Biodiversity in the Rhenish mining area – opportunities of a new landscape

MICHAEL EYLL-VETTER, WERNER SIHORSCH, GREGOR ESSER, GERMANY

1 Introduction

The loss of biodiversity is one of the world's greatest ecological challenges. Increasing land utilisation, alteration and the resulting degradation are having a significant global impact on biodiversity – the variety of species and habitats as well as the genetics within a species. Around one quarter of species worldwide are threatened by extinction today [8], with negative consequences for people. Many services provided for people by nature, called ecosystem services, depend on the existence of a high degree of biodiversity and are therefore threatened by its continuous decline. Maintaining the diversity of species and habitats is therefore a task that concerns all of society. Other sectors, such as agriculture and forestry as well as the extraction of raw materials and the supply of energy, also play an essential role.

For the RWE Group as a major energy supplier, protecting and promoting biodiversity is a key issue within the framework of sustainable corporate governance. This has therefore been established as a priority topic in a Group-wide sustainability strategy [14]. In terms of content, it represents a continuation of the biodiversity policy put in place by the RWE Group in 2015 (updated in 2022, [15]).

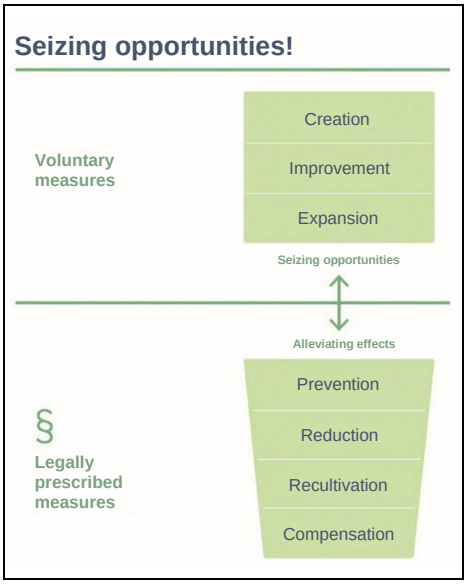

Figure 2: Measures for the abatement of consequences and to improve biodiversity according to the guiding principle of the abatement hierarchy (adapted from Rio Tinto (2004) in [9])

It establishes how the Group protects and promotes biodiversity in the course of its business activities.

Figure 1: 'Site diversity creates species diversity'. Biodiversity in the Rhenish mining area can be effectively increased in the course of recultivation with the help of this design principle. The example shown here is the area of the Goldene Aue on Sophienhöhe heights (left: 2018, right: 2021)

Dipl.-Ing. MICHAEL EYLL-VETTER,
RWE Power AG, Lignite Development segment, Stüttgenweg 2,
50935 Cologne, Germany
Tel.:+49 (0) 221/480-20111
e-mail: michael.eyll-vetter@rwe.com

WERNER SIHORSCH,
Kirchstraße 7 A, 52391 Vettweiß, Kelz, Germany
e-mail: werner.sihorsch@outlook.com

Dipl. Geogr., M.Sc. GREGOR EßER,
RWE Power AG, Schloss Paffendorf, Burggasse 1,
50126 Bergheim, Germany
Tel.:+49 (0) 221/480-22185
e-mail: gregor.esser@rwe.com

Based on the RWE Group's general biodiversity policy, a biodiversity strategy for the Rhenish lignite mining area (hereinafter BioDiS) was developed and implemented in 2018 with the expert assistance of the Recultivation Research Center and Raskin Umweltplanung based in Aachen [16]. This strategic approach is necessary to identify and utilise additional opportunities for the voluntary improvement of biodiversity beyond the legally required abatement of opencast mining consequences. Within the Group's activities, the design of post-opencast mine landscapes in particular offers great opportunities to positively impact local and regional diversity beyond the extent required by law. Including biodiversity in the planning and development of the post-opencast mine landscape has therefore been practised by RWE Power for a long time (Figures 1 and 2) [2].

2 RWE biodiversity strategy for the Rhenish mining area

2.1 Methodology

The area of application for the biodiversity strategy (BioDiS) includes the active recultivation of opencast mines in the Rhenish mining area – the region between Aachen, Mönchengladbach and Cologne – as well as the RWE species protection areas outside of recultivation. The strategy is implemented in the three functionally different habitats 'forest', 'open landscape' and 'bodies of water' that have been identified as areas of action (Figure 3). Measures for target species are defined in the respective areas of action, selected based on the following key criteria:

- Representativeness of the species for its area of action or for essential habitat structures
- The conservation status of the species or, where applicable, special responsibility for conservation of the species in the Rhenish mining area

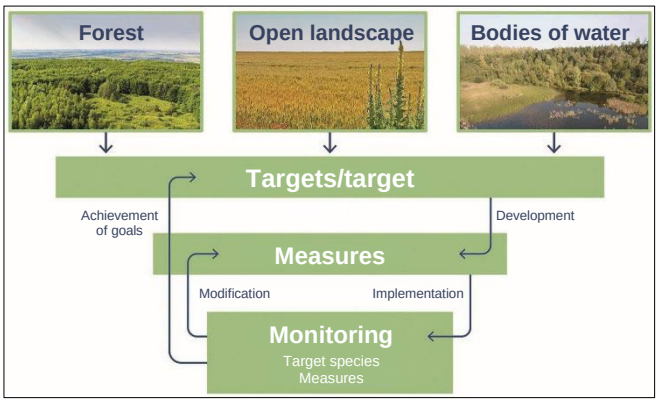

Figure 3: Flowchart for the development of biodiversity targets and their implementation in recultivation as well as the verification of target achievement

Information from the UN (IUCN) and targets from the biodiversity strategies of the EU, federal government and the state of North Rhine-Westphalia were also reviewed to determine the extent to which establishing higher-level objectives that are derived from this strategy and connected to it can improve biodiversity success in recultivation.

The concrete implementation of the RWE biodiversity strategy for all three areas of action is headed by the Recultivation Research Center and supports the comprehensive design of contiguous landscapes. Each area of action offers various habitats with different environmental conditions that are used by different species. In order to maintain and promote structural diversity in the habitats of the areas of action, thereby maintaining and promoting biodiversity, differentiated measures are therefore planned and implemented at the habitat level. Four habitats have been selected for each area of action that jointly represent the landscapes as a whole.

Professional execution of biodiversity promotion measures is accomplished with the accompanying verification of implementation and corresponding performance indicators. The success of the measures is in turn documented by the occurrence of the selected target species in the course of accompanying bio-monitoring. A functional amendment of biodiversity measures is carried out if the target species are not present.

The pronounced focus on representative target species is based on the high demands they place on their environment. Since these demands reflect the basis of existence for entire biocoenoses, their protection produces a 'windfall effect' for other species. Thus the presence or absence of the target species also allows conclusions to be drawn about the quality of the habitat as a whole [11, 13].

2.2 Forest area of action

Near-natural deciduous forest, (inner) forest edges, forest glades and arid ruderal sites have been differentiated as relevant habitats within the forest habitat as a whole. The development of near-natural deciduous forests is a stated goal in the BioDiS. In addition to the Sophienhöhe that is mainly forested with native deciduous trees, numerous forest glades of various sizes and a trail network with a length of more than 100km have been created (Figure 4).

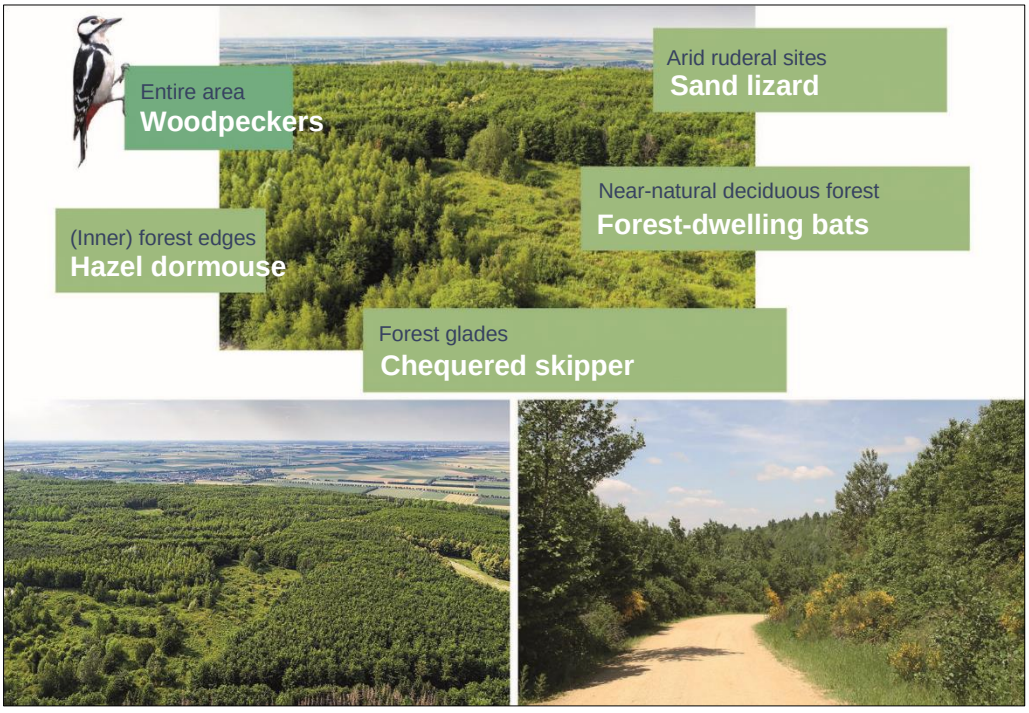

Figure 4:
Forest area of action: Habitats and target species. Near-natural mixed deciduous forests and structure-rich forest edges are elements of particular importance.

Figure 5:
Open landscape area of action: Habitats and target species. Species-rich edges and meadows as well as extensive fields of alfalfa are key elements.

The latter is used in recultivation specifically to create near-natural inner forest edges, and can significantly increase the habitat diversity in the forest by forming additional boundaries. Important ecological functions with regard to structural and species diversity as well as the networking of habitats in the forest are established in this way. Very arid ruderal areas of sand and gravel were included in the BioDiS implementation concept as a representative of extreme sites.

2.3 Open landscape area of action

The habitat structures of alfalfa fields, nutrient-poor grassland, structure-rich edges and nutrient-poor, arid open areas were identified as relevant elements within the open landscape habitat as a whole (Figure 5). Alfalfa fields in particular are a recultivation-specific habitat with very high biodiversity potential.

Contiguous alfalfa fields of this extent are not otherwise found in the landscape, making them a unique feature of recultivated areas. They provide food for numerous insects and nesting sites for ground-breeding birds. Animal species at risk of extinction, such as the short-eared owl and corn bunting, also have one of their last refuges in North Rhine-Westphalia here. Nutrient-poor grassland forms a contrast to the regularly fertilised farmland, making it an important element of a structure-rich open landscape. Edges forming the transition from one habitat to another are true biodiversity hotspots in most habitat types and were therefore included as a representative open landscape habitat. Sparser, rocky habitats and escarpments are also found in the open landscape aside from vegetation-rich areas.

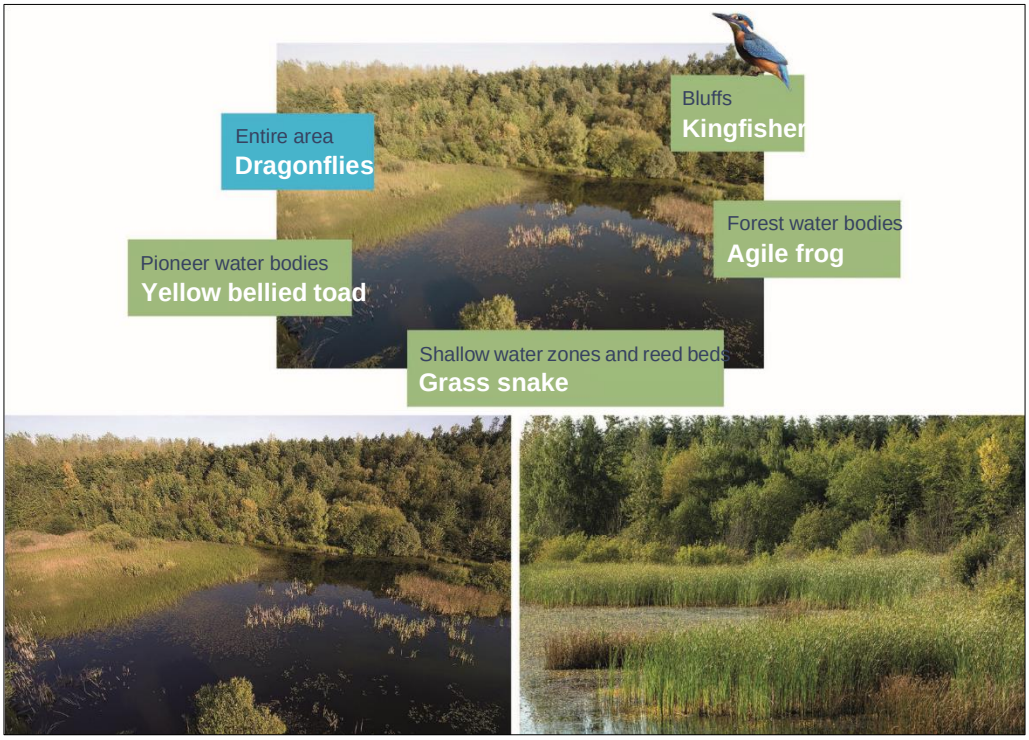

Figure 6:
Bodies of water area of action: Habitats and target species. Shallow water zones and reed beds are key elements.

2.4 Bodies of water area of action

The following habitats are differentiated in the bodies of water habitat complex: forest water bodies, shallow water zones and reed beds, pioneer water bodies and bluffs (Figure 6). Shallow water zones and reed beds in standing bodies of water play a central role in the protection of biodiversity due to their varied functions. They are used by birds as breeding sites, by juvenile fish and amphibians and by insects. Other species in turn depend on the low structural diversity of temporary pioneer water bodies that, due to the lack of vegetation, form a stark contrast to established bodies of water with reed beds. The near-natural design of water body structures, for example with bluffs is another objective for the bodies of water area of action in the BioDiS.

2.5 Special sites and species protection areas

Within recultivated areas and in the sphere of large species protection areas, special opportunities exist to realise lasting improvements and a gain in biodiversity (see [2]).

In accordance with the guiding principle ‘Site diversity creates species diversity’, special sites due to their specific features provide habitats of very high ecological value. Examples include species-rich meadows, heath and wetlands, elements of very high importance in the three areas of action that are described (Figure 7). The presence of these habitats in conjunction with maintenance that promotes biodiversity, with the help of nature-friendly grazing among other things, can further increase biodiversity voluntarily and beyond what is required by law.

3 Flagship projects of the RWE biodiversity strategy

3.1 Spechtwald Sophienhöhe

The goals of the ‘Spechtwald Sophienhöhe’ woodpecker forest project are to obtain meaningful information about the ecological condition of the forest areas and their development, using woodpeckers as the indicator group, and to improve the ecological value of recultivated forests through special measures (Figure 8).

Woodpeckers are a suitable target species group for the forest area of action in order to map all of the mosaic-like structural elements of a near-natural mixed deciduous forest (deadwood, forest edges, forest glades, species composition, age structure and so on) with the help of the various habitat needs of the different woodpecker species, and thus simultaneously represent many other species groups as well.

Sophienhöhe heights was chosen as the reference area for woodpecker mapping since it is almost fully forested on the one hand and all of the forest is still relatively young on the other hand, that is, up to a maximum of 40 years. For the cavity-nesting woodpeckers, the Sophienhöhe is therefore in a stage of development that just makes it interesting for colonisation by species in this group. Recording data for the entire area is hardly possible due to the large size of the Sophienhöhe at approximately 16km^2. Therefore, the method of sample area mapping commonly used in outdoor ecology is used (see [12]). To obtain results that are as representative as possible and can be transferred to the entire Sophienhöhe, four transects have been selected for mapping that represent the essential current inventory characteristics (inventory structure, age, species composition). Full recording in 2020 is followed by ongoing annual mapping of an individual transect, so that the various sections are mapped and evaluated again every four years.

Six of the seven woodpecker species occurring in North Rhine-Westphalia were found in the four transects on Sophienhöhe heights in the initial years of the study. Breeding was documented for three species (great spotted woodpecker, lesser spotted woodpecker, green woodpecker) while the others were identified as visitors seeking nourishment (middle spotted woodpecker, black woodpecker) or passage migrants (wryneck) (Table 1). The grey-headed woodpecker, which has not been found on the Sophienhöhe, is a low mountain range and alpine species (elevations up to 1500m); it is rarely found in lowlands [5, 6]. Two of the documented woodpecker species are on the North Rhine-Westphalia Red List: The lesser spotted woodpecker is endangered state-wide, the wryneck is at risk of extinction.

Based on the initial years of the study, the ecological development of recultivation on the Sophienhöhe is evidently very good. Reforestation and the associated species protection measures that were already implemented have created a diverse habitat structure that provides habitats with breeding sites and/or food for numerous species.

Figure 7:
Extreme habitats (left) increase site diversity and therefore also biodiversity. Even more species diversity potential is to be realised in RWE species protection areas (right).

Figure 8:
After just 40 years, six different species of woodpecker are already found in the Spechtwald Sophienhöhe woodpecker forest, including the very demanding black woodpecker (right) (source: Franz Kirstein, Peter Stollwerk)

Table 1: Endangered woodpeckers, relevant for planning, recorded in the course of mapping in 2020 [3]

Species name	North Rhine-Westphalia Red List	Protection	Status	Territories/ breeding pairs
Great spotted woodpecker	*	§	Breeding bird	31
Lesser spotted woodpecker	3	§	Breeding bird	5
Green woodpecker	*	§	Breeding bird	7
Middle spotted woodpecker	*	§§	Visitor seeking nourishment	–
Black woodpecker	*	§§	Visitor seeking nourishment	–
Wryneck	1	§§	Passage migrant	–

Classification for North Rhine-Westphalia Red List according to [7]

0: Extinct or lost
1: At risk of extinction
2: Highly endangered
3: Endangered
*: Not endangered
V: Early warning list; species has declined significantly, but not yet endangered
R: Extremely rare, (potentially) endangered
Protection: §§ = under strict protection; § = under special protection

Figure 9: Successful promotion of forest maturity and biodiversity through the placement of deadwood (source: Franz Kirstein, Ralf Krechel)

Even deadwood specialists among the birds, such as the lesser spotted woodpecker, were provided with breeding sites by ringing individual trees and through the placement of old, cut oak deadwood (Figure 9). This measure is of tremendous importance, especially for cavity-nesting woodpeckers and their successors in the nesting cavities.

As a conclusion based on the initial years of the project, the still relatively young forest landscape of Sophienhöhe heights has developed remarkably well in terms of biodiversity: Not bad, the woodpecker forest!

3.2 Hasenland Garzweiler

With the help of the brown hare as the target species, meaningful information has been obtained since 2020 in the ‘Hasenland Garzweiler’ project regarding the ecological condition of the open agricultural landscape in the

Figure 10: The Hasenland Garzweiler is not only home to brown hares. The last breeding sites of the short-eared owl and one of the last large corn bunting populations in North Rhine-Westphalia are found here as well (source: Franz Kirstein, Norbert Wolf)

Garzweiler recultivated area. Special measures are being implemented for the ecological improvement of the landscape.

The goal is to record the brown hare population in representative sections of the Garzweiler recultivated area and to compare this with the surrounding Börde regions. Improving the habitat conditions in agricultural recultivation is intended to support the brown hare population and therefore also promote biodiversity in the open landscape as a whole (Figure 10).

The brown hare population density is recorded using the ‘floodlight counting’ method [1]. At least two counts are performed per year, one in the spring to record the base population and one in the autumn for the autumn population.

The results of the initial years of counting show that the hare density in the Garzweiler recultivated area with a population of approx. 30 hares/100ha [3, 4] is higher than the average hare density in the adjacent Börde regions (approx. 10 to 20 hares/100ha) (unpublished, Landesjagdverband NRW, 2021) and significantly higher than the average hare density in the low mountain range landscape of western Germany (approx. 10 hares/100ha [10]). Nevertheless, the hare density in the Garzweiler recultivated area can be further optimised in view of ecologically ideal landscapes, notably through ongoing habitat improvements (verbal information from Dr Michael Petrak, Forschungsstelle für Jagdkunde und Wildschadenverhütung NRW, 2021).

While the proportion of special ecological structures in Garzweiler at approximately 10 per cent of the agricultural land is already higher than average for the landscape, their size can still be increased and the quality further optimised. In particular, the proportion of permanent ruderal and edge structures and the presence of suitable woody refuges are still too low. An influence of the comparatively high predator density and a negative impact of the adjacent A44n motorway cannot be excluded either.

Figure 11: Keys to the success of promoting biodiversity are mosaic-like farming structures with manageable field sizes as well as species-rich edge structures of sufficient size

Figure 12: Diverse and structure-rich ponds and small bodies of water are important elements for the promotion of amphibians

The results from the initial years of the project also strongly indicate that the field sizes in the recultivated area are too large and have a negative impact on the population density of the brown hare.

Thus there are numerous parameters that can be adjusted for existing optimisation measures as well as influencing factors for the assumed negative net growth rates in the Garzweiler district. The concept of measures for the open landscape under the RWE biodiversity strategy is correspondingly varied.

For interim management in particular, the following measures and performance indicators integrated into operations have been established to this end, which are also typical for the landscape in other Börde regions (Figure 11):

- Reducing field sizes to a maximum of 8 to 10ha.
- Increasing the proportion of special ecological structures in agriculture to a total of at least 15 per cent of the agricultural area (in line with the target of the state of North Rhine-Westphalia's biodiversity strategy).
- Widening existing, narrow flower and fallow strips to at least 12m.
- Combining various adjacent measures. Under the guiding principle 'dense and light', cover is created on the one hand and rapidly warming areas on the other hand (e.g. field margins next to fallow fields with natural vegetation).
- Alfalfa management; mainly latest possible mowing of alfalfa starting in August.
- Sustainable continuation of the accompanying ecological measures in the recultivated area beyond interim use by RWE (contractual nature conservation, round tables etc.).
- Expansion of overwintering structures.
- Establishment of woody refuges in the area.

The conclusion of the 'Hasenland Garzweiler' project is that the brown hare density in the Garzweiler recultivated area is higher than the average values elsewhere in the landscape. Nevertheless, optimisation potential still exists and shall be realised even more effectively in interim management going forward in the course of implementing the RWE biodiversity strategy, without detracting from the recultivation objectives to establish a high-yielding agricultural landscape.

In particular, reducing the average field size and increasing the percentage of ecological priority areas are expected to have long-term positive effects on the brown hare population in the study area.

3.3 Yellow bellied toad project in the Rhenish mining area

The 'Unken im Revier' project aims to strengthen the region's last two populations of the yellow bellied toad. The goal is to stabilise and propagate this amphibian species, which is otherwise extinct in the region, in the Garzweiler recultivated area and in RWE species protection areas in the 'Dickbusch' forest. Sustainable pioneer sites are to be created and a regional habitat network is to be established for this purpose.

There is a former gravel sedimentation pond of the company Rheinische Baustoffwerke on the Königshovener Höhe in the Garzweiler recultivated area. In the course of the Garzweiler opencast mine's ongoing recultivation, it has been converted and optimised as a species protection area for pioneer species such as the natterjack toad and green toad. The biotope complex of various extreme habitats that exists here meets the habitat needs of pioneer species such as the yellow bellied toad in their various development phases. Numerous additional small bodies of water have been established within and outside the basin and hiding places were created using rocks or deadwood (Figure 12).

The population of the yellow bellied toad in the Garzweiler recultivated area has increased from about 10 individuals originally, in 2020, to about 70 adult individuals today [3, 4]. Thus the ecologically relevant threshold of 100 adults for the presence of a stable population has not quite been reached. The range of the yellow bellied toad in the Garzweiler recultivated area is growing very favourably with the establishment of additional small bodies of water. Both to the north and the south-east, the species has already advanced considerably, i.e. by up to 1km, from the described original habitat. However, colonisation of the planned target habitats in the area of the Erftaue and a not yet fully recultivated area in the post-mine landscape has not been entirely accomplished yet.

The planned yellow bellied toad habitat network in the Garzweiler recultivated area comprises mainly agricultural areas.

Figure 13: In particular, pioneer species that are very rare in Germany, such as the green toad, yellow bellied toad and natterjack toad, find important refuge habitats in the recultivated landscapes (source: Norbert Wolf, Olaf Diestelhorst)

Small bodies of water and suitable land habitats were therefore created on the sites of the local wind energy plants as well. The areas around the wind energy plants are ideal for this purpose. This has been confirmed by the initial study results from 2022, which showed that these structures at all four sites were successfully accepted by the yellow bellied toad in the year they were established and in part also used for reproduction.

The yellow bellied toad project in the Rhenish mining area clearly shows that a moderate population of the yellow bellied toad has established itself in the Garzweiler recultivated area thanks to the extensive protection and development measures of the RWE biodiversity strategy. The population is gradually spreading and, based on the number of individuals, can already be classified as ‘nearly stable’ in the meantime (Figure 13).

4 Transfer potential beyond the post-mine landscape

The recultivation of the Rhenish lignite mining area, which is recognised worldwide, is the result of a decades-long learning process that continues to this day. Restoring the usefulness and maximising the nature conservation potential can only be achieved through an integrated process. Extensive accompanying scientific research is required in addition to an interdisciplinary approach. The recultivation areas in the Rhenish mining area are used by various experts as real-life laboratories and have contributed to the development of extensive expertise. This recultivation know-how is applied in many different areas today. The knowledge regarding the promotion of biodiversity, accompanied by making the landscape more attractive, is in particular high demand. Meanwhile, the consulting services of the Recultivation Research Center are utilised in recultivation planning for various types of excavations worldwide, combined with the objective of creating a sustainable landscape that is rich in biodiversity.

Species-rich landscape design is also an important element of a successful structural transformation in the Rhenish mining area. That is why the proven elements of recultivation are widely used for the improvement of a species-rich landscape in projects such as the Blau-Grünes Band Garzweiler blue-green belt of the Landfolge Garzweiler association or in master planning for the Neuland Hambach recultivation.

The biodiversity promotion approaches in the Rhenish mining area can be scaled up for large conversion and remediation areas around the world or transferred to smaller sites such as nature-friendly company premises and even private gardens.

Biodiversity research from the Rhenish mining area can also be of special significance for the energy transition. Climate protection and species protection should not and do not have to be contradictions. Intelligent solutions are therefore needed in order to achieve a gain rather than a loss of biodiversity in the course of the massive expansion of renewables. The proven recultivation elements and extensive expertise of the Research Center can make valuable contributions here. Initial pilot measures on wind farms in the Garzweiler recultivated area show that recultivation know-how is in demand here as well (Figure 14).

5 Summary and future prospects

The recultivation of mining areas in Central Europe provides a great opportunity to promote biodiversity over the long term. It requires the earnest motivation of the operator and strategic management of the recultivation process with significant attention to nature protection concerns.

Such a strategic approach has been implemented by the mine operator in the Rhenish mining area with the introduction of the RWE biodiversity strategy (2018) in the course of opencast lignite mine recultivation. The potential for species diversity that exists in the course of economic activity was thereby voluntarily realised beyond the extent required by law. The willingness to engage in sustainable biodiversity promotion is also expressed by the RWE Group by identifying biodiversity as a priority topic in the RWE sustainability strategy [14].

The results of RWE’s biodiversity strategy are transparently documented by the Recultivation Research Center as part of public events and annual reports, and the further development of support measures with experts and project partners is ongoing.

Biodiversity measures are designed and implemented for highly demanding target species in the forest, open landscape and bodies of water areas of action within the framework of the RWE biodiversity strategy. At the same time, the implementation of the measures is verified on the basis of self-imposed performance indicators and bio-monitoring of the target species.

Figure 14: Biodiversity promotion measures on wind farms can support biodiversity over the long term without endangering species put at risk by wind power (source: Olaf Diestelhorst)

Measures are adapted if the target species are not present or their population targets are not met. When the target species parameters are met, one can assume that the biodiversity is above average for the landscape.

The implementation process for the RWE biodiversity strategy is managed by the Recultivation Research Center. Implementation and monitoring are carried out in close interdisciplinary cooperation with the RWE operations and specialist departments as well as universities, specialist offices, biology stations, conservationists and specialist authorities.

The projects under the RWE biodiversity strategy impressively demonstrate the lasting promotion of biodiversity in the Rhenish mining area in conjunction with the voluntary implementation of measures. Species that are rare and at risk of extinction are strengthened and their populations are expanded. The habitat design necessary to accomplish this simultaneously makes the landscape more attractive. Therefore, promoting biodiversity is always a win-win and supports a successful structural transformation.

After the opencast mines are flooded and the mining infrastructure has long been removed, recultivation is what will remain in the Rhenish mining area for centuries. The crucial basis for effective recultivation in the Rhenish mining area is being established today. It is therefore of critical importance to take nature conservation concerns into account in the process during the remaining years of recultivation in order to create a livable, species-rich landscape that can be used over the long term.

References/literature

[1] Deutscher Jagdschutz-Verband (ed.) (2003): Wildtier Informationssystem der Länder Deutschlands (WILD) Projekthandbuch. – 1st edition, Bonn.

[2] EßER, G., JANZ, S. & WALTHER, H. (2017): Förderung der Biodiversität in der Rekultivierung des Rheinischen Braunkohlereviers. – World of Mining – Surface and Underground **69**, 6: 327-334.

[3] Recultivation Research Center (2021): RWE Biodiversitätsstrategie für das Rheinische Braunkohlerevier (BioDiS) – Jahresbericht 2020. – Ed.: RWE Power AG.

[4] Recultivation Research Center (2022): RWE Biodiversitätsstrategie für das Rheinische Braunkohlerevier (BioDiS) – Jahresbericht 2021. – Ed.: RWE Power AG.

[5] GEDEON, K. et al. (2014): Atlas Deutscher Brutvogelarten. – Stiftung Vogelmonitoring Deutschland and Dachverband Deutscher Avifaunisten, Münster.

[6] GRÜNEBERG, c. et al. (2013): Die Brutvögel Nordrhein-Westfalens. – NWo & LANUV (ed.), LWL-Museum für Naturkunde, Münster.

[7] GRÜNEBERG, c. et al. (2017): Rote Liste der Brutvogelarten Nordrhein-Westfalens, 6th edition, as of: June 2016. – Charadrius 52: 1-66.

[8] IPBES (2019). Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. - IPBES secretariat, Bonn, Germany. https://doi.org/10.5281/ zenodo.3553579

[9] IUCN (International Union for the Conservation of Nature, ed.) (2015): Risiken und Chancen des Biodiversitäts-managements und der damit verbundenen Einbeziehung der Stakeholder in dem von RWE betriebenen Braunkohlentagebau Hambach. – ed. IMBODEN, c. & MOCZEK, N., IUCN (Gland, Switzerland).

[10] Positivtrend beim Feldhasen hält an. (2022, 8 April): Accessed on 16 June 2023, from https://www.natuerlich-jagd. de/im-original/positivtrend-beim-feldhasen-haelt-an/.

[11] JEDICKE, E. (2016): Zielartenkonzepte als Instrument für den strategischen Schutz und das Monitoring der Bio-diversität in Großschutzgebieten. – Raumforschung und Raumordnung, **74**, 6: 509-524. https://doi.org/10.1007/ s13147-016-0448-x

[12] MÜHLENBERG (1989): Freilandökologie. – 2nd newly revised edition. Heidelberg, Wiesbaden.

[13] MÜHLENBERG, M, & HOVESTADT, T. (1992): Das Zielartenkonzept. – Norddeutsche Naturschutzakademie (NNA) reports, **5**, 1: 36-41.

[14] RWE AG (2022): Zukunft im Blick – Nachhaltigkeitsbericht 2021.

[15] https://www.rwe.com/-/media/RWE/documents/09-verantwortung-nachhaltigkeit/cr-berichte/bericht-2021.pdf

[16] RWE AG (2022b): Biodiversity Policy.

[17] RWE Power AG (2018): RWE biodiversity strategy for the Rhenish lignite mining area. – https://www. forschungsstellerekultivierung.de/downloads/biodiver-sitaetsstrate-gie_20190529_endfassung.pdf