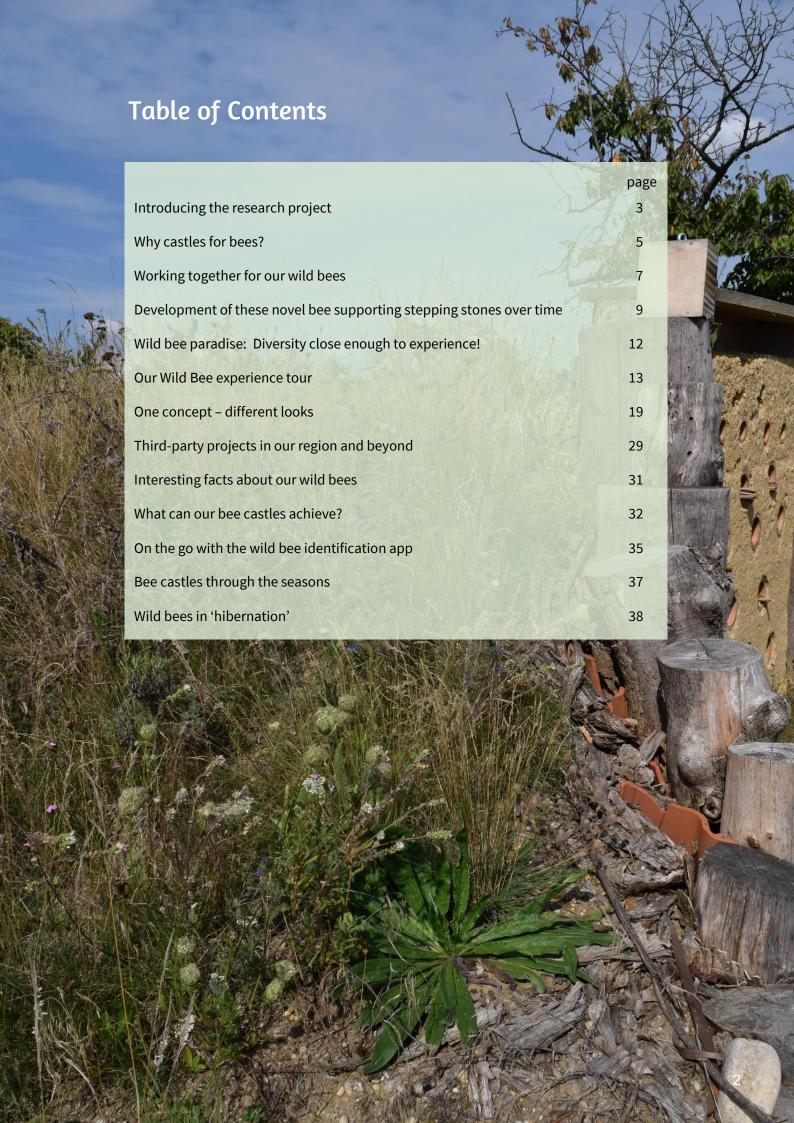


Ingmar Landeck, Friederike Kleinschmidt, Christian Hildmann

Bee castles - A novel concept for a stepping stone for wild bees



Working together to support and study wild bees



Introducing the research project

In March 2022, the project 'Bee Castles – Citizen Science for a Network of Habitats for Wild Bees' was launched. Until July 2025, it was carried out by the Research Institute for Post-Mining Landscapes in Finsterwalde, together with our partners, the Förderverein Naturpark Niederlausitzer Heidelandschaft e.V., Kerngehäuse e.V. and the Heinz Sielmann Foundation.

The project area includes the two nature parks Nieder-lausitzer Landrücken and Niederlausitzer Heideland-schaft as well as the connecting corridor between them. The aim was to create an entire network of stepping stones for wild bees, which will also ensure the survival of other animal species.

The aims of the project were to raise awareness of wild bees, to improve knowledge about wild bees in the Lower Lusatia region, and to establish special stepping stones, so-called bee castles (in German: Bienenburgen), and document their function.

Bee castles are a novel concept for a complex nesting and feeding habitat that we have developed specifically for wild bees. It combines various proven approaches from wild bee conservation, such as a clay wall and deadwood logs. In addition to wild bees, these facilities also support the diversity in a wide range of other species groups, e. g. other insects (butterflies, hover flies, beetles, solitary and parasitic wasps), spiders, lizards, snakes and small mammals.



Due to their complex construction, bee castles promote local populations of wild bees more sustainably and comprehensively than many other artificial nesting facilities.



They not only provide wild bees with food and nesting sites, but host complete species communities of such nesting sites, including the entire spectrum of parasitoids, kleptoparasites and hyperparasites from a wide variety of species groups.



The construction is compact and designed to be scalable and therefore particularly suitable for use in residential areas.

QR codes for further information, building instructions and other information materials





Wild bees identification app

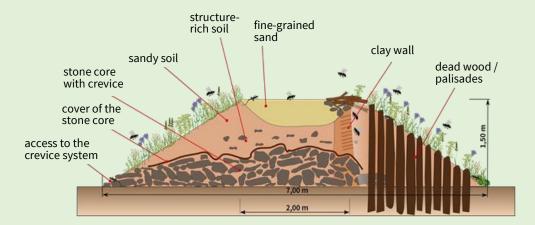




Why castles for bees?

Around half of all wild bee species known in Germany are either endangered, missing or already extinct. This decline has not spared Lusatia either: habitat loss is severely reducing the available nesting opportunities and food supply. Wild bees make a major contribution to the pollination of many flowering plants, including agricultural crops such as rapeseed, sunflowers, legumes and fruit, and are therefore extremely important for food production. In order to halt the decline in wild bee species, a dense network of suitable habitats is needed. Natural habitats and historical settlement structures (e.g. half-timbered houses) are becoming increasingly rare, and even conventional 'bee

hotels' without nesting opportunities for groundnesting wild bees are not sufficient. As part of the project 'Bee Castles – Citizen Science for a Network of Habitats for Wild Bees', a concept was developed for a multifunctional habitat with nesting and feeding habitats for various wild bee species: the bee castle. It is intended to serve as a stepping stone and habitat island in residential areas, at their edges as well as in the transition to open agricultural landscapes, and to help connect wild bee populations by establishing a habitat network that is as dense as possible.





Cross-section of a bee castle and QR code for free download of the construction plan.



View of the bee castle on the grounds of the Heinz Sielmann Foundation's Wanninchen Nature Discovery Centre.



In the winter of 2022/2023, eight bee castles were built in the Elbe-Elster district and two in the Dahme-Spreewald district in southern Brandenburg with the help of numerous volunteers. The core of the circular bee castle is made of rocks, which, with its crevice system, provides a place for wild bees and other species, such as sand lizards, to hibernate or hide. This stone core is covered with a suitable material (fleece, broken roof tiles) before nutrientpoor, sandy soil is applied on top. About a quarter of the bee castle is formed by a clay wall facing southwest. The necessary stability is achieved by wooden palisades, which provide a nesting habitat for wild bees that breed in dead wood. If the bee castle is large enough, the top can be filled with sand to provide another nesting habitat. The sides of the mound can then be sown or planted with suitable native flowering plants to provide food for the wild bees. These stepping stones can be easily scaled in size from a diameter of 2.5 m upwards and are suitable for both allotments and public green spaces. The ten bee castles (minimum diameter 7 m) built as part of the project are open to the public and are intended to inspire others to follow suit.









1 Entrance to the crevice system, 2 Sandy top with sparse vegetation, 3 Nest Entrance of a ground-nesting wild bee, 4 Mound embankment with developing young plants from seed mixture (common kidneyvetch in the center of the image).

Working together for our wild bees

In order to protect wild bees effectively, as many helping hands as possible are needed. Our ten bee castles were built with the active support of citizens in the villages and communities. Planning for the construction began even before the project started. This is because the future 'castle lords' – the owners of the planned locations for the structures – had already given their permission during the application process, and the citizens in the communities were involved in the implementation from then on.

The following steps had to be completed:

- 1. Erecting log palisades (22 running metres)
- 2. Laying the stone core (8 tonnes)
- 3. Erecting the mound (20 tonnes)
- 4. Tamping the clay wall (1 tonne)

After the project team had finalised the construction plan for the bee castles and procured the building materials, construction consultations were held with representatives of

the local support groups. A model of a crosssection of the castle was particularly helpful in making our ideas easier to understand.

Armed with the necessary information, these representatives were then able to seek out interested citizens who wanted to participate in the construction of the systems. Appointments were then made, the building materials delivered, and each of the ten systems erected in four construction phases (each lasting 2-3 hours).

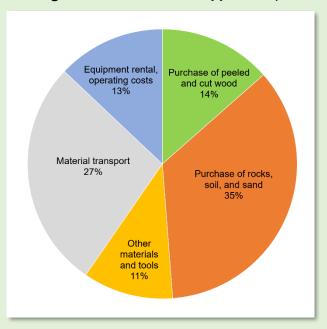
During the construction process, ideas from the participating citizens were repeatedly incorporated into the construction concept.

Ultimately, the construction of the structures turned into a collaborative practical workshop lasting several days, during which ecological concepts were also taught. In the end, each participant had not only learned about the concept of bee castles in theory, but had also been involved in the individual steps of the construction process in a practical way, thus gaining hands-on experience.

Work steps with associated time and personnel:

Work step	Working hours [h]	Share of total construction time [%]	Personnel expenses
Set location, measure contour, set boundary markers	2	9,8	2-3 persons
Procure materials	2	9,8	2 persons
Excavation work	1	4,9	3 persons
Construct palisade walls from logs	2,5	12,2	5 persons
Lay the stone core	2	9,8	1-2 persons
Build the earth mound	2,5	12,2	5 persons, incl. driver
Build the clay wall	3	14,6	1-2 persons
Drilling holes in the wood and clay wall	5	24,4	3 persons
Sowing the seed mix	0,5	2,4	2 persons

Sharing of the overall costs of approx. € 1,300:



Characteristics of the used soil materials:

Characteristic	Description
carbonate	carbonate-free
pH value	slightly acidic (pH 5,4–6)
nutrient content	nitrogen: low, N _t 0,02 - 0,05 % P _{plant available} : low * K _{plant availible} : low – medium *
texture	very sandy ** (fine sand 35 %, medium sand 30 %) weak to moderately silty
soil type	weak to moderately silty sand, Su2 to Su3 **
coarse soil content	medium ** (fine gravel to coarse gravel, partly medium to coarse grus)
bulk density	low - medium**
humus	low to medium humus content (h2 to h3) **





** Ad-Hoc-AG Boden (2005): Bodenkundliche Kartieranleitung, 5. Auflage (KA5)

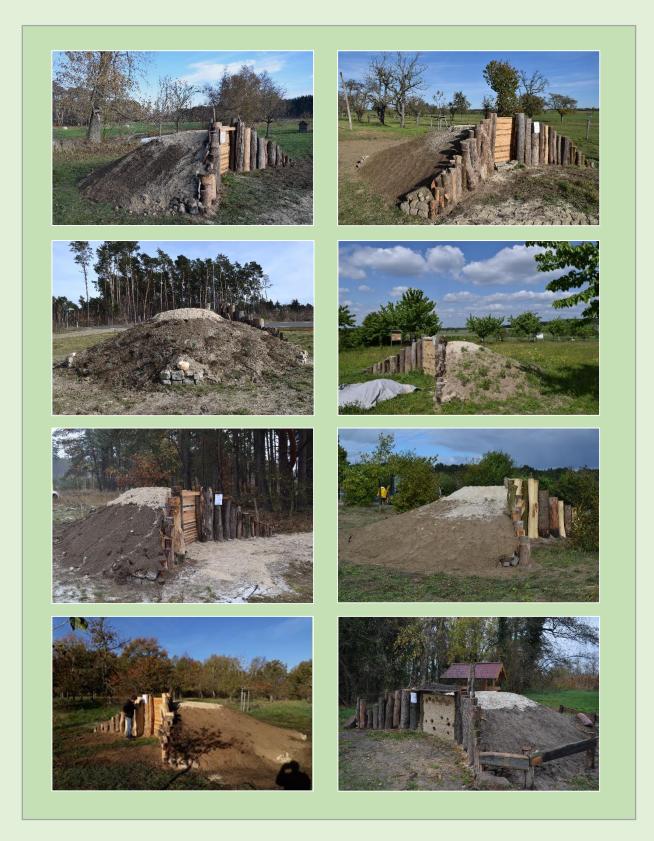
At the beginning, there were only a few of us who had an idea how to build a bee castle and how it works. By the end, there were many of us who knew how to do it.



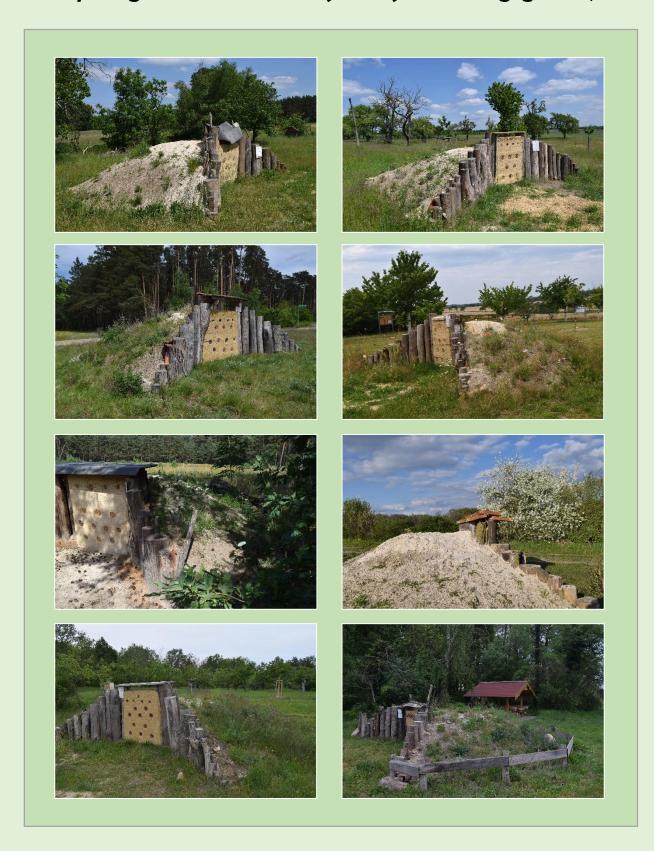


Development of these novel bee supporting stepping stones over time

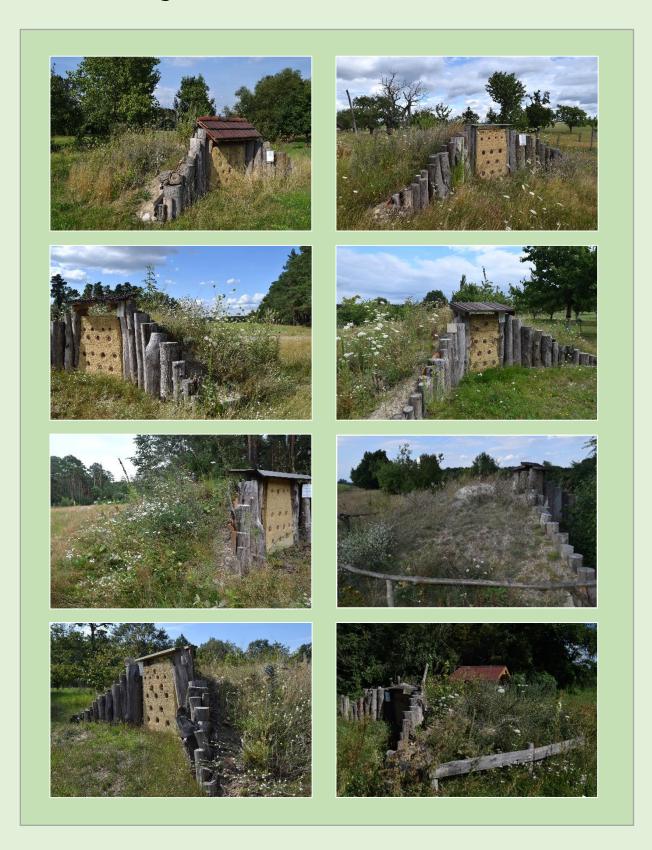
... just after construction (2022)



...in spring and summer of the following year (2023)



... and during the second summer (2025)



Wild bee paradise: Diversity close enough to experience!

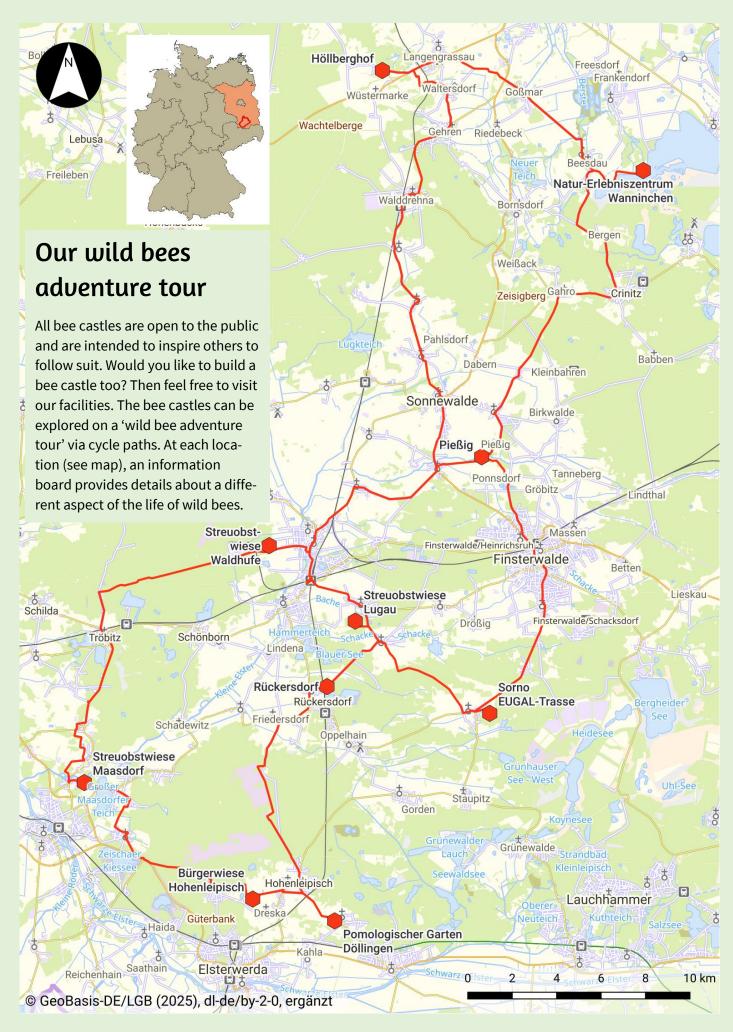
Bee castle with a bee-friendly garden

On the grounds of the Heinz Sielmann Nature Experience Centre in Wanninchen, on the edge of the Wanninchen nature reserve (Heinz Sielmann Foundation), a wild bee experience garden has been created alongside the bee castle. Post-mining landscapes are important spaces for nature experiences and environmental education. The knowledge and experience gained from them can be transferred to the rest of the cultural landscape for targeted conservation measures. It therefore makes sense to establish a learning centre at the interface between these two parts of our cultural landscape, which provides information about these findings and experiences and makes them accessible to everyone. Visitors should be introduced to the connections between pollinators and the landscape in a simplified, vivid way within the frame of a lively exhibition,

encouraging them to take action to preserve biodiversity in our cultural landscape, which is structurally poor in many places and predominantly used for agriculture, as well as in residential areas. The existing experience of the Heinz Sielmann Foundation in Wanninchen will also be expanded to include a section specifically tailored to pollinators and wild bees, which will include guided tours and lectures on the topic. Workshops on learning how to create wild bee habitats with nesting sites and food sources, from gardens to open farmland, will complement the versatile programme.

This bee garden is home to 107 native wild and beefriendly ornamental plant species from 31 plant families, including several species of thyme, knapweed, leek, mullein, scabious and sweet clover.

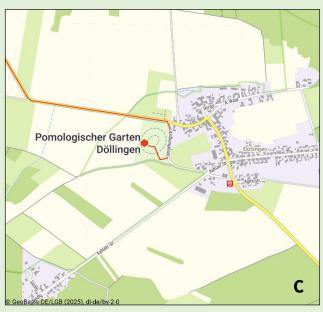


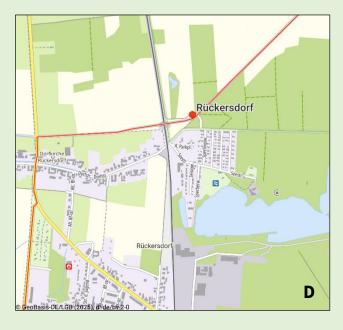














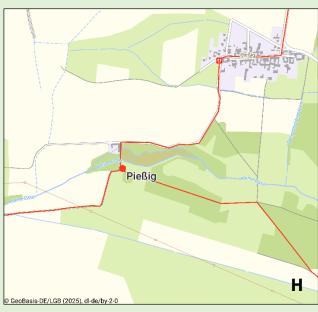
Detailed maps showing the locations of our bee castles:

- A Maasdorf orchard meadow
- B Hohenleipisch public orchard meadow
- C Döllingen pomological education and show garden
- D Rückersdorf bee castle
- E Sorno bee castle













Detailed maps showing the locations of our bee castles:

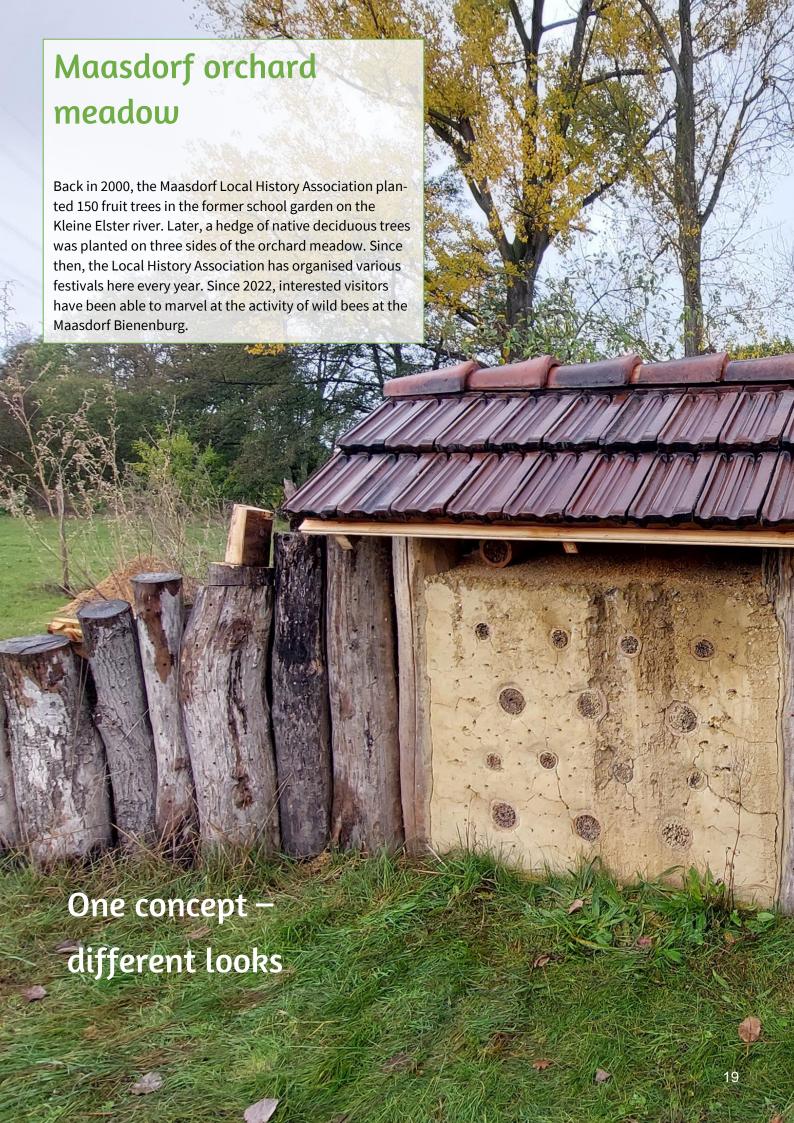
- F Lugau bee castle
- G Waldhufe orchard meadow, Doberlug-Kirchhain
- H Pießig watermill
- I Heinz Sielmann Nature Experience Centre, Wanninchen
- J Höllberghof Langengrassau



View of the back of a bee castle and the mound made of nutrient-poor soil covered with lush flowering vegetation. At the lower left edge of the image, an entrance to the crevice system of the stone core is visible.



An area close to an entrance to the crevice system. Limited root space and extreme dryness prevent dense vegetation in the long term.





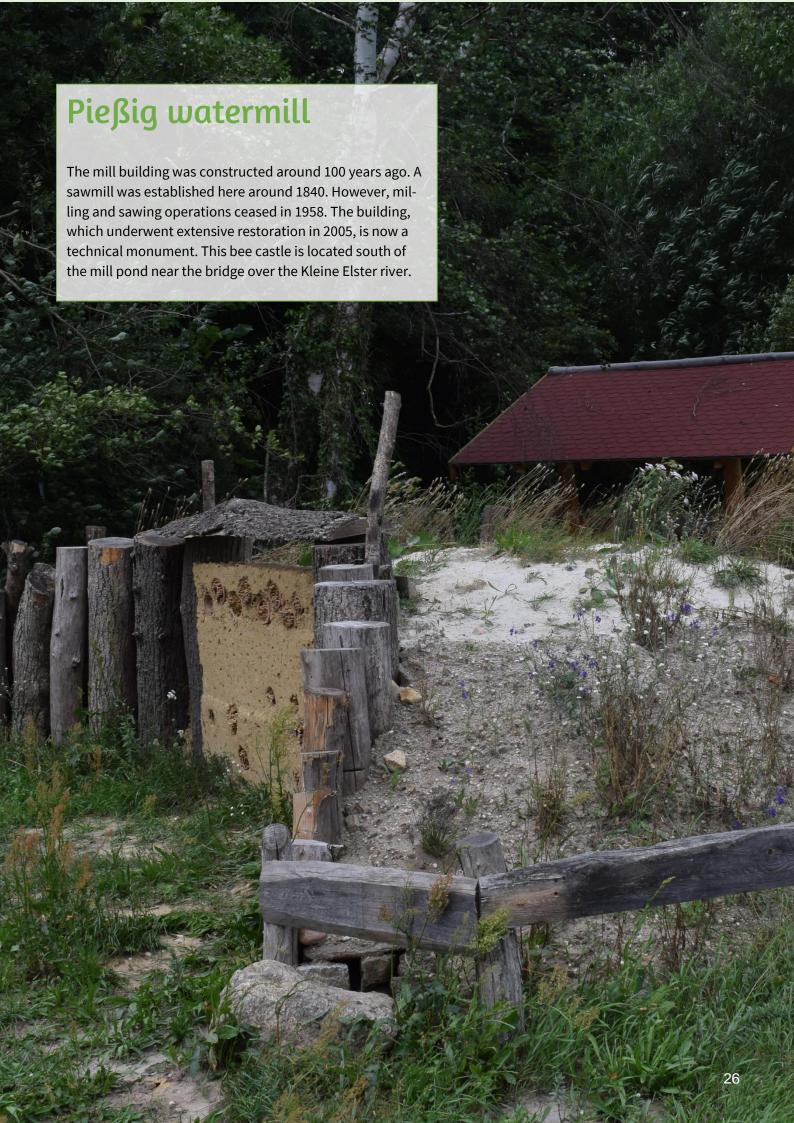










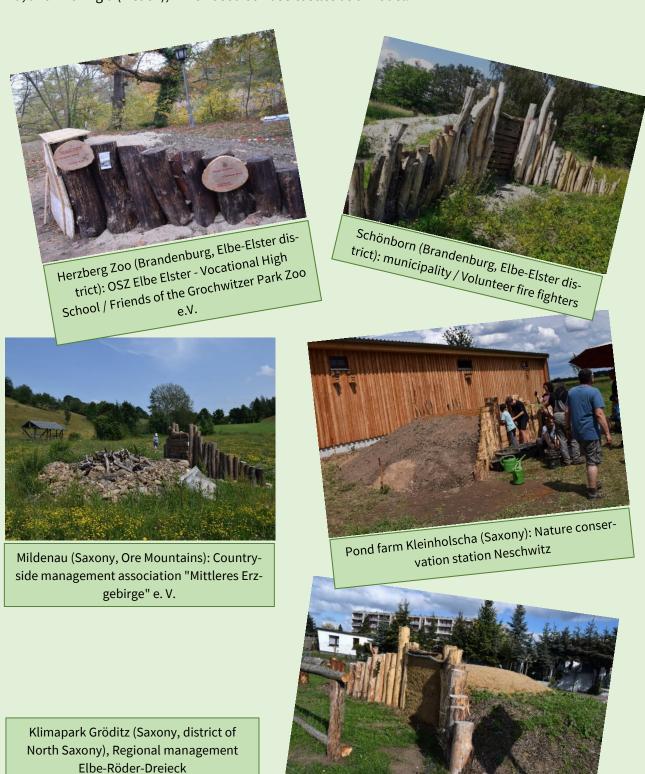






Third-party projects in our region and beyond

Since 2023, 46 independent projects have already been realised in the federal states Brandenburg (21), Schleswig-Holstein (12), Saxony (7), Saxony-Anhalt (3) as well as Berlin, Mecklenburg-Western Pomerania, and Thuringia (1 each), which used our bee castles as a model.





Eberswalde, near Finow (Brandenburg): ALNUS e. V. - Working group for landscape management, nature conservation, environmental education and urban ecology Eberswalde (photo credit: Laura Gerhards)



Lübeck (Schleswig-Holstein): Burial garden Vorwerk, Hinze Garden Center

Interesting facts about our wild bees

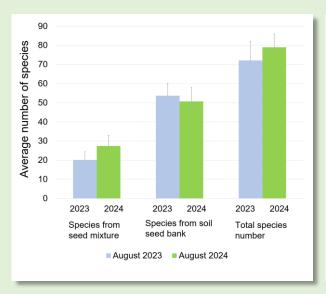


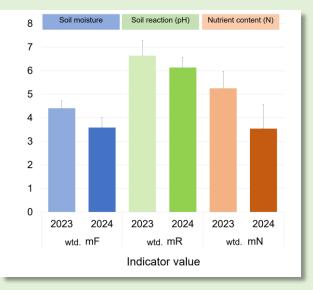
What can our bee castes achieve?

Plant stock: During the first two years of development, the vegetation showed some remarkable developments. Already during the first growing season, sparse vegetation developed on the hills, covering between 40 and 60 % of the ground and consisting of an average of 72 vascular plant species. Of these, 28 % came from sowing and 72 % from the diaspore bank of the soil material used. Fifteen of the total of 44 pollen- and nectar-producing plant species sown could not be detected in the first year. The three poppy species, field larkspur, common ox tongue and grey cress had a particularly strong influence on flowering.

In the second year, plant diversity continued to increase, mainly due to the emergence of additional sown species. However, some plants from the soil seed bank disappeared again because they were not adapted to the extreme site conditions of the mound.

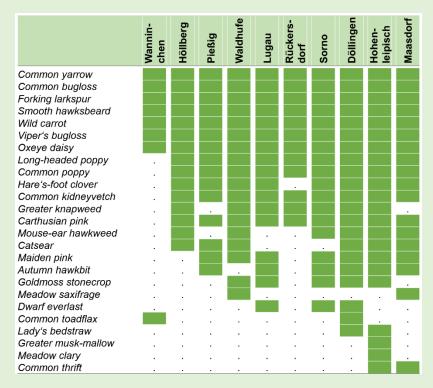
The calculation of the mean weighted indicator values showed that the soil used in combination with the shape of the mound created a dry, slightly acidic and nutrient-poor site. The seed mixture used had also been optimised for such site conditions.







Due to pronounced dryness and nutrient deficiency, patchy vegetation remains on the hilltops for a particularly long time.



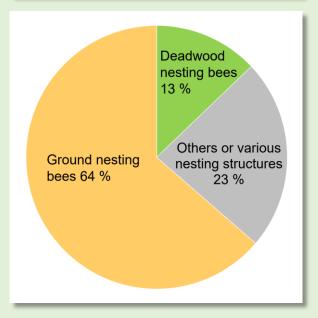
Not all species from the sowing are already recognisably present in the first year. The development is slower than when sowing annual species, but more sustainable in the long term.

Wild bees: There are also remarkable things to report about wild bees. Shortly after the construction was completed, just when the walls of the nest tubes pressed into the clay were still damp, the first female bees checked whether everything was in order. A total of 122 wild bee species visited the bee castles in the first year and could be observed there building nests or foraging for food. On average, 34 wild bee species were found on our novel stepping stones. However, only a few were present at several locations. The vast majority were only present at individual locations or at less than half of the locations.

In the first two years of development, we were able to record a total of 170 wild bee species and an average of 59 species per facility.

Almost three quarters of all wild bees in Germany build their nests in the ground. At the bee castles, an average of around two thirds of the species also belong to ground-nesting bees and only 13 % to deadwood-nesting species. This suggests that the mounds do not have a selective effect and that the selection of nesting material provided corresponds to regional needs.

Genus Number of s			pecies	
		2023	2024	2023- 2024
Mining bees	Andrena	22	9	24
Bumblebees/Cuckoo bumblebees	Bombus	14	14	16
Masked bees	Hylaeus	9	10	13
Leafcutting and Mortar bees	Megachile	9	9	11
Nomad bees	Nomada	9	7	14
Blood bees	Sphecodes	9	9	12
Narrow-bodied Furrow bees	Lasioglossum	8	14	19
Furrow bees	Halictus	6	8	8
Mason bees	Osmia	5	7	10
Flower bees	Anthophora	4	4	4
Colletes or Cellophane bees	Colletes	3	3	4
Sharptail bees	Coelioxys	3	2	4

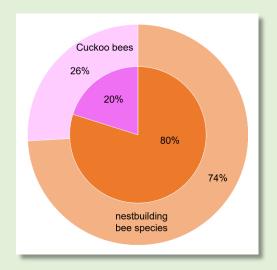


The fact that, on average, 20 % of cuckoo bee species were already present suggests that the first occupants came from nearby nesting communities, from which their parasitoids could easily follow them. Of the 170 wild bee species in total, 26 % were parasitoids.

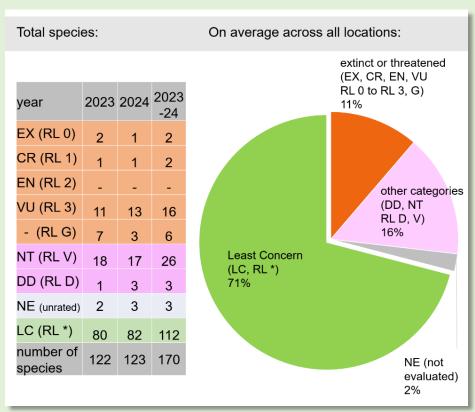


Of the 170 wild bee species identified to date, 15% are endangered or considered extinct or lost according to the valid Red List from 2000 in Brandenburg.

The average proportion of Red List species across all facilities was 11%.



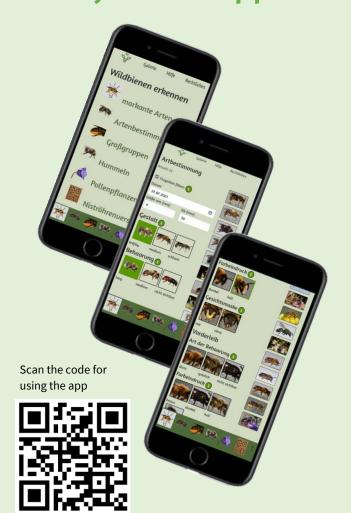
Number and proportion of endangered wild bee species (Red List Brandenburg¹):



Dathe, H.H. & C. Saure (2000): Rote Liste und Artenliste der Bienen des Landes Brandenburg (Hymenoptera: Apidae). – Naturschutz und Landschaftspflege in Brandenburg 9 (1), Beilage: 3-35.



On the go with the wild bees identification app



As part of the Bee castles project, we have developed an app that can be used to identify wild bees in Lower Lusatia and their habitats and report their exact location for research purposes. It is a simple web app with offline functionality that does not require installation. The species selection stored in the app is based on the wild bee species found in Lower Lusatia that can be identified in the field. Of course, the app can also be used in other regions of Germany. Once a wild bee or habitat has been identified, the find can be reported to our project team using the app. It is particularly helpful to send the exact location of the observation and a photo of the bee or habitat.

The reports received are checked for accuracy by our project team and collected in a database. We also carry out exemplary follow-up mapping for particularly significant wild bee finds. If users of the app provide an email address when registering, we also provide feedback on the reports. The results of all mappings will be presented to interested parties in lectures in the project region. At the end of the project period (July 2025), a report on the results of our citizen science research will also be published on our website (www.bienenburgen.de).



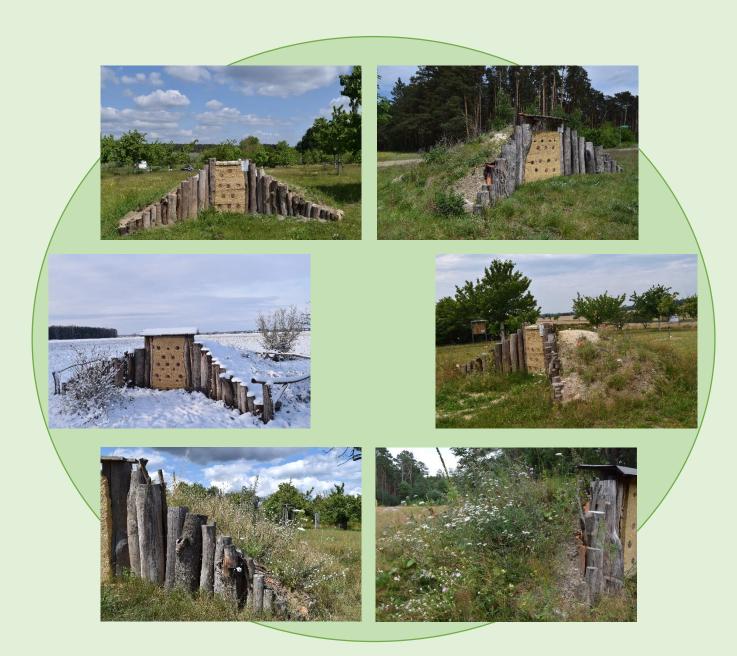
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Insect observations by citizen scientists Review by our project team (wild) bees identifiable to (wild) bees not further genus level identifiable others identifiable to Wild bee findings with photoother Interesting observations of observations graphs useful for identification other insects and location data (coordinates) Blauschwarze Holzbiene (Xylocopa violacea) **P**rojektumring Nachweise und Beobachtungen Wildbienen-Monitoring Bürgerforschung, Wildbienen-App 1 Ivy bee (Colletes hederae), (Stand: 13.09.2024) 2 Ashy Furrow bee (Lasioglossum sexnotatum), 3 Red Mason bee (Osmia bicornis), mating couple, 4 Campanula Mining-Bee (Andrena curvungula) 5 Very similar to a male long-horned bee: long-horned weapon fly (Stratiomys longicornis); photo credit: Falk Rühle (1, 2, 4), Andre Gütte (3), Berit Lehmann (5)

Bee castles through the seasons

Over the course of a year, the bee castles appear in a constantly changing vegetation cover. Seasonally different flowering aspects are used by the species adapted to them. In late summer, tall perennials in particular dominate the picture. But one thing remains the same for most of the year. There is always a buzzing and crawling in the tangle of flower stems, leaves and stalks. The mound shape invites you to take a look inside the vegetation without having to lie face down on the ground. Only when the temperatures cool down does calm return. The busy activity of the insects

gives way to the cold season, only to reawaken again in the following spring. However, life has only retreated and not left the bee castle. In and on the dead plants of the year that is coming to an end, between leaves on the ground, in dead wood, in the numerous crevices and even under the surface of the earth, eggs, larvae and pupae of the next generation of insects are waiting to develop further with the warmer temperatures of spring, so that the cycle of colourful crawling and buzzing can begin anew.



Wild bees in 'hibernation'

Wild bees do not hibernate, as is the case with warm-blooded animals such as hedgehogs, bats or dormice. They either overwinter as flying insects in a protected winter quarters or directly in the nest as a developmental stage or fully developed bee in winter torpor. This means that any type of wild bee nest or nesting habitat, including artificial nesting aids and, consequently, our bee castles in winter, are full of wild bees in hibernation.

Different species of wild bees hibernate at different stages: as larvae, pupae or fully developed bees. In Central Europe, most species survive the winter as pre-pupae, also known as resting larvae. Some hibernate in their brood cells. This is typical for species that fly in spring. Red mason bees (*Os-*

mia bicornis) hatch in August and rest as fully developed bees in the nest for eight months until they finally leave in early spring. The development of the spring fur bee (*Anthophora plumipes*) is very similar.

Furrow bees (Halictus, Lasioglossum) and most blood bees (Sphecodes) hatch and mate in the summer to late summer of the year in which their development began. However, the drones die in the cold autumn and only the fertilised females hibernate in the ground. The same applies to the young queen bumblebees. On the other hand, the new generation of Blue-black carpenter bees (Xy-locopa violacea) that hatch in late summer, hibernate unmated, since mating does not take place until the following spring.



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Partners in the region

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