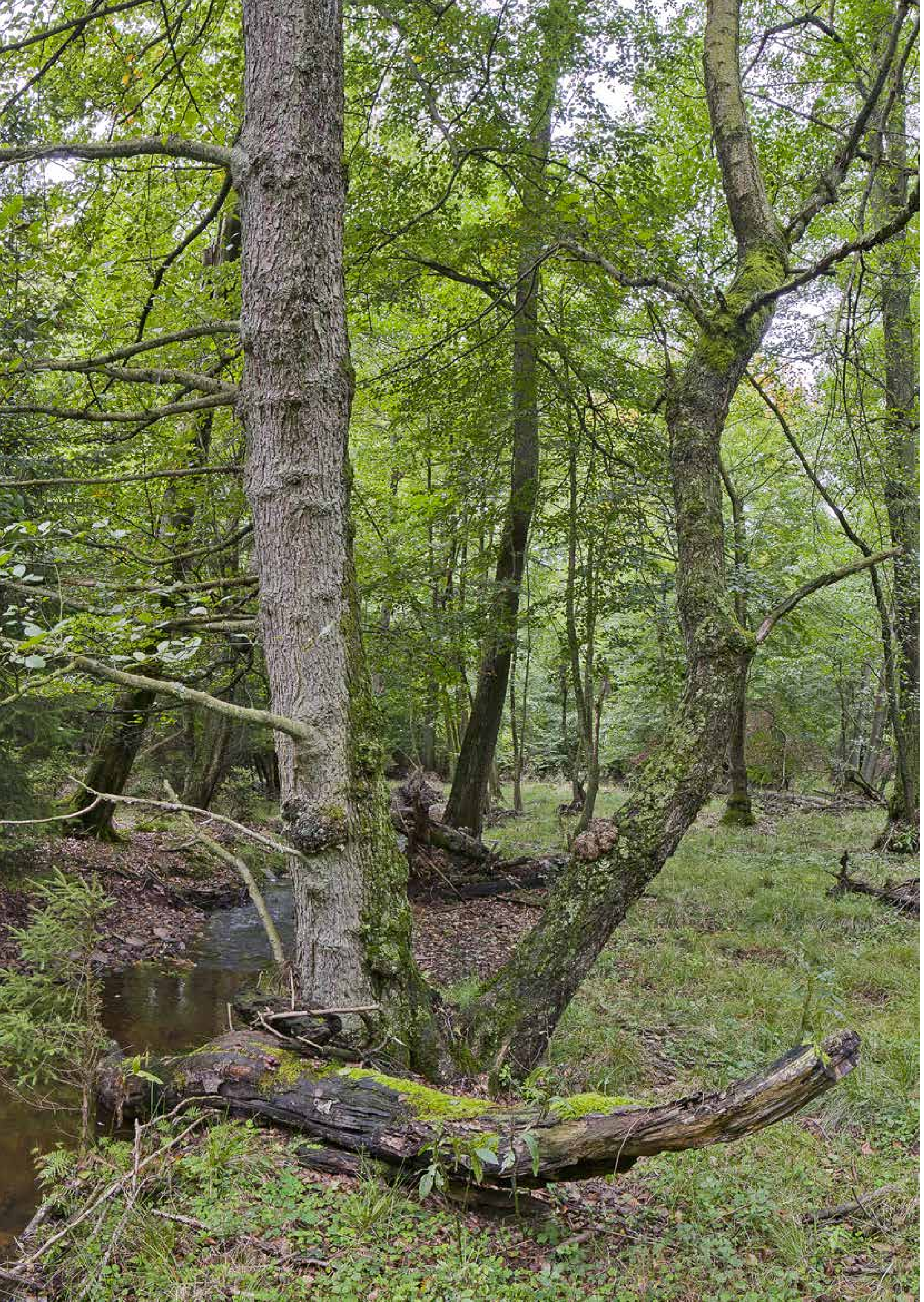
Stream valleys in the Arnsberg Forest

LIFE-Project 2009 - 2014



LIFE Project „Stream valleys in the Arnsberg Forest"

The Arnsberg Forest is one of the largest forested areas in North Rhine-Westphalia. Numerous watercourses, ranging from small brooks to broad streams, flow through the forest. In areas of less intensive forestry utilisation, valuable natural habitats were preserved and were able to develop. Floodplains and bogs provide a home for the Kingfisher and the Black Stork, for the Black Alder and the Downy Birch, for the Brown Trout and the Bullhead.

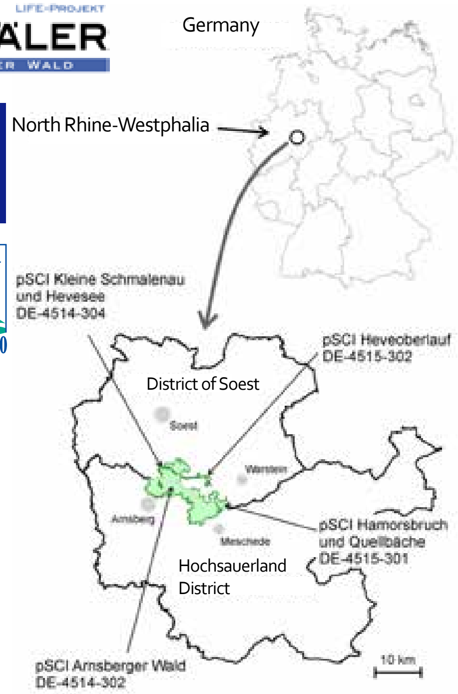
In addition to the exploitation of the forest as a source of wood, many stream valleys were utilised for centuries as meadows or pasturage. Water was both a blessing and a curse. It provided the soil with nutrients and prevented it from drying out, but also submerged the flat floodplains and turned them into marshes.

To prevent this, drainage ditches were dug, streams were channelized and their courses were relocated, meadow irrigation systems were constructed – the closer to human settlements, the more elaborate were the measures taken. It is impressive what our ancestors accomplished in order to obtain food and animal fodder from the barren landscape. This involved a great deal of painstaking and arduous labour.

Around the beginning of the 20th century, the colourful wetland meadows became increasingly uneconomic in an agricultural environment where the emphasis was being placed on higher and higher productivity; often they were left to become fallow. The production of spruce wood was more economically attractive. Many stream floodplains were turned into dark and species-poor spruce forests.

Today, the state-owned areas of forest and meadow in the Arnsberg Forest are nature conservation areas and form part of the Europe-wide network of protected areas called „NATURA 2000". The high-priority protected areas covered by the Fauna-Flora-Habitat Directive and the legally protected biotopes of alder-ash woodland, softwood alluvial forest, and springs, spring valleys and natural watercourses are being left to develop naturally. In areas where spruce forests dominate the stream floodplains, these are being progressively converted into habitat-typical deciduous forests. The streams and the floodplains will become the main arteries of this forest landscape. The LIFE project was conceived to play a central role in this development. This brochure provides an impression of the nature of the stream valleys, the factors affecting them adversely, and the remedial measures that have been taken.

The oldest Black Alders in the project area are here in the Hevensbrink valley.



„LIFE" is a financing programme of the European Union for the benefit of the environment.

This LIFE project was initiated and planned by the ABU in collaboration with the Lehr- und Versuchsforstamt Arnsberger Wald, Biologische Station Hochsauerlandkreis and the Naturpark Arnsberger Wald.

Coordinating beneficiary: ABU - Biological Station Soest

Partners and participants in the project::
Naturschutzzentrum - Biologische Station - Hochsauerlandkreis / Naturpark Arnsberger Wald / Landesbetrieb Wald und Holz NRW - Lehr- und Versuchsforstamt Arnsberger Wald / Municipality of Meschede / District Council of Arnsberg / District of Soest / Hochsauerland District / Ministry for Climate Protection, Environment, Agriculture, Nature Conservation and Consumer Protection NRW

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ABU Biologische Station

Naturpark Arnsberger Wald

Naturschutzzentrum - Biologische Station - Hochsauerlandkreis e. V.

Landesbetrieb Wald und Holz Nordrhein-Westfalen
Lehr- und Versuchsforstamt Arnsberger Wald

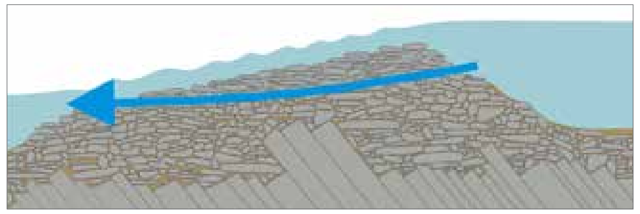
Ministerium für Klimaschutz, Umwelt, Landwirtschaft, Natur- und Verbraucherschutz des Landes Nordrhein-Westfalen

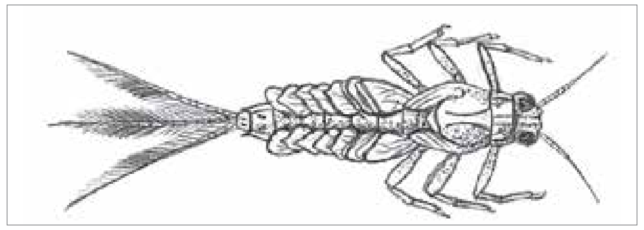
Near-natural

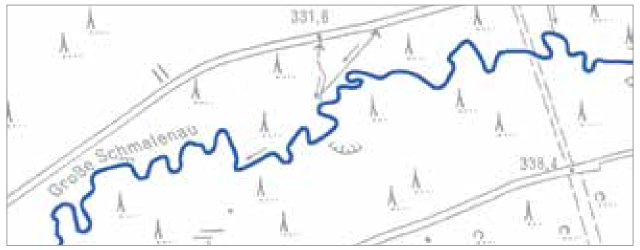
In the area covered by the LIFE project there are numerous near-natural stream sections that give a very good impression of how the natural condition would look. The photo shows the near-natural Heve. It is broad and only cuts slightly into the floor of the level flood plain. The bed of the stream mainly consists of gravels. Pools of slowly-flowing water alternate with riffles (shallow rapids). The alluvial alder forest is flooded with light.

Near-natural

Floodwater streams through the valley of the Kleine Schmalenau. The meandering, near-natural course of the stream can no longer be seen. As the stream only transports a small portion of the water volume, its gravel bed is protected from the destructive force of the flood. The floodplain provides the inundation zone and benefits because seeds are spread by the high water, which also exposes patches of bare soil that later serve as a germination bed..







Near-natural

In the photo above the Große Schmalenau shows the typical sequence of calm pools and gravel banks with quickly-flowing water.

In the riffles, the banks of gravel are not only rapidly overflowed, the top 10 to 20 cm of the gravel is also permeated by oxygen-rich water, as the blue arrow indicates. This is the habitat of insect larvae like dayflies, the so-called interstitial.

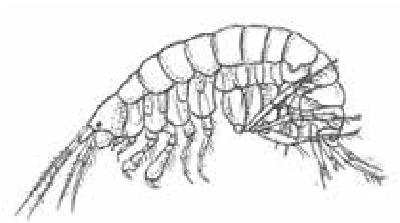
Trout find ideal spawning ground here. The eggs develop in the gaps between the gravel, surrounded by the clear water of the stream.

It is only possible for these structures to form if the stream meanders through a broad, flat valley and spills into the floodplain as soon as even small rises in water level occur.

The gravel that lies in the valley floodplains under a layer of loam was formed from siliceous, i.e. low-lime rock. It is transported in the streams as so-called bedload at high water. The streams receive new gravel from the V-shaped valleys and by means of lateral displacement in the flood-plain. The stream bed is only in equilibrium if the if the quantity of bedload transported downstream is in balance with the amount of new gravel coming in. This equilibrium is sensitive.

Deciduous trees are important to the streams for several reasons. They provide the necessary mixture of light and shade. The fallen autumn leaves are the decisive food source for the creatures in the stream. Tree trunks, branches, twigs and the leaves caught in them provide a wide variety of habitats in the stream and ensure that floodwaters quickly overflow into the floodplain.

View of the tangle of branches, twigs and closely-packed leaves in the near-natural Große Schmalenau



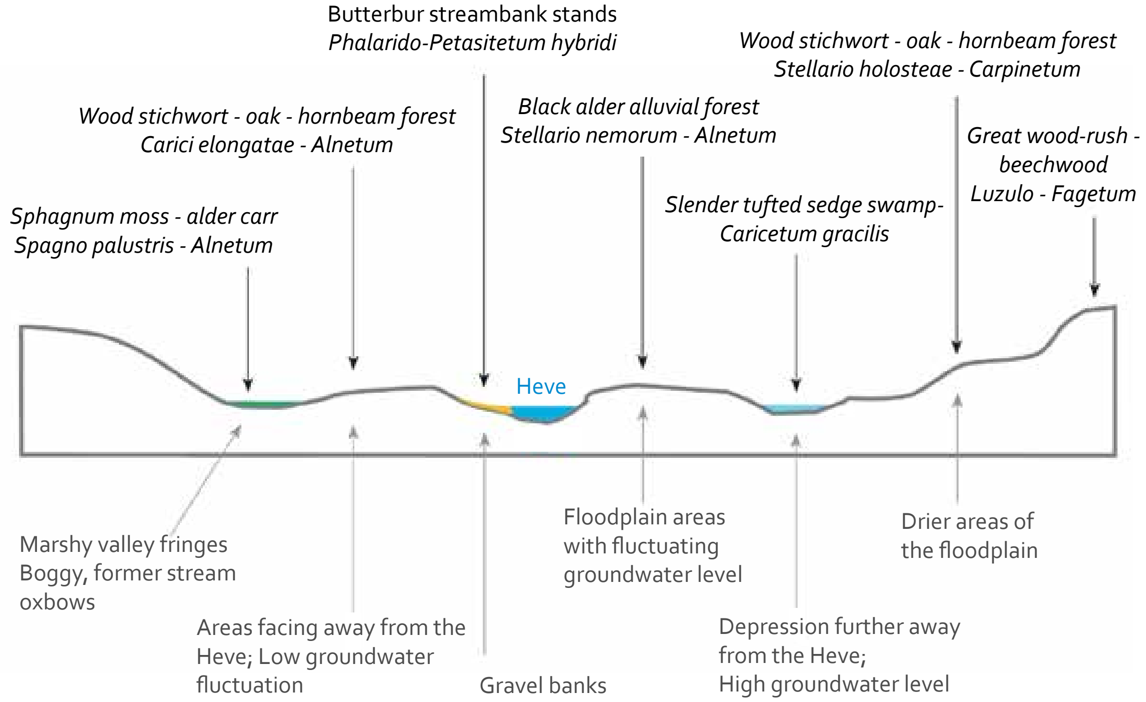
The closely-packed leaves are home to large numbers of freshwater shrimps. They chew up and eat the leaves, and thus make the nutriments available for the ecosystem in the stream. In simplified form, one could say that fallen autumn leaves are the fuel and freshwater shrimps are the motor.

Near-natural

Flooded with light and with an abundance of ground vegetation: these are the characteristic features of old alluvial alder forests. The black alder is particularly well adapted to the extreme conditions of the floodplains. In times of flooding, when their roots are completely submerged, they breathe through cork pores – so-called lenticels – in their trunks. In areas that are less often exposed to flooding, the black alder is replaced by the common oak.

Near-natural

An alluvial alder forest provides a variety of biotopes: wet and boggy habitats border on dryer ones, here a rush bog or sedge swamp, there a grass-dominated area.



This diagram shows the typical biotope distribution in the near-natural Heve floodplain.

Light plays a very important role: black alder, common oak, birch and hornbeam, the main tree species of the alluvial forest, need light to germinate and develop into healthy saplings.

In the night of 18th January 2007, hurricane Kyrill flattened large expanses of spruce forest. Just a few years later, more and more birch trees are taking over the cleared areas.

Floodwater is of special importance for the black alder. The tree's seeds fall out of the cones in autumn and winter, and are distributed throughout the floodplain by water. If a seed is washed onto bare soil, there is a good chance that a new tree will grow.

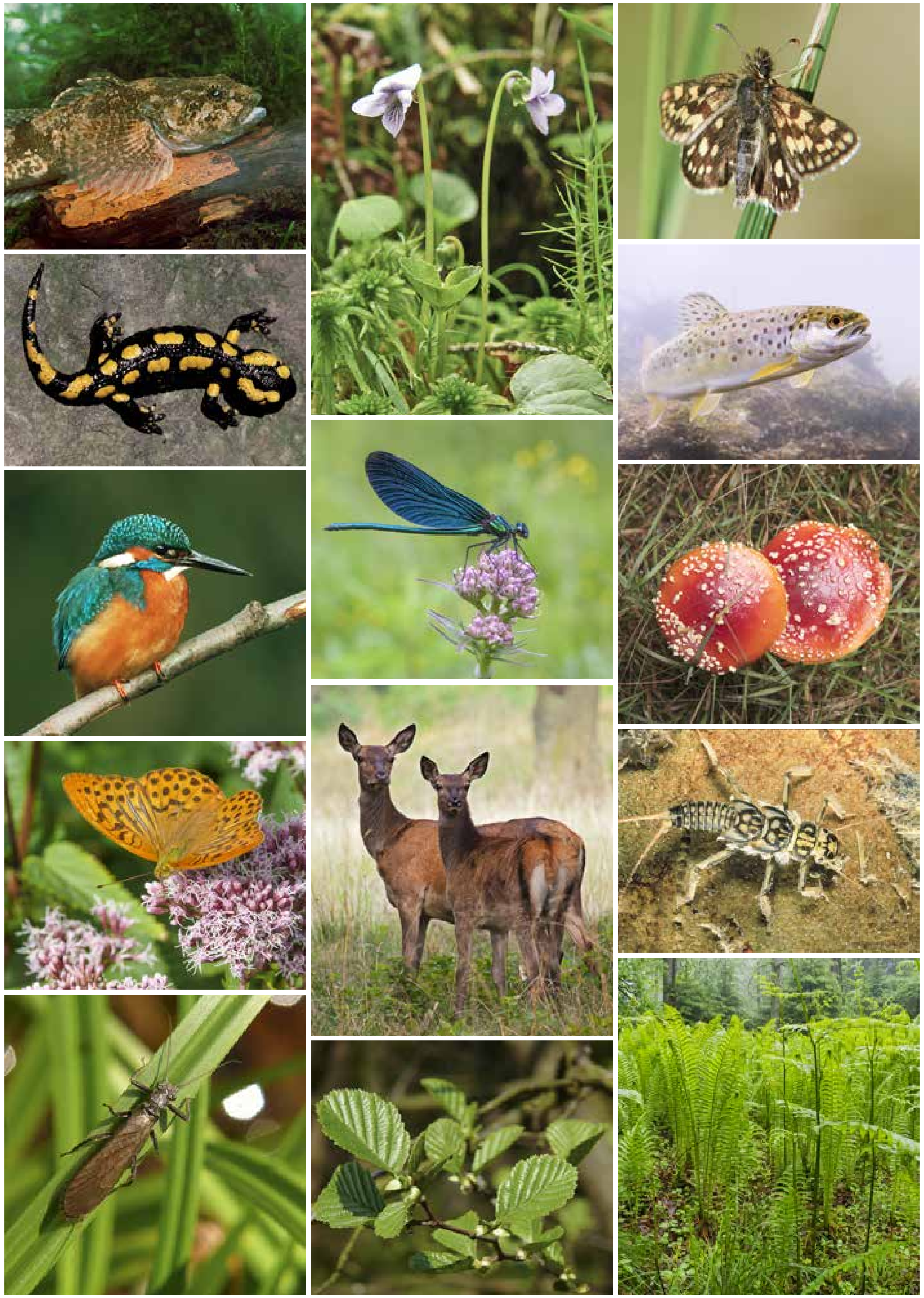
In wet locations that are constantly supplied with spring and ground water, rush bogs develop. This is a very wet and sensitive habitat.

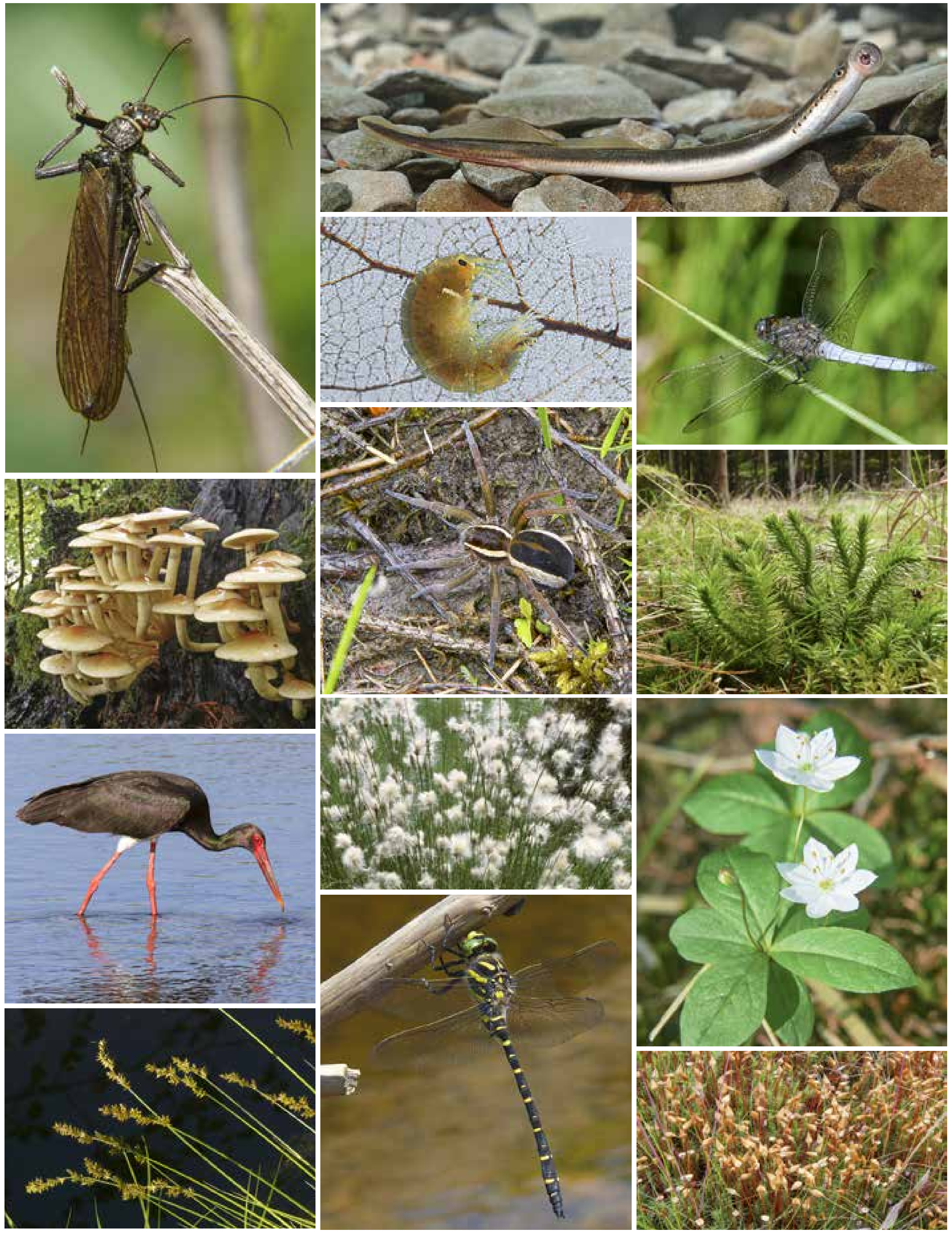
In near-natural sections of the stream, extensive stands of Butterbur can be found on the gravel banks.

Near-natural

Barren, acidic, boggy soils: these are the conditions that plants have to cope with in the Hamorsbruch area. The Carpathian downy birch is adapted to such extreme conditions. With their gnarled growth and sometimes multiple trunks, the old birches are characteristic of the section of the Hamorsbruch that has not been cultivated for decades. Cotton grass and clubmosses grow in the shelter of the downy birches.

Diversity





Bullhead
Fire Salamander
Kingfisher
Silver-washed fritillary
Stonefly

Marsh Violett
Beautiful demoiselle
Red deer
Black alder

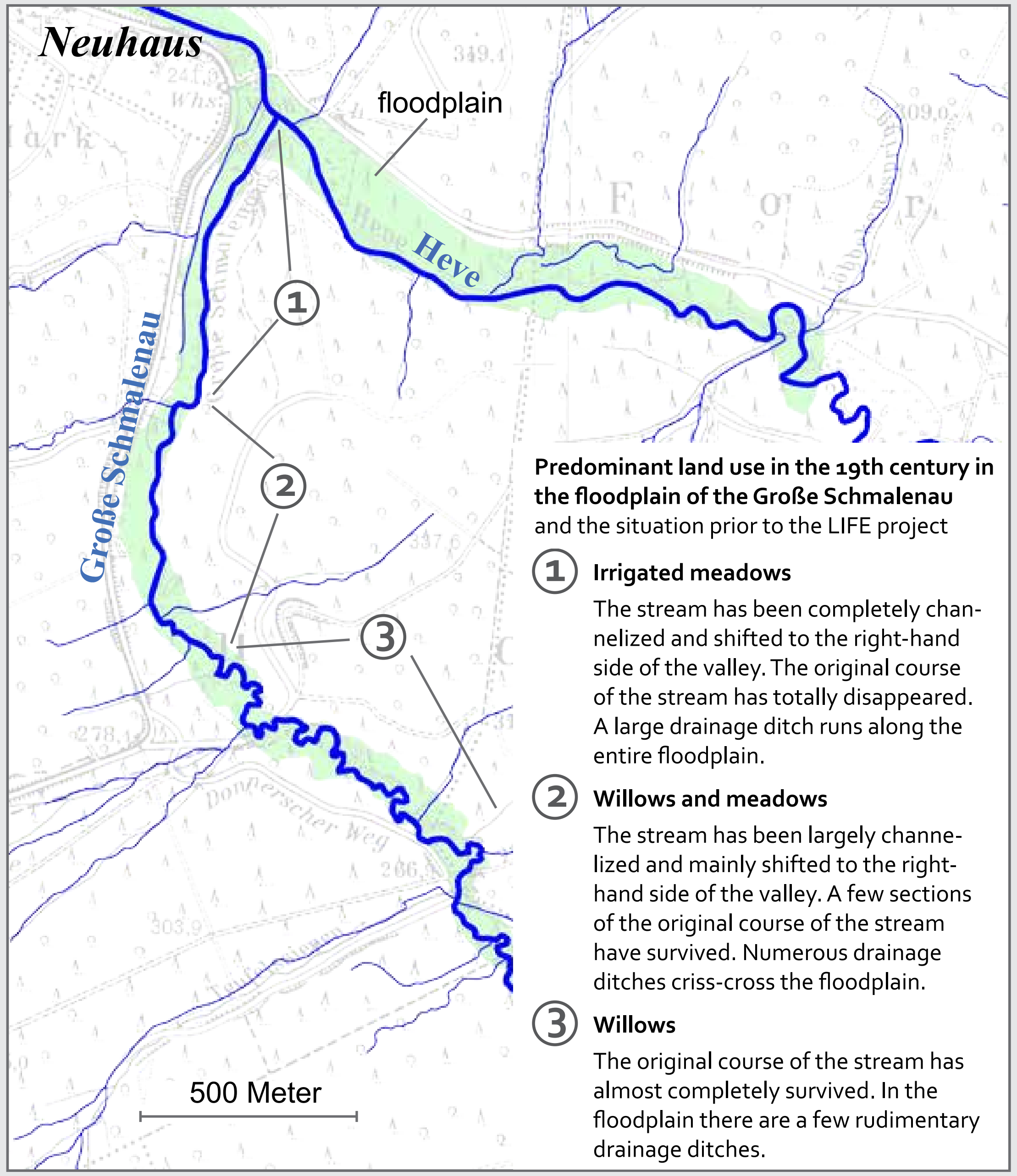
Grizzled skipper
Brown Trout
Fly Agaric
Stonefly larva
Ostrich Fern

Alderfly
Fungi
Black Stork
Elongated Sedge

Brook Lamprey
Freshwater Shrimp
Spider
Cotton Grass
Golden-ringed Dragonfly

Keeled Skimmer
Club moss
Northern Starflower
Moss

This map shows the course of the Heve and Große Schmalenau streams near the hamlet of Möhnesee-Neuhaus up to the year 2002.
In the near vicinity of the hamlet of Neuhaus, the Heve was extensively straightened as early as 1832. The lower course of the Große Schmalenau was channelized in the mid 19th century.



Predominant land use in the 19th century in the floodplain of the Große Schmalenau and the situation prior to the LIFE project

① **Irrigated meadows**
The stream has been completely channelized and shifted to the right-hand side of the valley. The original course of the stream has totally disappeared. A large drainage ditch runs along the entire floodplain.

② **Willows and meadows**
The stream has been largely channelized and mainly shifted to the right-hand side of the valley. A few sections of the original course of the stream have survived. Numerous drainage ditches criss-cross the floodplain.

③ **Willows**
The original course of the stream has almost completely survived. In the floodplain there are a few rudimentary drainage ditches.

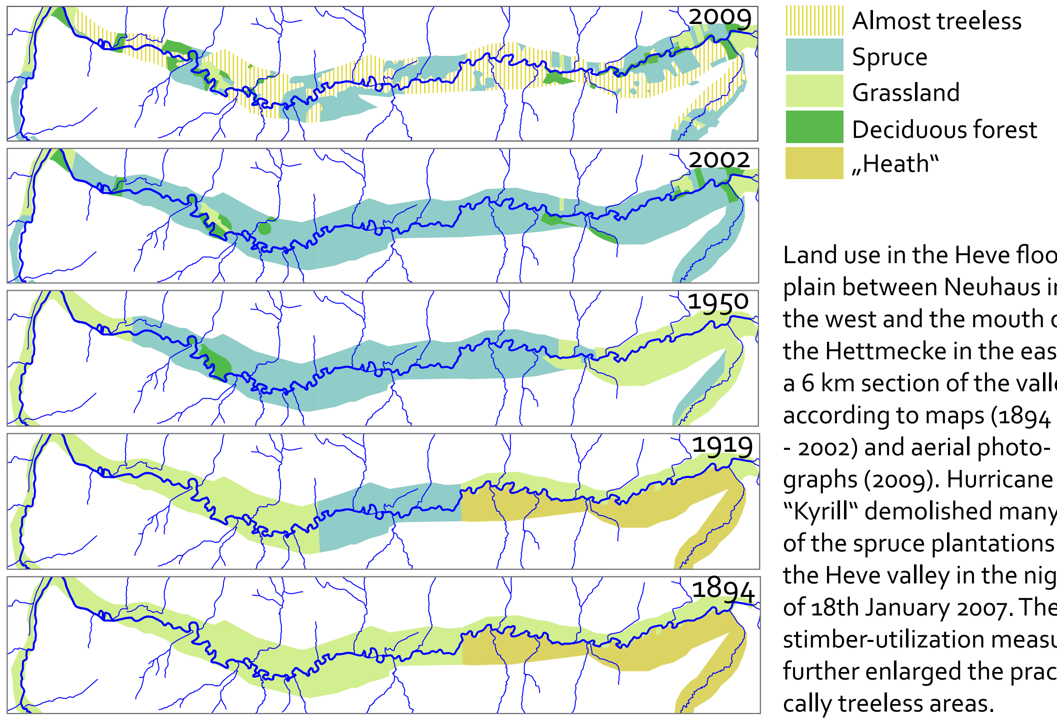
The confluence area of the Grosse Schmalenau and the Heve, with the situation before and after the channelizing of both streams. Source: "Special map of the Royal Forest Directorate of Obereimer. Prepared partly on the basis of the Blanquet cadastral land register of 1832 by Dankelmann, partly on the basis of a new survey in 1845 by Lex; corrected and compiled in 1852 by Krohn, ...

History of the landscape

In the middle ages, the Arnsberg forest was primarily used for hunting purposes. In the vicinity of human settlements, woodland grazing played an important role. For instance, in the foundation charter for the village of Hirschberg they were regulated as early as 1306. Ores were mined in the rocky slopes of the stream valleys. To smelt them, large quantities of charcoal were needed. Even today, the levelled sites of charcoal-burning stacks can still be found in the forest. Landscape descriptions from the period 1583 to 1761 speak of a poorly-managed high forest, interspersed with heathland. Pastures and wild meadows predominated in the broader valleys. Around the year 1600 there were good populations of capercaillie and black grouse, and hazel grouse were particularly common. In 1786, sod-cutting in the heaths was forbidden, and the forests had been badly degraded due to overgrazing, woodcutting and lack of management. The treeless areas with grass, heath and bush grew larger and larger. Large quantities of wood were used for fuelling the saltworks along the Westphalian "Hellweg" salt road and a glassworks established in 1762 and operated for some years in Neuhaus. This hamlet had its origins in an Elector's hunting lodge built around 1750. As from 1806, a settlement was established by foresters' families and marginal farmers.

After the area was ceded to Prussia by the Vienna Congress of 1815 some roads was paved. In 1821, a reallocation of land was carried out and resulted in the extensive separation of forests and pastures. This led to redevelopment of the largely devastated forests. As late as 1850 there were still only isolated stands of spruce trees in the Arnsberg Forest, but large plantations were later established. The reason for this was that the very fast-growing spruce could quickly meet the demands of the Ruhrgebiet's coal mines, the railway, and the building and furniture industries. It was also planted to replace the deciduous trees felled as part of the 2nd-world-war reparations. Most of the alder woods were converted around 1920 into spruce and oak plantations. However, after 1940 alders were again planted at some locations in the stream valleys. Around 1980, around half the area of the Arnsberg Forest was taken up by spruce plantations.

At the beginning of the 1980s, the large-scale planting of poplar trees was perceived to be threatening an area of oaks and a site of the rare ostrich fern at the Kleine Schmalenau stream. As a consequence, an area of 100 ha was designated as the nature reserve "Kleine Schmalenau-Hevesee", and later purchased. This period saw increasing efforts by conservationists, which were finally rewarded by the designantion of a number of nature reserves, including "Arnsberger Wald" (SO) and "Breitenbruch-Neuhaus" (Hochsauerland District) in 1991. Ten years later, the FFH (Fauna-Flora-Habitat) area of Arnsberger Wald became part of the European network of protected areas known as Natura 2000.



Land use in the Heve floodplain between Neuhaus in the west and the mouth of the Hettmecke in the east in a 6 km section of the valley according to maps (1894 - 2002) and aerial photographs (2009). Hurricane "Kyrill" demolished many of the spruce plantations in the Heve valley in the night of 18th January 2007. The stimber-utilization measures further enlarged the practically treeless areas.

History of the landscape

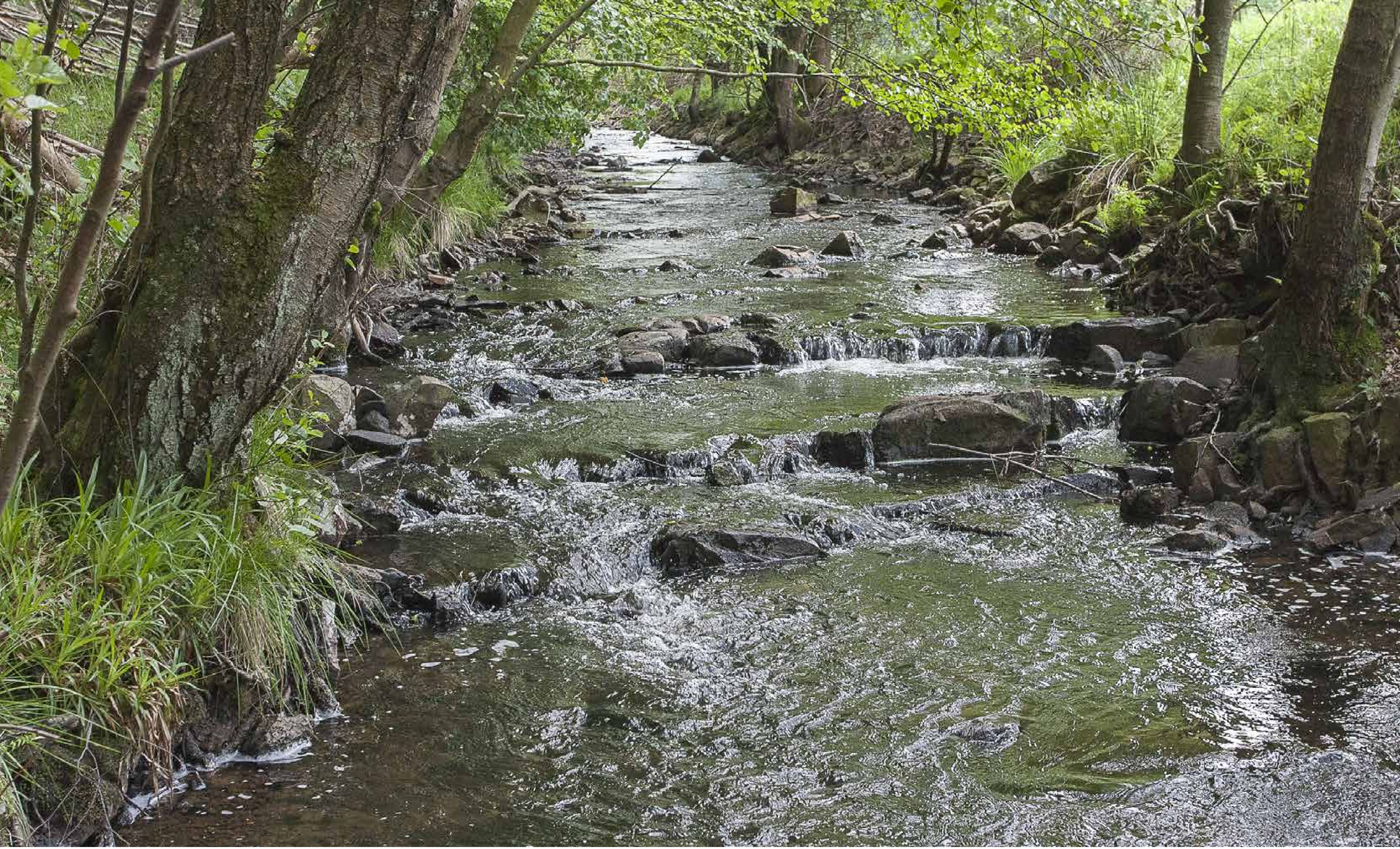
In the night of 18th January 2007, Hurricane "Kyrill" caused enormous damage in the Sauerland area. The picture shows clearing-up operations taking place in the Heve valley about 4 km upstream of Neuhaus on 4 th March 2007.

Non-natural

Channelized, deeply downcut, dark and without leaves: these are typical impairments of numerous sections of the streams in the Arnsberg Forest. The LIFE project had the aim of introducing a development towards near-natural conditions.

Non-natural

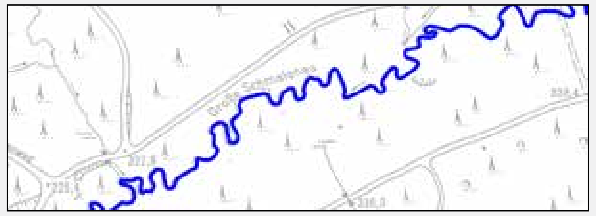
These pictures of high water rushing along the channelized lower course of the Große Schmalenau prior to the LIFE project give an idea of the forces involved. Fish, insects, leaves, branches, twigs and the gravel bed are simply washed away. The section of the stream is left impoverished. And the former floodplain, at the right of the picture, stays dry. It is deprived of the variety and vitality that would be brought by floodwater from an overflowing stream.

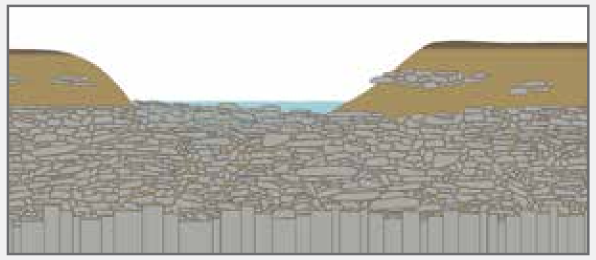


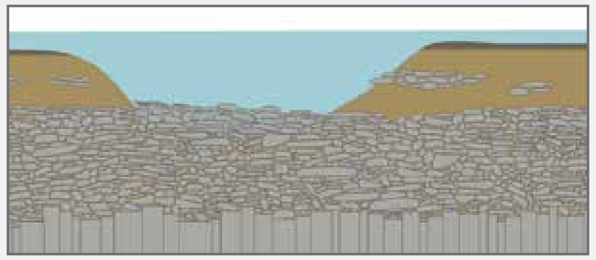
Non-natural

After the high water has subsided, the stream presents a seemingly idyllic picture. But this appearance is deceptive: the ridges of rock protruding from the water prove that the all-important bed of gravel is missing; carried away by the rushing torrent of water.

Near-natural

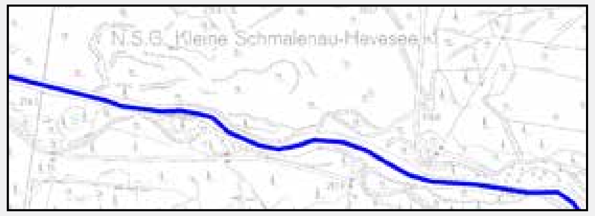


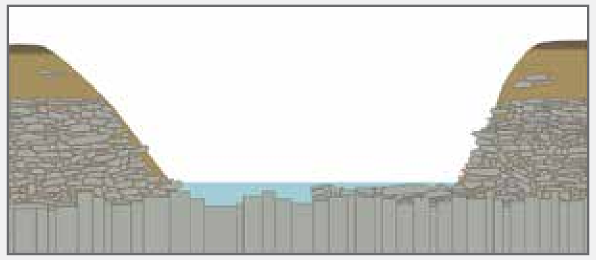


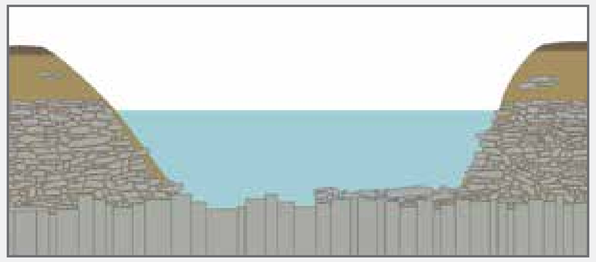


The course of the stream shows numerous loops or meanders (degree of sinuosity of 1.7 to 1.8) and cuts just a few decimetres into the floodplain. Its bed is mainly made up of gravel, and in the shallow riffles the rapidly-flowing, oxygen-rich water permeates the gravel banks. This so-called interstitial is the habitat of insect larvae and the spawning place for trout. High water quickly overflows into the surrounding floodplain, because the stream can only transport a limited amount of water. This protects the stream and its bed against the great force of rushing water, while young fish and insects are not carried far, and the floodplain of the stream benefits from the high water.

Non-natural





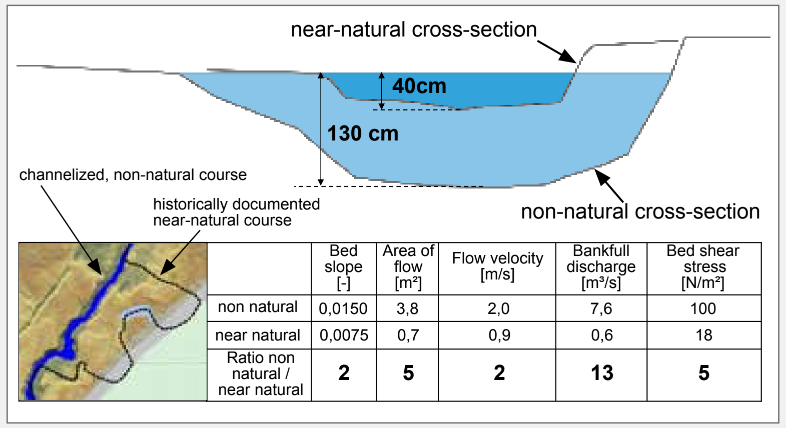


The stream is straightened and channelized, and has cut down so far that the bedrock has been reached. Experts call this "bed erosion". The deeper the bed of the stream, the greater are the forces exerted by the water. The damaging erosion only stops when a stratum of solid rock is reached. So little gravel is left that the all-important interstitial is missing. High water flows at great speed in the deep, channelized bed of the stream. The torrent tears everything away – gravel, insects, snails and young fish. The high water cannot overflow into the stream floodplain, which therefore lacks vitality; no seeds are carried into it by water.

Bed erosion

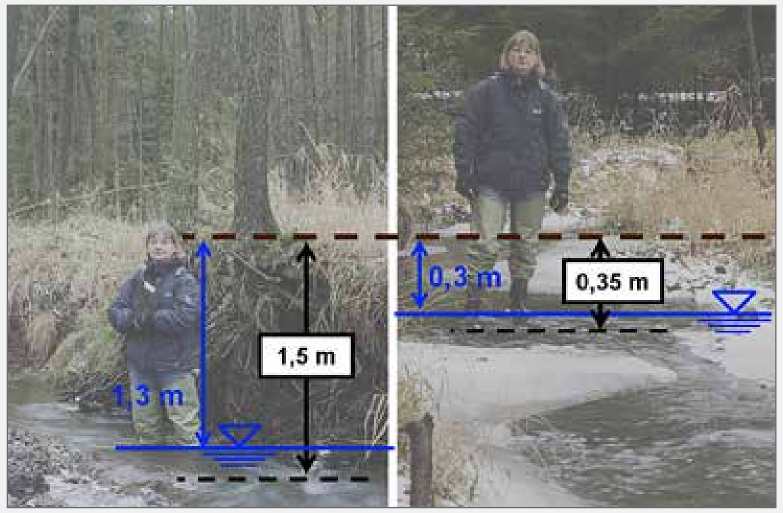
At the Kleine Schmalenau it was possible to directly compare an eroded profile with a near-natural stream profile. Immediately beside the modern course of the stream, a slight depression in the floor of the spruce forest could be recognized as a rudiment of the former, near-natural course of the stream.

The near-natural former stream profile was cleared of debris and both the profiles were measured.



	Bed slope [-]	Area of flow [m²]	Flow velocity [m/s]	Bankfull discharge [m³/s]	Bed shear stress [N/m²]
non natural	0,0150	3,8	2,0	7,6	100
near natural	0,0075	0,7	0,9	0,6	18
Ratio non natural / near natural	**2**	**5**	**2**	**13**	**5**

There are big differences between the eroded, channelized profile and the historical, near-natural profile. This can also be seen from a simplified comparison of the key data for the bankfull discharge flow of the near-natural and non-natural cross-sections. The creatures in the stream and the gravel of the stream bed are subjected to considerably higher flow forces in the non-natural stream profile. In addition, the floodplain of the non-natural stream is only flooded in the event of very extreme high waters, which occur very infrequently.



This example from Hevensbrink illustrates the same effect: on the left is the channelized, eroded course of the stream; on the right is a near-natural section with numerous meanders only a few hundred metres upstream.

Lack of passability

Many creatures living in the streams frequently travel lengthy distances – to reach spawning grounds, to survive as a young fish by avoiding the large, predatory adult fish, or to return upstream after having been washed downstream by high water.

If impassable obstacles divide the stream into excessively short sections, the species diversity suffers and the population density declines. Prior to the LIFE project, there were many migration obstacles in the local streams. Here are some examples:

① An adequately large culvert was unfortunately installed too high. Its smooth concrete bottom and the shallow flow of water, together with the cascade at its end, make this structure in the Große Schmalenau an impassable obstacle for many creatures.

② This is a very typical example: a pipe that is the far too small, with a cascade at its end, isolates this small tributary stream from the Heve.

③ This cascade in the Kleine Schmalenau is one metre high and was the result of bed erosion caused by channelizing.

④ This weir was built in order to feed water into the ditches of the earlier meadow irrigation system at the lower stretch of the Große Schmalenau. It was impassable for many creatures, but is also a significant historical feature of the landscape.

The natural rapids between the pools present no obstacle to the creatures inhabiting the stream. Brown trout overcome them by making a short sprint, even if their backs protrude out of the water.

The creatures on their travels are not only those using the actual waters of the streams: many insects fly along the floodplains in search of suitable habitats. And many have to travel back up the valley to compensate for the distance that they, as larvae, were washed downstream by high water.

For many species of insect, dark spruce forests – like this one on the Große Schmalenau – are not only an unattractive habitat, they are also an obstacle that can neither be flown through nor flown over.

Sombre Goldenring

Non-natural

Pure stands of spruce trees are dark and species-poor. Particularly in the young, very dark, plantations hardly anything else is able to flourish. The ground is bare. Such forests interrupt the natural biotope network of the stream floodplains.

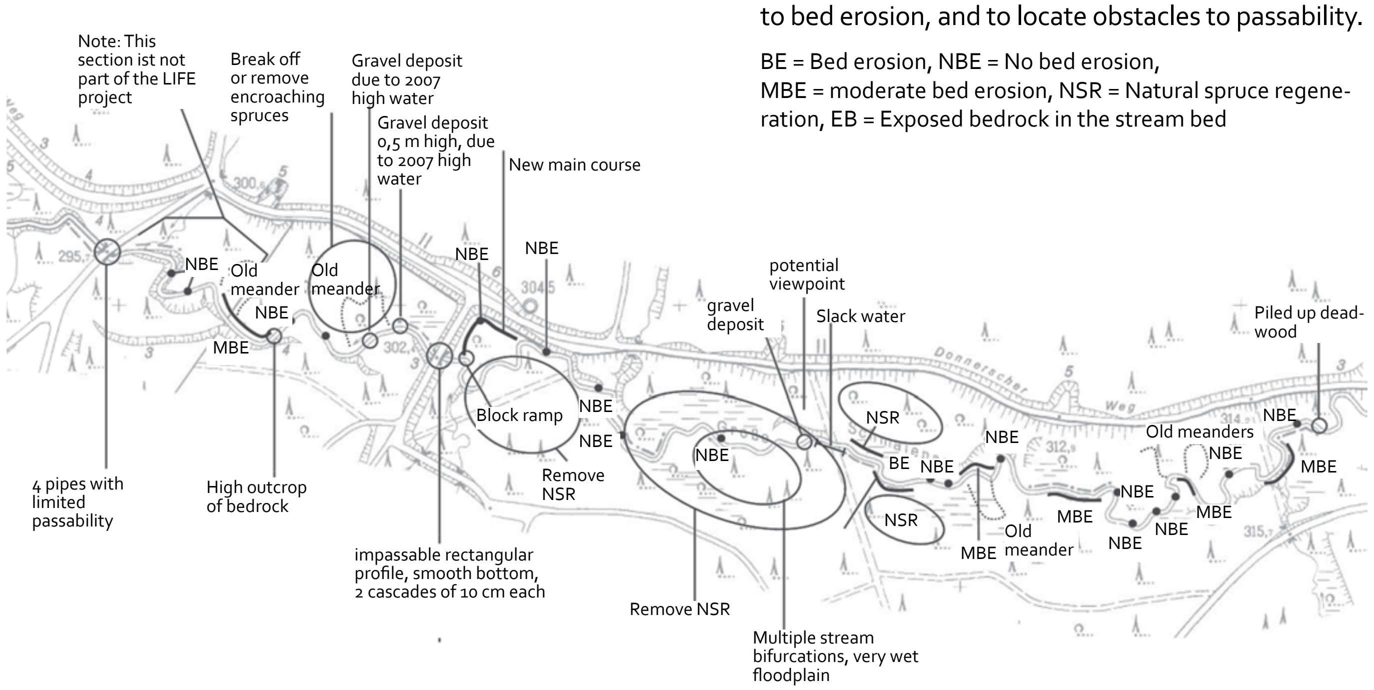
Non-natural

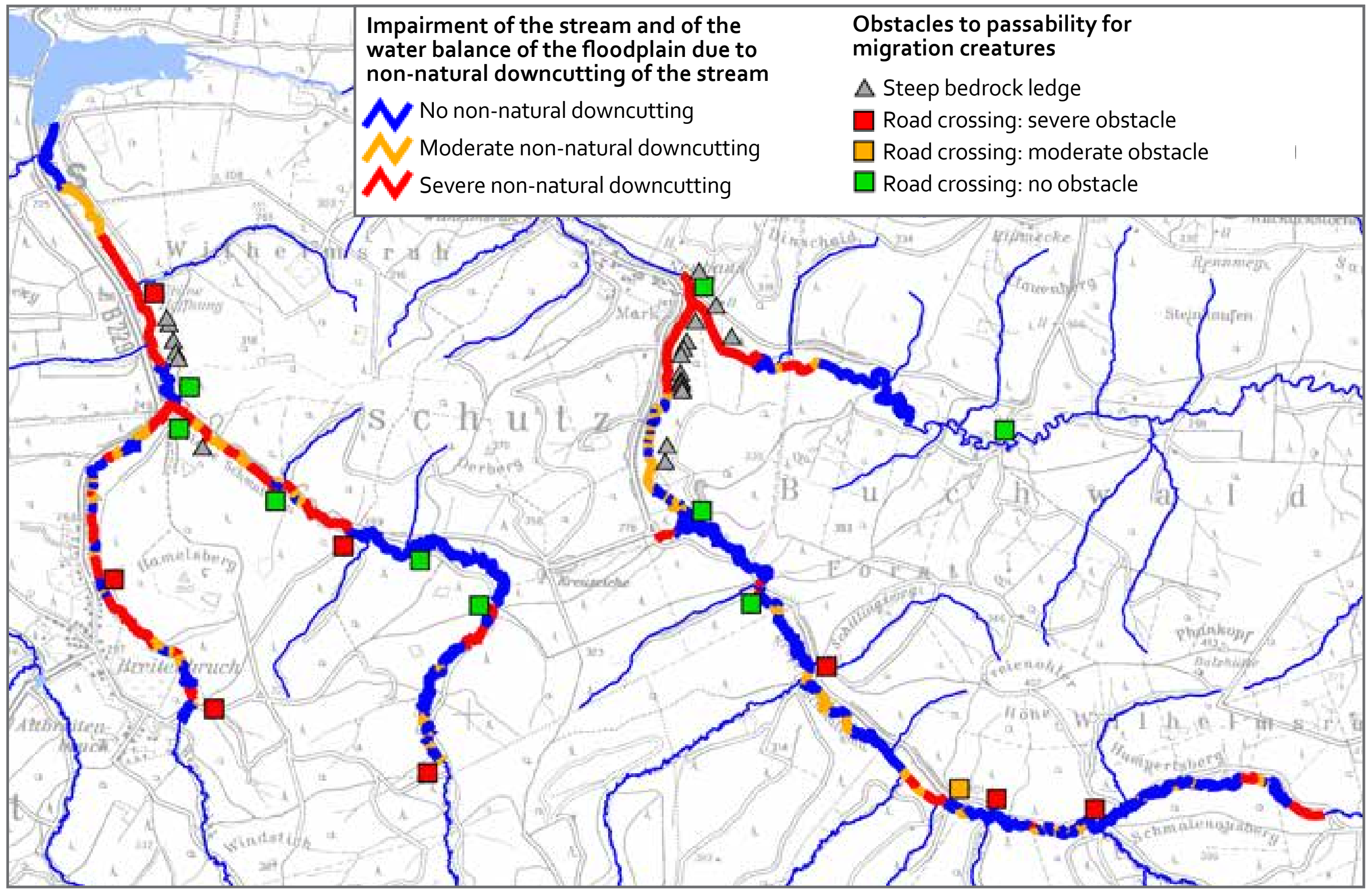
The extensive spruce plantations of the Arnsberg Forest produce thousands of seeds every year. Once germinated, young spruce trees grow very vigorously and can even flourish in half shade. When they have properly taken root, they often grow higher than the deciduous trees and shade them out.

Mapping

Mapping work was carried out to determine the extent of non-natural downcutting of the streams due to bed erosion, and to locate obstacles to passability.

BE = Bed erosion, NBE = No bed erosion,
MBE = moderate bed erosion, NSR = Natural spruce regeneration, EB = Exposed bedrock in the stream bed





Mapping was carried out at the streams where restoration measures were planned.

The photo on the left shows a section of the Große Schmalenau. Although the stream has a near-natural, meandering course and therefore its bed also has a natural slope, it is almost totally lacking in dead wood and fallen leaves. The reason for this is the surrounding spruce forest. The downcutting of the stream was assessed as partially moderate and partially natural.

ID_Intern: | Gebietsteil: KSse05 | Obj-Nr: 0 0 1 8 | AL ☐ | VA ☐ | Monit-Fl ☐
BT - | Kartierer R. Kutscher | K_datum 24.11.09 | Zeit 14.00

Lage: Linksseits an der Kl. Schmalenau

BT: AC4 | Zusatz_c

FFH_LT (FFH-LRT)	Erhaltungszustand				Ansprache
☐ 3260 Fließgewässer mit Unterwasserveg.					
☐ 91D1 Feuchter Hochstaudensaum					Vegetation
☐ 7140 Übergangs- / Schwingrasenmoor					Alnion
☐ 9110 bodensaurer Buchenwald					Zielbiotop
☐ 9160 Eichen-Hainbuchenwald					
☐ 91D1 Birken-Moorwald					
☒ 91E0 Erlen- / Eschen-Auwald	C	C	C	C	AC5
☐					

Gehölze	BHD [cm]	Höhe [m]	Deckung [%]	Anzahl	Deckung [%]
B1		-			B1
B2 Alnus glutinosa	15 - 30	25 - 28	30		B2 40
Picea abies	10 - 15	- 15	10		
S Picea abies	-	0,8	< 1		S < 1
K Deschampsia cespitosa	-		30		K 40
Juncus effusus	-		5		
M Sphagnum spec.	-		30		M 50

Fichtenproblem: ☐ Fichtenbestand | ☒ bedrängende Fichten | ☐ Fichtennaturverjüngung

Altersklasse: ☐ 1 Jungw | ☐ 2 Stangenh | ☒ 3 schw BH | ☐ 4 mittl BH | ☐ 5 starkes BH | ☐ 6 st BH m Jungw | Alt-Het ☐ ty altersheterogen

Standort Feuchte: ☐ stn frisch | ☒ sto feucht-nass | ☒ sto2 wechselfeucht | ☐ stw quellig, durchsickert | ☐ ga Gewässer

Boden / Ober-Fläche: ☐ str Torf-substrat | ☐ stz welliges Relief | ☐ ug Ameisen-haufen | ☐ uc Wurzel-teller | ☐ uc1 Baum-stubben | ☐ ga1 temp. Kleingew. | ☐ ga2 perm. Kleingew | ☐ ot Bulten-Schlenken-K

Totholz: ☐ oj1 stark stehend | ☐ oj2 stark liegend | ☐ oj3 schwach stehend | ☐ oj4 schwach liegend

Feldschicht
☐ ue – reiche Krautschicht | ☒ tg – moosreich
☐ ue1 – verarmte Krautschicht | ☒ th – torfmoosreich
☐ ue2 – Krautschicht mit gefährdeten Pflanzenarten | ☐ ti – flechtenreich
☐ oc – zwergstrauchreich | ☐ tj – binsenreich
☐ od – farnreich | ☐ tk – seggenreich
☒ oe – grasreich | ☐ tm – hochstaudenreich

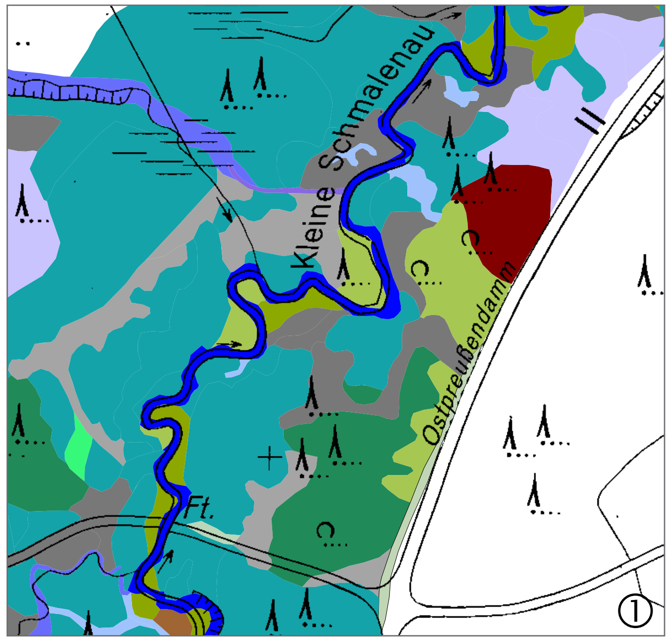
Befahrbarkeit: ☒ no nicht befahrbar | ☐ bed bedingt befahrbar | ☐ bef befahrbar

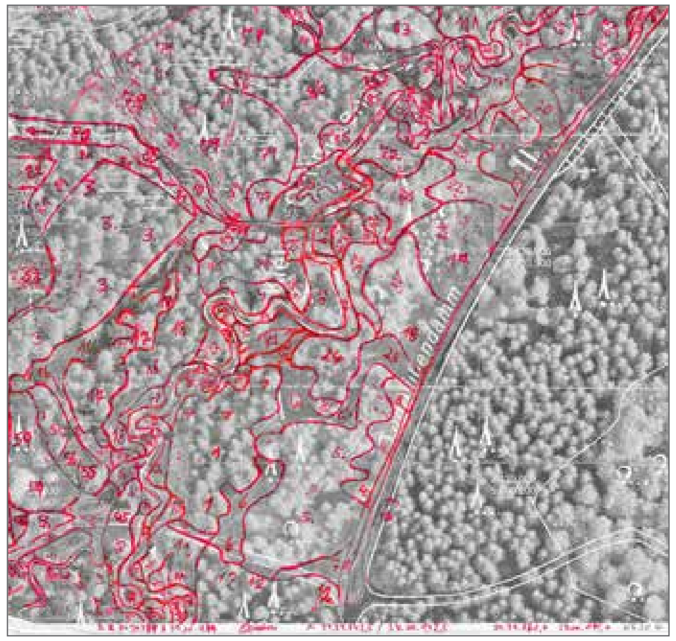
Maßn-Ort MN - | Maßntyp 1
2 | 3 | 4

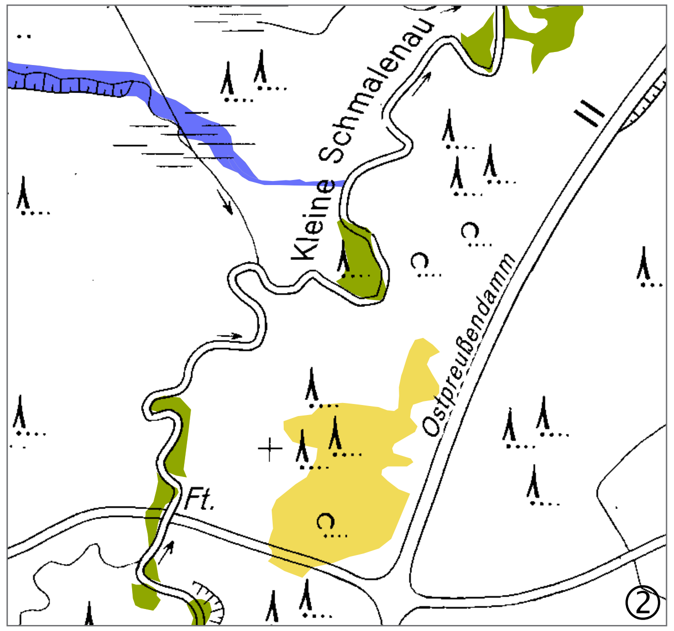
Maßn 1: C: 2a \ Entf. konkurrierende Fi. in Laubw.
Maßn 2: C: 4 \ Kleinflächiges Nadelentfernen schaffen
Maßn 3
Maßn 4
Maßn 5
Maßnbem: Fichten im Umfeld beseitigen – Bach in die Fläche bringen

Häufigk.: s selten, f frequent, d25 dominant Deckung >25-50 %, d75 dom. D. >50-75 %, d75 dom. D. >75-100 %, d25 dom. lokal D. >25-50 %

Mapping



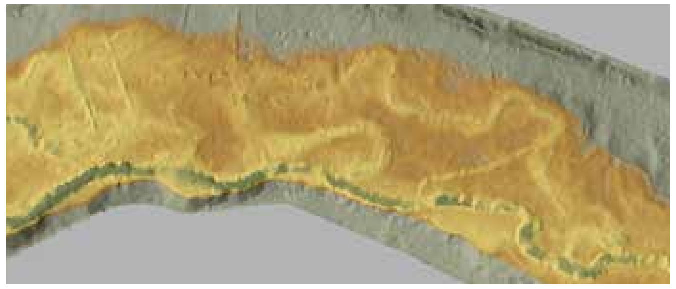


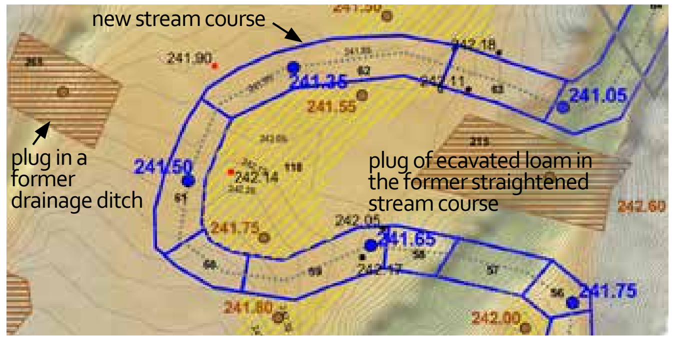


Using an aerial photograph as the basis, areas with different types of biotope were marked off in a field map and data relevant to the planning work were entered in a formsheet.

Linking of the digitalized areas stored in a geographical information system with the detailed data administered in a database produced a good planning basis for the stream restoration work and for the necessary removal of spruce trees.

① types of biotope
② FFH biotope types and l egally protected biotopes
③ Planned removal of spruce trees





Stream restoration: planning

Nature provides the model: the meandering form of the natural stream course, the broad, shallow bed of the stream, the ratio of the natural length of the stream course compared to the length of a channelized stream ("degree of sinuosity") of approx. 1.7 to 1.8, the dimensions of the stream loops, and the profile of the stream.

Data from a laserscanning flight were used as a basis for digital terrain models. When the computed section of the valley is horizontalized by the calculated degree of valley slope, and the different height zones are coloured in accordance with a defined colour scale, an excellent picture is obtained of the differences in ground levels, and the existing old stream structures therefore show up perfectly. These traces of the old stream course provide valuable indications for the possible restoration measures.

In still-existent old stream courses, the gravel bed is exposed at the shallowest points and measured. In areas where near-natural stream courses can no longer be identified, test trenches are excavated. These provide good data relating to the thickness of the alluvial loam.

The digital terrain model is used for the calculation of contour lines at 10-cm-intervals, which are then superimposed on the coloured, horizontalized terrain model. Additionally measured points in the terrain can be used to correct the terrain model. Together with the parameters obtained from the natural stream courses, this provides the basis for the implementation plan. The quantity of soil to be excavated and the quantity needed for the blocks of soil to plug the channelized course are then determined with the aim of balancing the quantities locally (blue line: new stream course, brown hatched: backfills, blue dots: planned stream bed heights, brown dots: planned terrain heights, yellow hatched: slight depression, red dots: measured terrain heights).

Stream restoration: construction sequence

The course of the new stream was plotted and pegged out in the terrain. ① Only the overlying loam of the floodplain was excavated, not the gravel, even if its surface level is higher than the planned bed of the stream. The reasons: It is a favourable initial situation for the new stream if its bed level is as high as possible. This means that quick widening of the course will take place, preventing downward erosion of the bed. The momentum of the stream then carves out the gravel bed to create the typical sequence of pools and riffles.

The fish were removed from the channelized section that was to be closed with a plug of loam, ② then the excavator piled up gravel and stones to form a wall behind the beginning of the new loop of the stream. If enough gravel is available, the new loop can already be activated at this stage.

The loam that had been stockpiled for the plug was now piled onto the bank. ③ The excavator pushed the mass of loam into the water, and repeated the process until the old channelized course was filled. The plug was then compacted by repeatedly driving the excavator over it and topped up until a height 0.3 to 0.5 m above floodplain level was reached. This ensures that high water flows around the plug and not over it, and thus protects it from being destroyed by backward erosion. If a great length of the old channelized section can be filled, it is not necessary for the plug to be higher than the surrounding terrain.

If the new loop is long, precautions must be taken to ensure that the discharge flow does not come to a stop during the activation process. ④ This can be done by installing a pipe in the loam plug; after the new stream has been activated, it can be removed again.

The construction work proceeded in the direction of flow. ⑤ The picture illustrates the different positions of the water level before and after the restoration measure.

At some places trees had to be removed to allow construction of the plugs, or if they obstructed the crossing points of new loops and the old channelized stream course. ⑥ These trees were placed in the new stream as deadwood.

The masses of loam were normally moved with the excavator; small transport vehicles that do not harm the soil were only used by way of exception.

Small measures ....

... big effects! If the natural stream was channelized and shifted to the side of the valley, but the original meandering course still exists, as was the case here in the upper course of the Große Schmalenau, the required measure is obvious: the channelized stream course should be closed and the original course reactivated.

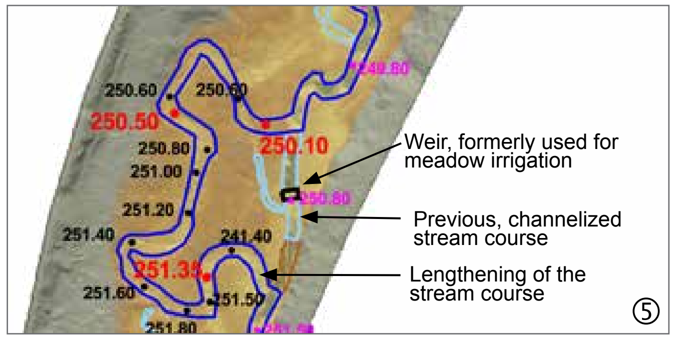
In such cases, however, the quantities of soil needed for completely filling the channelized stream course are not available, as the artificially enlarged and deepened erosion profiles are always several times larger in volume than the near-natural stream. For this reason, it is particularly important to construct safe plugs of floodplain loam such that high water cannot flow over them. Otherwise, they would inevitably be destroyed, with the unwanted result that the channelized stream course would be reactivated.

Drainage ditches in the floodplain can best be closed off with the aid of a small, light excavator that does not harm the soil. Excavated cohesive soil from the adjacent area is dumped into the ditch and compacted into a firm plug by driving the excavator over it a number of times.

Even though the reactivation of an existent old stream loop may seem to be the obvious restoration measure, caution is required. In the course of time, some cut-off loops have developed into valuable habitats. In such cases, a new stream course is the better solution.

High water in the upper section of the Große Schmalenau. The old channelized course was plugged and the still-existent natural, bed of the stream meandering through the alder forest was activated.

Passability



Seven impassable road crossing structures were replaced with new ones. The decisive factor for retaining or replacing a structure is that the created bed of the neighbouring stream must be 30 to 40 cm thick, and that the conditions downstream of the structure must exclude the possibility of future downcutting due to bed erosion. To ensure that these prerequisites are achieved, the course of the stream is lengthened if necessary by adding a further loop.

① If the road crossing has a large span width, an extra high egg-shaped profile of corrugated steel can be a good solution.

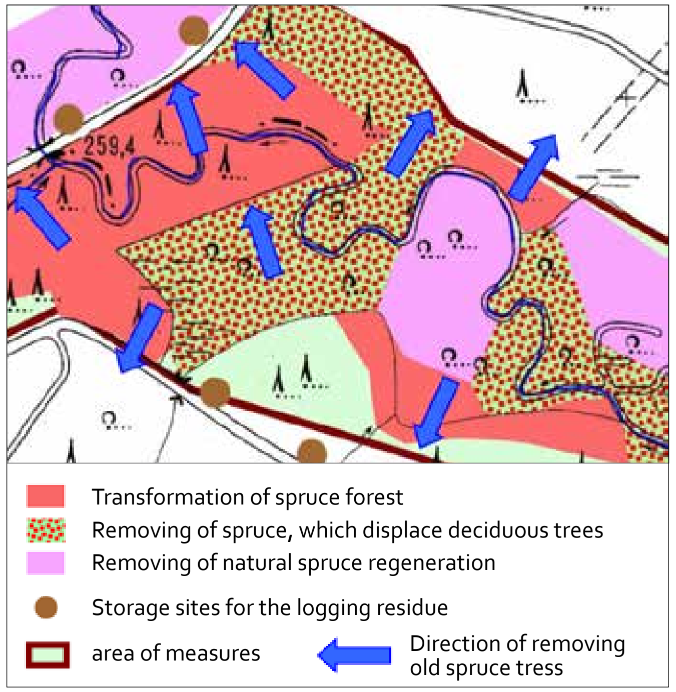
② If the span width is small, a concrete box profile can be used.

③ In the case of very small streams, large concrete pipes can even be used. These are cheaper than made-to-measure concrete box profiles.

④ In every case, a check was first made to see whether lengthening of the stream's course below the road crossing would make the structure passable. Here, this procedure is illustrated by example of the Kleine Schmalenau: Red marks the channelized course, blue is the course after lengthening of the stream by adding a further loop. Lengthening of the course results in a higher-level stream bed at the road crossing structure, and thus in a higher water level. In some cases, this is enough to make the structure permanently passable. The advantage of this solution: Significantly lower project costs because the existing structure can be retained.

⑤ In one case, generous lengthening of the Große Schmalenau made it possible to bypass an old weir that had been used many decades ago for feeding water into the meadow irrigation system. Passability of the stream was successfully restored while retaining the historical weir, which is a significant landscape feature.

Alluvial forest development: planning



Two fundamental principles played a role in the planning of spruce removal: no heavy vehicles should be driven over the sensitive floodplain soil, and the minimum possible amount of spruce felling residue should be left in the area. These are preconditions for creating the best possible starting conditions for alluvial forests with a species-rich ground vegetation layer.

The areas where spruce trees should be removed were decided on the basis of data provided by the vegetation survey and additional inspections of the terrain. Three types of non-natural spruce forest were found:

- Uniform old spruce forests with occasional black alders surviving by streams.
- Stands of old spruce growing at the edge of or within alluvial forests of alder or oak, and displacing the deciduous trees.
- Natural spruce regeneration in alluvial alder forests and in spruce forests.

The old spruce trees to be removed were marked by the district forester, and the felling directions and sites for processing the felled spruces were defined.

The skid trails to be used by the forestry contractors were marked; the letter "E" indicates the final point up to which the machines were allowed to drive.

Alluvial forest development: spruce removal

Old spruce trees were generally felled using power saws ①. The soil conditions seldom allowed a forestry harvester ② to drive into the area and undertake the felling. The floodplains were off-limits for forwarders, because of the especially high soil loading of these vehicles.

③ Sometimes it was possible for a forestry harvester to pick up felled spruce trees and delimb them outside the floodplain. ④ However, the spruces were usually dragged by rope out of the floodplain as a full tree. If the distance was too great for a rope, or if the soil was too wet, a crane truck was used.

The old spruce trees could only be taken out of the forest via the defined skid trails. It was often possible to work directly from the logging road, so that it was not necessary to drive the heavy log transport vehicles over the forest floor.

Storage sites for the logging residue were decided locally. The material was processed into woodchips.

When the spruces were felled and dragged out of the floodplain, branches or tops often break off. When this happens in particularly sensitive boggy areas, they had to be manually removed. Volunteers from the ABU and the Biological Station of the Hochsauerland District helped with this work.

Older saplings in areas of natural spruce regeneration were manually cut by forestry contractors using power saws and are either dragged by rope out of the floodplain or carried manually into the adjacent spruce forest.

⑤ Very small saplings were cut with a brushcutter. Saplings of this small size could be left lying in the area.

In a number of organized work assignments, dedicated volunteers helped with the removal of saplings in areas of natural spruce regeneration.

An alluvial forest in the making

When the spruce trees have been removed, a new alluvial forest is able to develop. Wherever light reaches the ground, alders and oaks germinate, as do rowans, birches and other light-hungry trees. As these species are all palatable to some extent, they have to be protected against serious damage caused by browsing roe, red and sika deer. Moderate damage is not a great problem, because in the new alluvial forest the trees do not have to grow with straight trunks as the production of wood is no longer the main consideration. But the trees need help to survive past the sapling stage.

Protective sleeves are placed over small naturally-regenerated saplings so that they can grow unhindered until they are so large that the nibbling deer can no longer seriously harm them.

In areas that completely lack black alder that can serve as seed trees, young black alders are planted. These are trees that have been grown from indigenous seeds.

Wooden enclosure fences adequately protect planted groups of oak trees against damage caused by browsing deer.

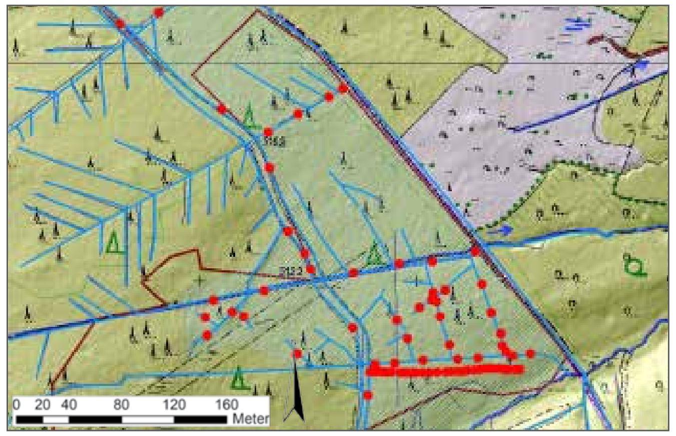
However, if the conditions are right the alluvial forest can develop without assistance. Wherever the spruce trees were removed and the stream restoration work created areas of bare soil, hundreds of black alder seedling shoot out of the ground.

A very special combination of events proved favourable for natural regeneration of alder forest in some valleys in the Arnsberg forest: First, Hurricane Kyrill blew down dark spruce plantations on 18th January2007, then a severe flood occurred on 9th August 2007. This flood washed gravel and mud into the floodplain and thereby created an ideal germination bed for black alders. Innumerable saplings took root and grew in densely-packed stands. In the course of time, some of these will dominate and others will die away. This is a new alluvial alder forest in the process of development.

But spruce trees also profit from the new light conditions. In areas where there is a strong natural regeneration of spruce, this must be eliminated until a grass covering becomes established or black alders are growing.

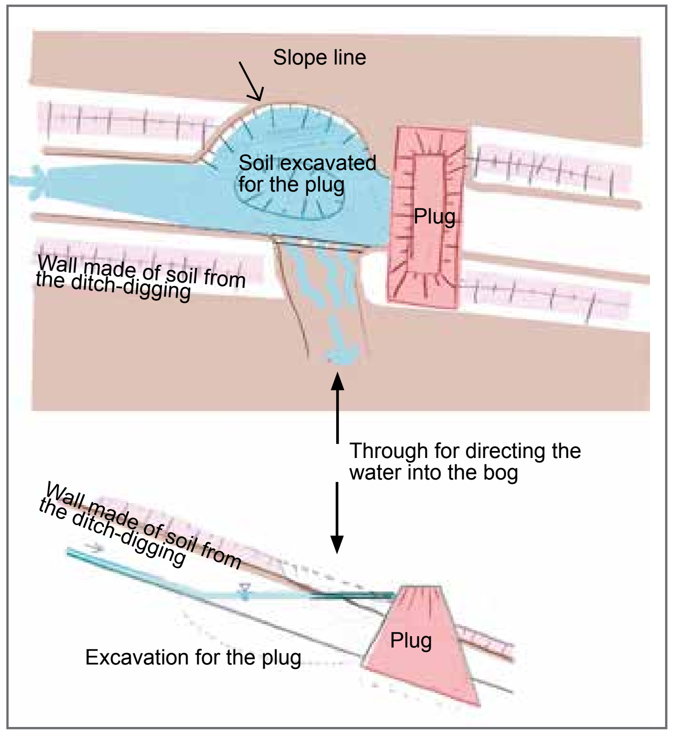
Natural regeneration of black alder in the Heve valley

Water for the Hamorsbruch



Bogs depend on water for their existence, and are able to store it in enormous quantities and for long periods of time. Bogs are a special kind of habitat. In the Hamorsbruch, rare species of plant grow on the bog soil, and a rare forest community has become established: the Carpathian Downy Birch forest.

Every drainage measure permanently damages the sensitive structure of the bog. And in the Hamorsbruch the smaller and larger drainage ditches excavated in past times criss-cross the sloping area in a fishbone pattern. This cleverly-conceived network of drainage ditches was specially devised to suit the terrain slope and to dry out the bog. This created the conditions required for large-scale planting of spruce trees – and critically endangered the survival of the bog and of the specialized species that depend on boggy conditions.



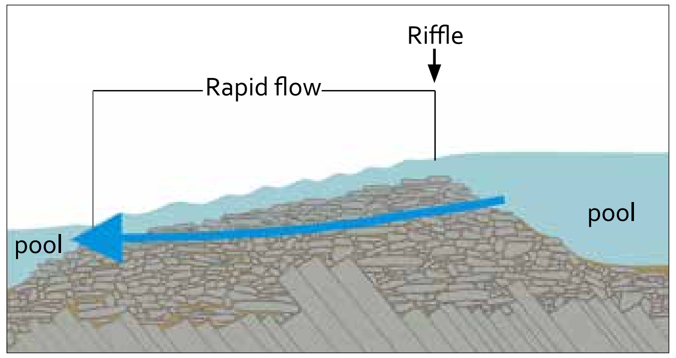
Closure of the drainage ditches

The aim of the bog restoration project was to keep the water within the area for the maximum possible length of time and to stop the drainage ditches from functioning. A Swiss expert with long experience in such projects helped with the selection of the right ditch-closure methods.

The first attempt at closing off the ditches met with failure. The sensitive bog soil could not support the 8-ton excavator that was used, and the machine's crawler track could not cope with the spruce tree stumps and wet areas. However, the second attempt went perfectly: This time, a walking excavator was used.

The drainage ditches are closed off by the following method: At the chosen location, the bog soil is first stripped down to the inorganic material. Upflow of the future closure plug, inorganic soil is excavated and carefully placed to form a broad block of soil. This is then compacted with the excavator bucket to form the plug. To ensure that water does not flow around the plug, but stays in the area to re-irrigate the bog, at least one trough-like opening into the bog is made in the wall of the ditch. The block of inorganic soil is then covered with bog soil.

To enable restoration of the bog, drainage ditches had to be plugged at 46 places.



Monitoring

Are the implemented measures having the desired effect on the flora and fauna? Are the structures of the new stream sections developing into more natural forms? A monitoring programme was designed to give initial answers, and provide at least the basis for long-term documentation of developments.

Streams

The before-and-after condition of stream sections that were lengthened – either by constructing new courses or by reactivating old ones – had to be documented. For this purpose, it was important to find a method that is not too complicated but provides meaningful data indicating the development of the stream.

A characteric feature of the near-natural streams in the valley floodplains of the project area is the riffle-pool sequence, i.e. shallow water rapidly overflowing a gravel bank, then a deeper and calmer pool, and then another rapidly-overflowed gravel bank. An imaginary line in the stream, connecting step-by-step the deepest points of the cross profiles, would rise and fall according to the sequence of riffles and pools. The riffle is where the flow speed changes from "hardly noticeable" to "rapid". If one measures the deepest point in the riffle – which often lies approximately in the middle of the stream – one obtains a characteristic point. The higher this point is situated, the more quickly will high water overflow the stream banks and spread out over the floodplain. If these characteristic points sink in the course of time, this is an unmistakeable sign of damaging stream bed erosion.

Wherever new stream loops were constructed in order to lengthen the course, the typical riffle-pool sequence is created later by high-water events. But even in such cases, characteristic points representing the bed height can be found after the stream restoration work has been completed. The coordinates and the absolute height of the characteristic points on the stream bed are determined with the aid of a tachymeter.

Vegetation

The measures carried out in the course of the LIFE project have far-reaching consequences for the vegetation. At 16 50-m-long and 10-m-wide transects marked in the terrain, the vegetation was recorded in detail and the plant species were noted. At some of these transects the before-and-after situation could be documented. At the others, the present situation is documented and the data allow future comparisons. The tree species planted during the LIFE project were recorded and monitored. Documentation of the habitus and any damage suffered by the saplings enables an evaluation of the vitality and establishment of the planted trees.

Dragonflies and damselflies

The effect of measures directed at creating light-flooded alluvial forests was monitored using the Beautiful Demoiselle Calopteryx virgo as an indicator species. Work carried out for a diploma thesis had revealed that in the project area this beautiful damselfly preferred near-natural stream sections that were fringed by alder trees. Here, the males occupy sunlit patches as their mating territory and wait for females that are willing to mate. However, the species avoids dark stands of spruce. The results of the monitoring: The species very quickly occupied the stream sections that had been freed of spruce trees and uses them as breeding territories.

The dragonfly survey revealed a previously unknown population of the rare Keeled Skimmer *Orthetrum coerulescens*. In the Arnsberg Forest, this thermophile species inhabits the spring bogs of the small tributary streams. It has also profited from the measures carried out under the LIFE project.

Macrobenthos

In all the stream sections where restoration measures were planned, a "before and after" study of the macrobenthos (larger invertebrates living in or on the sediments) was carried out by the Working Group "Aquatic Ecology" of the University of Duisburg-Essen. Within the scope of a thesis written for the state examination, samples taken in the years 2010 and 2011 were evaluated. In the initially restored sections of the Kleine Schmalenau and Heve, a clear improvement in the habitat diversity was proven. Macrobenthos species, some of which had previously been absent from the channelized sections, quickly populated the restored streams. Normally the repopulation of restored stream sections is a lengthy process. At the Heve and Kleine Schmalenau, however, it was proven that the positive effects of stream restoration took place significantly more quickly. The second picture from the top shows a Stonefly, whose larvae live in the stream.

Fish species

The presence or absence of fish species, and also the occurring age classes, provide indications of the condition of the stream. The method used in order to study and evaluate the fish stocks in streams and rivers is electrofishing. Between two poles, a weak electrical field is built up in the water. Any fish entering this field are stunned for a short time. In this state they can be netted, identified and measured. Afterwards, they are released unharmed.

The study was conducted along 20 sample sections of 100-m length on up to three occasions. The aim was to compare the status of the fish fauna before and after the implementation of the restoration measures. A total of around 1,800 fish of 10 species was recorded. The most common species of fish, which was found in all the streams, is the Brown Trout, followed by the Bullhead and the Chub. The first effects of the stream restoration are already noticeable. Prior to the restoration, 21 specimens of the Brook Lamprey, a specially-protected FFH species, were caught compared to 49 specimens after the restoration.




Opening - Workshop - Conferences - Excursions - Lectures

The LIFE project was opened on 18th February 2009 by Eckhard Uhlenberg, who was the state's environment minister at the time. The former President of the Landesbetrieb Wald und Holz, Frank-Dietmar Richter, and the Chairman of ABU, Joachim Drüke, welcomed the numerous guests from politics, administration and nature conservation associations.

A workshop held on 22nd and 23rd April 2010 focussed on exchange of experience, discussions on the subject of biotope restoration, and excursions in the project area. 30 participants from research and practice in Germany attended the event organized by ABU. The workshop provided important stimuli for the planning of restoration measures, and valuable contacts were established.

A website, flyers and newspaper articles were important publicity media for the project. Excursions in the project area were of particular significance for the interested public, as well as for experts from administration and science. A total of 65 excursions were held within the framework of the project.

Project information was presented at six exhibitions and events. The project was featured in radio reports on two occasions.

The event of greatest scientific importance was a presentation of the technical principles and the measures carried out during the LIFE project at the "Symposium for European Freshwater Sciences", held on 1st to 5th July in Münster. The LIFE project was co-organiser of the symposium.

At rotating information pillars, visitors to the Arnsberg Forest can learn about the LIFE project, about plants and animals, about the measures implemented under the project, and about the Europe-wide network of protected areas called „NATURA 2000".

On 11th November 2012, Carina Gödecke, President of the state parliament, Eckhard Uhlenberg, Vice- President of the state parliament, and environment minister Johannes Remmel opened an exhibition in the state parliament about LIFE projects in NRW. One of these was the LIFE project "Stream valleys in the Arnsberg Forest".

LIFE trails

Two circular trails were designated on existing forest hiking trails within the framework of the LIFE project. Along these trails, hikers are provided with information, are guided to special or typical locations, and can have a rest on one of the seats.

The starting points for the trails are the car parks close to the following taverns:

„Zum Tackeberg“
Neuhaus 54
in Möhnesee-Neuhaus,

Waldgasthaus „Schürmann“
Lattenberg 7
in Arnsberg-Oeventrop.

The LIFE information pillars are located at these car parks, and seats are provided for those needing a rest.

For each LIFE trail there is a leaflet showing the route and giving additional information. You can download the leaflet under www.life-bachtaeler.

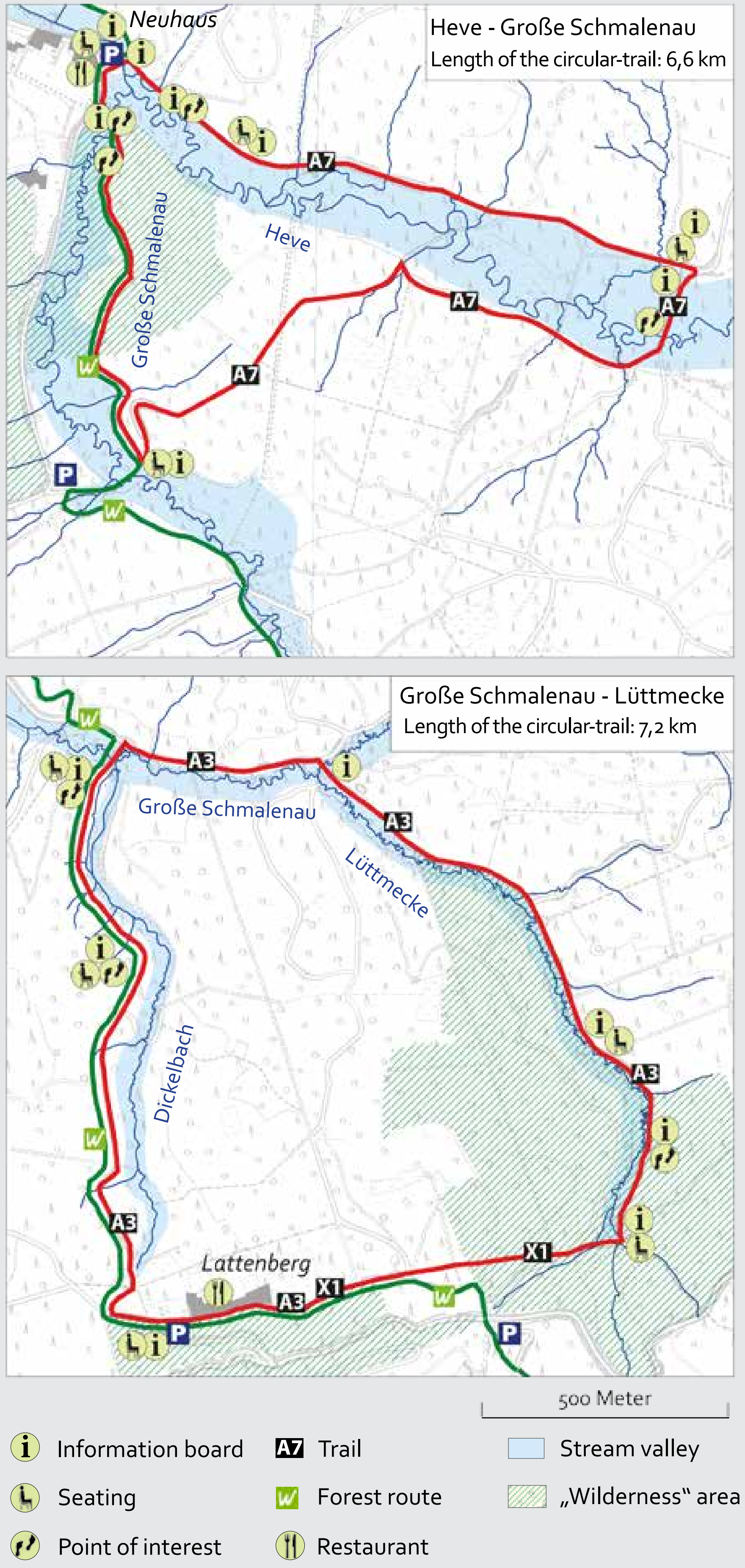
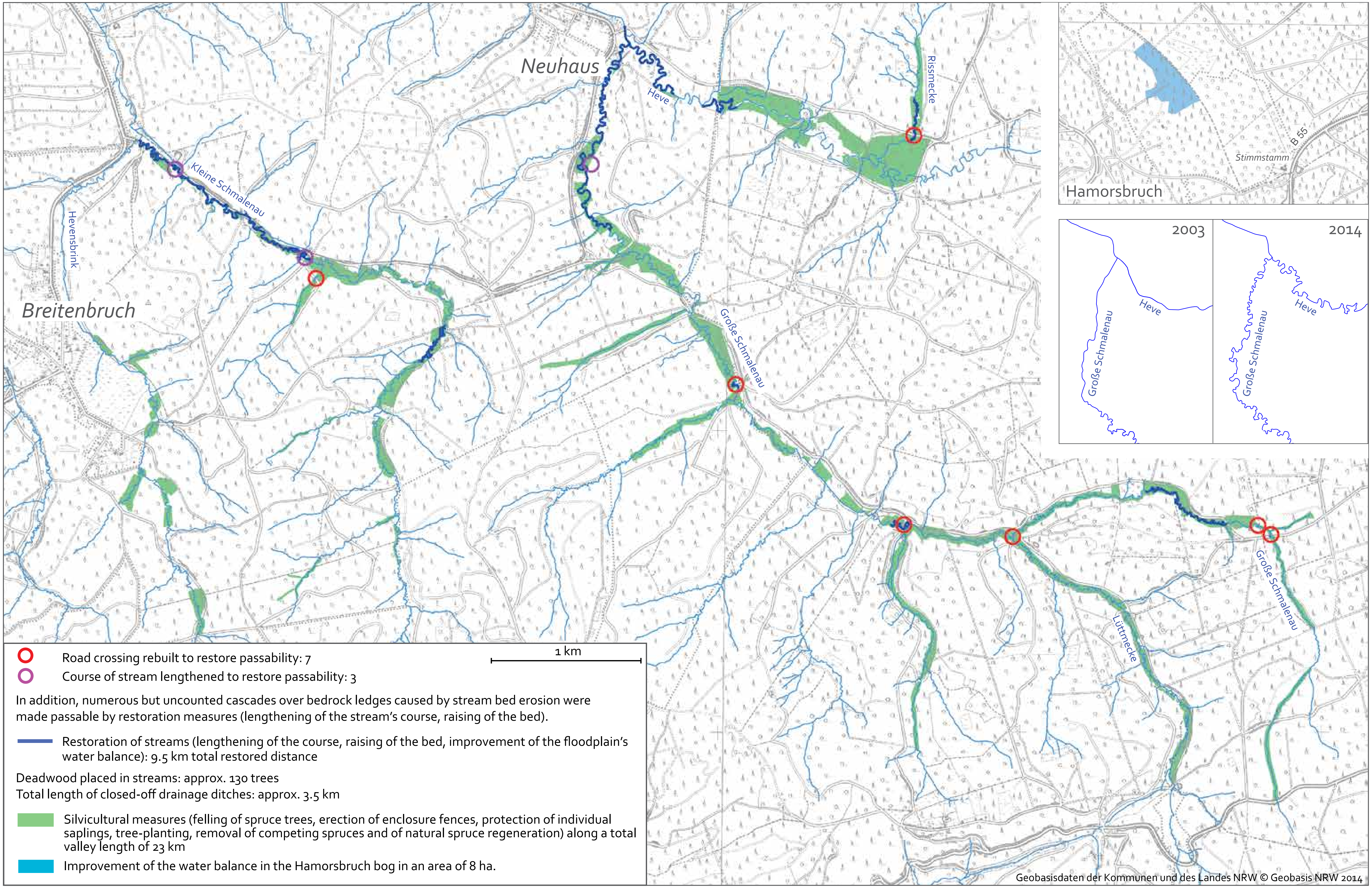


Photo right side: View from the LIFE-circal trail „Heve - Große Schmalenau“ into the valley of Heve

Project map and scope of restoration measures



Involved parties

Conception and permit applications: ABU (Birgit Beckers, Joachim Drüke), Lehr- und Versuchsforstamt Arnsberger Wald (Peter Bergen, Carsten Arndt) and Biologische Station Hochsauerlandkreis (Werner Schubert)

Project management: ABU (Birgit Beckers, Olaf Zimball)

Working group of the project partners:
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Biologische Station Hochsauerlandkreis: Dr. Axel Schulte, Christoph Hester
Stadt Meschede: Peter Kotthoff, Roland Wiese
Naturpark Arnsberger Wald: Michael Matysiak, Simone Schicketanz, Sandra Bohnke
ABU: Birgit Beckers (Leitung), Roland Loerbroks, Joachim Drüke, Ralf Kubosch, Olaf Zimball

Stream planning: ABU (Joachim Drüke, Roland Loerbroks, Birgit Beckers), Biologische Station Hochsauerlandkreis (Christoph Hester), Beck & Staubli, Zug

Digital terrain model: Dr. Michael Leismann

Supervision of stream restoration works: ABU (Birgit Beckers, Roland Loerbroks, Joachim Drüke)

Planning and construction management of crossing structures: Gewässerbüro Klein, Allagen (Wolfgang Klein, Ina Filipponi)

Vegetation mapping: Biologische Station Hochsauerlandkreis (Dr. Axel Schulte), ABU (Ralf Kubosch), Annelie Fröhlich

Monitoring of fish fauna: ABU (Olaf Zimball, Dr. Margret Bunzel-Drüke)

Hydromorphological monitoring: ABU (Roland Loerbroks, Joachim Drüke)

Monitoring of dragonflies: Julia Wrede, Dr. Ralf Joest

Monitoring of macrobenthos: Universität Duisburg-Essen (Dr. Armin Lorenz, Lara Kremer)

Silvicultural planning and supervising: Biologische Station Hochsauerlandkreis (Christoph Hester), ABU (Birgit Beckers) und Lehr- und Versuchsforstamt Arnsberger Wald (Carsten Arndt, Lorenz Lüke-Sellhorst, Christoph Grüner, Gerd Richter, Klaus Kotthoff)

Indigenous seed stock: Lehr- und Versuchsforstamt Arnsberger Wald (Martin Rogge, Heike Herrmann)

Planning and construction management of visitor infrastructure: Achim Berger

Design and printing of information boards: Josef Brackelmann, Karl Rusche, Joachim Drüke, Birgit Beckers, Dagmar Fromme

Publicity work: ABU, Biologische Station Hochsauerlandkreis, Naturpark Arnsberger Wald und Lehr- und Versuchsforstamt Arnsberger Wald

Permits required by water and nature protection laws: Kreis Soest (Manfred Thomas, Philipp Büngeler, Jutta Münstermann) and Hochsauerlandkreis (Paul Werner Bräutigam, Rita Schneider-Niedermeier, Martin Susewind, Hans-Theo Körner)

Financing and technical support: Arnsberg District Council (Dagmar Schlaberg, Peter Wahlers, Edgar Schuh), MKULNV (Ingrid Rudolph, Georg Keggenhoff), Particip (Cornelia Schmitz)

Contractors Silvicultural: Forstwirtschaftsmeister Jürgen Feldmann, Meschede-Freienohl / Forstbetrieb Klute-Lenze, Sundern-Allendorf / Forstbetrieb Christian Wülbeck, Schmallenberg / Marcel Knickelmann, Möhnesee- Neuhaus / Forstbetrieb Harald Wieland, Großerlach-Neufürstenhütte / Stefan Jatzkowski, Garten- und Landschaftsbau, Bad Sassendorf / Forstunternehmern Rolf Wohlgethan, Möhnesee / Neue Arbeit Arnsberg, Arnsberg / Martin Dielenhein, Medebach-Dreislar / Holz-Harth, Bad Berleburg / Martin Koch Rückebetrieb, Arnsberg / Thomas Müller, Forstbetrieb, Olsberg-Gierskopp / Suttroper Forstwelt, Warstein / Klute Garten- und Landschaftsbau, Sundern-Stockum.

Contractors stream restoration: Mario Kutscher, Dienstleistung im Tief- und Straßenbau, Warstein-Allagen / Hermann Vogt, Kultur- und Landschaftsbau, Drensteinfurt / Opitz, Tief-, Bahn- und Landschaftsbau, Hamm / Sauer & Sommer, Staßen- und Tiefbau, Meschede-Wennemen / Paul Tillmann, Straßen- und Tiefbau, Meschede-Eversberg / DWK Bau, Tief-, Straßen- und Landschaftsbau, Schmallenberg-Kirchrarbach / Ulrich Springob, Garten- und Landschaftsbau, Attendorn-Albringhausen

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Conclusion

This LIFE project had a precursor: A study titled "Naturnahe Entwicklung der Heveaue" (near-natural development of the Heve floodplain) published by ABU in 2004 documented the contrast between very near-natural, impressive stretches of the Heve floodplain on the one hand and the non-natural monotonousness of spruce plantations, channelized, eroded stream sections and dried-out floodplains on the other hand.

A look at other stream valleys in the Arnsberg Forest nature conservation area showed that a similar situation existed there, and this quickly led to the idea of cooperating with the Landesbetrieb Wald und Holz to implement a LIFE project. The state-owned areas of land provided the prerequisites for the success of such a project. In addition, it had long been one of the expressed aims of the nature conservation area to introduce a development towards near-natural conditions.

While the measures required for the restoration of channelized, eroded streams and dried-out floodplains quickly became clear, lengthy and intensive discussions took place regarding the silvicultural methods, i.e. the way to convert monotonous spruce plantations into open alluvial forests with alders and oaks. Finally, it was decided to use the five-year project period to determinedly reduce the stands of spruce and create the starting conditions for open alluvial forests.

The LIFE project has only provided the starting impetus. The further development has to be monitored, and the way to near-natural alluvial forests must be supported by follow-up measures if necessary. The realization of the project and the good collaboration between the bodies involved has provided the motivation for this future commitment, and volunteers from the nature conservation societies and the biological stations will provide assistance. They have come to know and love the stream valleys and their nature.

We feel sure that the numerous visitors to the Arnsberg Forest will also be enthusiastic about the initiated developments. The two newly-dedicated LIFE trails will certainly play their part by promoting interest in the changes that are taking place.

For a very long time, numerous streams and rivers were channelized, and their floodplains were drained. A great deal of nature was lost. Today, more and more people realize how important it is to have areas of relaxation, rich in animals and plants, in the middle of a hectic environment in which the focus is placed on uncompromising efficiency.

The large and mainly state-owned Arnsberg Forest, situated not far from the Ruhr district conurbation, is already of outstanding importance for people and for the conservation of flora and fauna. It has further potential; we should use it wisely and carefully the benefit of people and nature.

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The project was realized on land owned by the state of North Rhine-Westphalia, administered and managed by the Landesbetrieb Wald und Holz, represented by the Lehr- und Versuchsforstamt Arnsberger Wald. Without the constructive,and committed cooperation of the forestry office, the head of the forestry enterprise Lorenz Lorenz Lüke-Sellhorst, der district forester Carsten Arndt, Christoph Grüner, Gerd Richter, Peter Meier, Klaus Kotthoff - and without the support of his manager Günter Dame , the project would not have been possible.

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Impressum

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