Research Semester Report

Establishment and Conservation of Connecting Landscape Elements for a Functional Biotope Network

Implementing Methods of Regenerative Agriculture: Cultivation of Agroforestry and Ecosystem Revitalization

As part of a case study in Alt Madlitz in Brandenburg, Germany

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Abstract

A decrease of biodiversity can be witnessed in European agricultural landscapes. It is caused by homogenization and fragmentation. This report documents landscape transformation by restoration and application of regenerative forms of land use. It investigates the potential of syntropic agroforestry systems to function as a biotope corridor. Revitalizing methods for periglacial small water bodies (Ger. „Feldsölle“) are described. The focus lays on the conceptual framework for a case study in Brandenburg, performed by the Finck trust at the agricultural business Gut & Bösel. Practical implementation and field work, planting lists and a photo documentary are displayed. The report is the result of a 12-week research period that is part of the master program for Biosphere Reserves Management at the University for Sustainable Development in Eberswalde, Germany.

Introduction

Agricultural landscapes in Germany and the whole of Europe are experiencing a decrease of biodiversity. One of the reasons for this development is the *homogenization* of cultivated landscapes. Nutrient supplies are consistently high through steady application of fertilizers and pesticides. This causes a spatial and temporal loss of habitat structures (Dauber et al., 2018). Another reason for the decline of biodiversity is the loss of large and connected ecosystems. Transformation of areas that were initially forested to open cropland leaves species which are depended on those habitats with less space for living. Particularly in agricultural landscapes often relicts of previously large ecosystems can still be found. These areas are small and isolated from each other. Therefor this process is referred to as *fragmentation*. Today in the cultivated landscapes of central Europe most of the terrestrial and aquatic habitats are fragmented. This process leads to complex and drastic consequences for the local flora and fauna. Particularly for stenopotent species, the spatial decrease of habitats will lead to a reduction of population size and eventually cause a loss of genetic variability. Single habitat fragments offer limited territories and therefor ranging opportunities are lacking for area-sensitive species (Aßmann et al., 2016).
Several different conservation strategies are currently applied to cope with the challenges described above. One of them is *ecosystem restoration,* which is the act of restoring degraded landscapes or landscapes elements back to their natural state. The active reduction of anthropogenic influences on a specific ecosystem will allow it to rebalance its natural functions (Renaturierung - Lexikon Der Geowissenschaften, 2022). *Ecosystem revitalization* is a sub-form of ecosystem restoration that focuses on the reestablishment of natural dynamic processes within a specific habitat to support the local flora and fauna (Revitalisierung - Lexikon Der Geowissenschaften, 2022). Simultaneously *regenerative agriculture* offers an alternative to conventual forms of agriculture, which has the aim to rebuild soil and help agricultural ecosystems to produce a maximum of photosynthesis without invasive tillage and application of fertilizers (Definition - Regenerative Landwirtschaft, 2023). *Agroforestry systems* are a form of regenerative land use in which the cultivation of woody, perennial shrubs, and trees with field crops and/or animal stock are combined within the same agricultural unit (Ehritt, 2020). They generate scenic improvement, decrease eolian and fluvial erosion, modify the microclimate, and increase yields. In addition, they significantly structure and diversify the landscape providing a network of closed meshed linear elements switching between fields and woodland. Hence, they contribute greatly to the biotope network (Plieninger et al., 2009). The integrated cultivation of timber in agriculture shows positive effects for landscapes with little structural heterogeneity. Short-turn-over plantations and agroforestry systems can function as additional structural landscape features and therefor provide habitat to plants and animals within cultivated landscapes. However, the effectiveness on the local biodiversity yet still depends on the surroundings of the respective areas (Dauber et al., 2018).

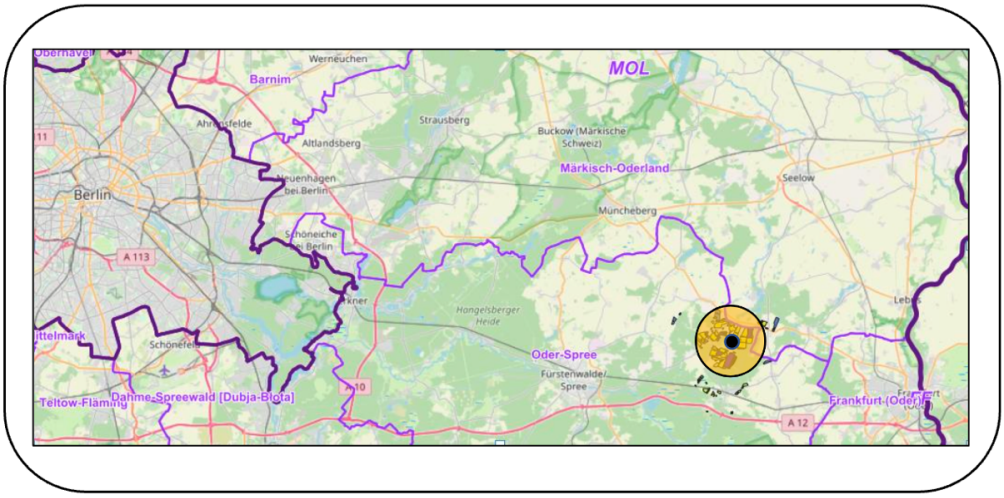
This paper documents the establishment of an agroforestry system and the revitalization of periglacial hollows, which are turned back into small water bodies at the farm Gut & Bösel in Alt Madlitz in eastern Brandenburg, Germany. It investigates the process of (re)establishing and conserving connecting landscape elements for a functional biotope network.
The paper aims to display the process of implementing practical conservation measures at a project site with a strong focus on the conceptual framework and instruments for environmental fieldwork. It is the result of a 12-week research period which is part of the Master Program “Biosphere Reserves Management” at the University for Sustainable Development in Eberswalde, Germany. Biosphere Reserves are defined as areas that are to be protected and developed uniformly under the German Law

of Conservation. They are regions that own unique characteristics for certain landscapes, which meet with the requirements for nature and landscape conservation. They serve as areas for preservation, development or restoration of landscapes that have been shaped by traditional forms of land use and therefor historically grew a diverse composition of species and biotopes. Furthermore, they function as examples for sustainable development and test ground for economic land use that is saving natural resources and environmentally friendly[1] (Bundesamt für Naturschutz, 2022).
This paper focuses on an environmental perspective; thus, it does not cover any form of economic or financial analysis for ecosystem restoration or agroforestry. The research period was limited to 12 weeks and therefor did not allow enough time to investigate into those topics. Funding opportunities and partnerships that bring research and conservation together, are plentiful in Germany and therefor create a big field which could not be covered in this paper. The project site is not located within a Biosphere Reserve, yet the research program investigated sustainable land use forms and integrated conservation. Both topics are relevant for Biosphere Reserve research and development.
Because of time limitation not all phases of the project could be participated in. The project preparation took part before the start of the research period. Transformation of land use forms is a graduate process, which in many cases shows its (positive) results only years after the initial changes were applied. This paper allows a selective view on the research topic but does not replace any long-term data collection and analysis in this field.

The place of research

The research project took place at Gut & Bösel, which is a family-run farm with an area of 3000 ha in eastern Germany. The farm is situated in Alt Madlitz, a small town between Berlin and the polish border. Since 2002 the Bösel family and their employees are working with arable farming, holistic grazing management, forestry, and agroforestry. Additionally, the Finck foundation was founded, to study the economical, ecological, and social effects of regenerative land use systems. The foundation has partnerships with several universities and research institutions (Boesel, 2022). Figure one shows the location of Alt Madlitz.

Figure 1: Location of Gut & Bösel

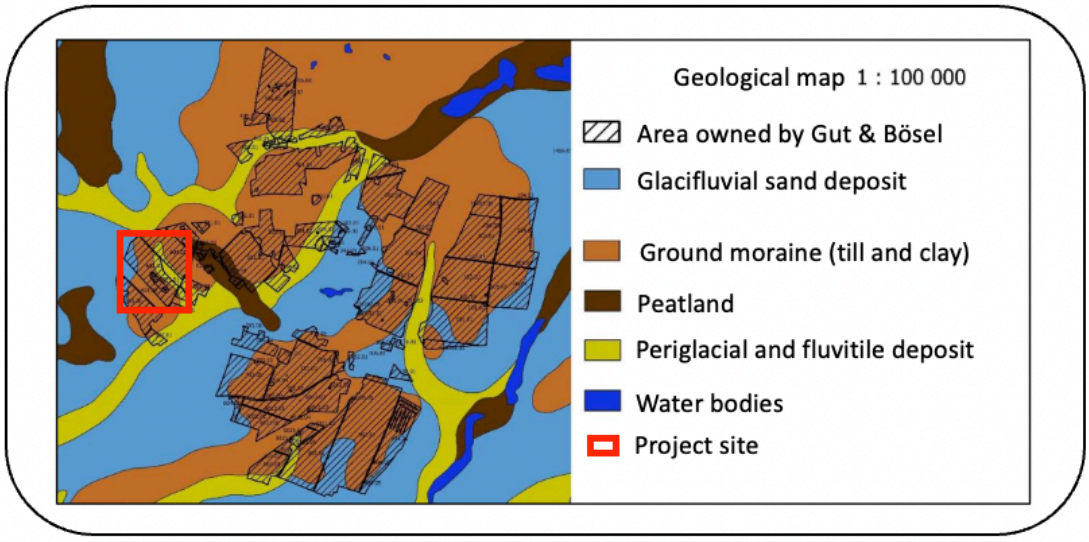


Created by J. Hanisch, 2020

[1] Translated with deepL (Kutylowski, 2022)

Alt Madlitz is located at the “Lebuser Platte” which is the transition zone between the eastern Brandenburg plain region and the heath-lakes region, which are both part of the northern German young morainic landscape. The “Lebuser Platte” is a young, lightly curved moraine that is covered by glaciofluvial sand deposits. From north to south gullies formed in the Brandenburg stage of the Weichsel ice age. Therefore, the main soil types are “loamy sand” and “very sandy clay”. More typical landscape features are hollows (German: singular “Feldsoll”, plural “Feldsölle”[2]) and small depressions that were formed by periglacial processes and that form a network of small water bodies today. (Hanisch and Hofstätter, 2020). The hollows are a typical landscape feature of the landscape in Brandenburg. They are small, round basins in the ground that formed in places where leftovers of the glacial masses melted. Because of accumulating nutrients through intensive agriculture and changes in the climate, with less precipitation, many of these hollows are drying up. (Rosenbach & Thiele, 2022). The German Law of Conservation defines a “Feldsoll” with a minimum size of 25 m2 as a protected aquatic biotope for endangered species and as a step-stone biotope that animals use to move in between larger ecosystems. In particular for amphibia these small water bodies are important places to spawn and hibernate. They are home to frogs, toads, newts, and salamanders. Especially in areas with evidence of *Bombina bombina* (red-bellied toad) and *Triturus cristatus* (Crested newt), which are protected by FFH[3] guidelines. Therefor the hollows are an important part of a functional biotope network (Cwielag, 2022). The following figure two shows the geological map of the area cultivated by Gut & Bösel. The project site is marked with a red square.

Figure 2: Geological map of Alt Madlitz with marked project site



Created by J. Hanisch, 2020; modified and translated with deepL (Kutylowski, 2022)

The project site has a total size of 53.79 ha. Most of the area has been cultivated for crop production in the past. There are four periglacial hollows on the site, of which two are in the north-east, two in the south-east. In the central western part, there is a patch of alder trees growing, which is connected to a hedge that crosses over to the western part of the area. The eastern edge borders a country road underneath which tunnels for amphibia have been installed. Figure three shows an arial image of the project site from 2021.

[2] Translated with deepL (Kutylowski, 2022)
[3] FFH = Flora-Fauna-Habitat, a spart of the SARC (Special areas of Conservation) within the European Union.

Figure 3: Aerial imagine of the project site

Regional management plans

The county of Oder-Spree is the responsible authority for nature conservation in the region around Alt Madlitz. On their website they state: "To conserve the populations [of endangered species], there must be areas, in which, out of respect for the nature, human activities are reduced. Within the region of Oder-Spree, compared to other regions in Germany, there are many refuges for endangered plants and animals. To conserve them is one of the main tasks of the Oder-Spree authorities"[4] (Lindemann, 2022). The website further offers insight to the landscape management plans which assess the current state of the landscape and the regions. The plans also function as the base for further regional development and suggests conservation measures. Five different maps have been reviewed for the purpose of the project that is discussed in this document. The following paragraph summarizes the most important key factors regarding the project site.

(K1) Map of Biotopes shows, that the area of the project site mainly consists of agricultural land. In the north-east of the area there is a deciduous tree biotope in polygon shape, on the eastern edge there are two deciduous point biotopes and a deciduous alley. In the center of the project site there are two protected small water bodies that are periglacial hollows. The northern, eastern, and southern edges of

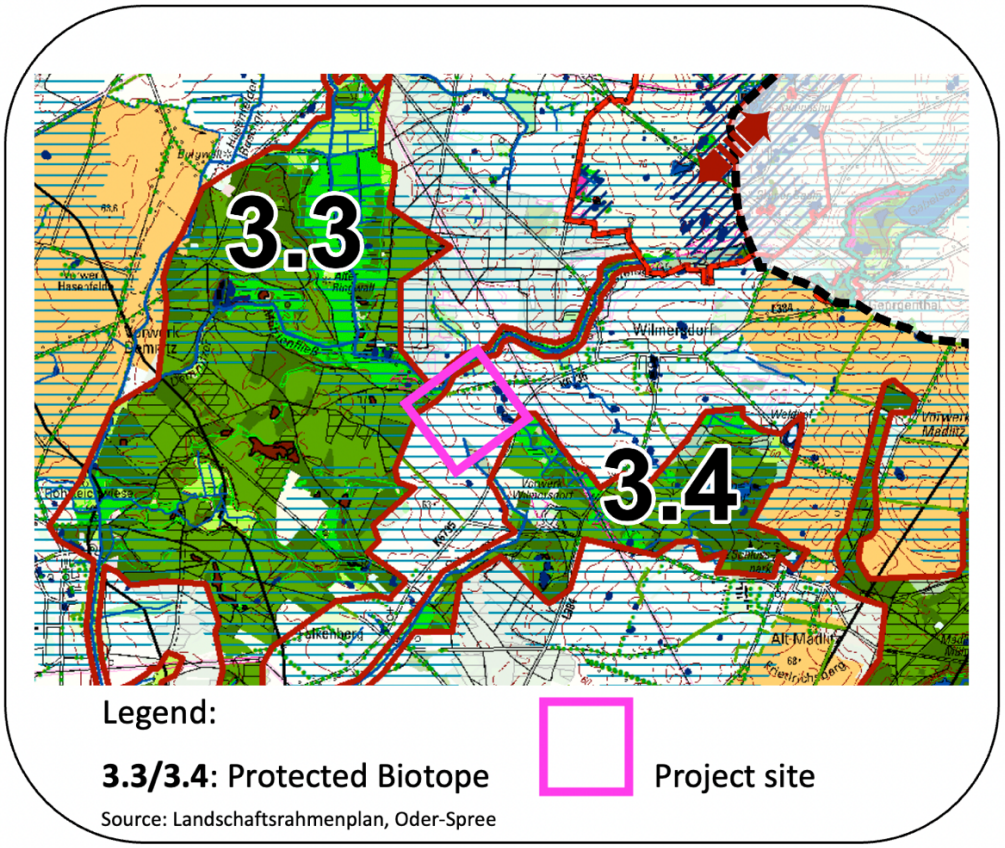
[4] Translated with deepL (Kutylowski, 2022)

the area touch with agricultural land, the western edge touches forested biotopes, grassland and protected wet grasslands.

(K2) Map of plants and animals shows population of amphibia in the center of the site, congruent with the small water body biotopes: *Bufo viridis* (European green toad) and *Rana lesonae* (pool frog). Areas close by show population of *Rana arvalis* (moor frog) (south-east), *Lissotriton vulgaris* (smooth newt) (south). Additionally resting areas on marshland, that are visited by *Grus grus* (common crane) are marked in the west of the project site (grassland and protected grassland biotopes), together with *Bombina bombina* (fire-bellied toad) and *Bufo bufo* (common toad). *Bufo viridis, Rana arvalis, Bombina bombina* and *Grus grus* are marked as species that have high relevance for the conservation management.

(E3b) Map of Biotope Network shows that the project site is situated between two existing biotopes (no. 3.3 and no. 3.4, east and west) which are marked as fragments of the regional protected biotope network. Both areas are mapped out with a mixture of core zones of fenland and small-scale peatland, core zones of natural managed forest and connecting areas for natural managed forest. Additionally, there are core zones for small scale water bodies and subregionally important water streams located in both areas. Both biotopes, as well as the project site are marked as connecting biotope network areas for small-scale water bodies. The sole and direct connecting point for biotope no. 3.3 and biotope no. 3.4 is a small water stream, where the southern tips of the marked areas are meeting.
The project site itself is mapped out with two core zone habitat areas for small scale water bodies in the center ("Feldsölle"), the extension of a water stream (north) that is connected to area no. 3.4, a deciduous tree biotope (north) and a hedge (south).

Figure 4: Map of Biotope Network



(E4) Map of requirements and use of the landscape shows that the project site falls under the increased requirements for land use according to water conservation. The western half of the site is marked as agricultural land with high risk for erosion, in the center of the site the two hollows are marked as small-scale water bodies that are to be conserved and developed as core zone areas within the biotope network and habitats for endangered amphibia. Conservation measure for protection of amphibia have high priority on the project site, as well as the surrounding area, particularly in months of animal migration. Additionally, extensification and more structural elements in the landscape shall be introduced.

(E1) Map of concept for development shows the different thematic concepts for landuse development. The project site is marked as an area that is to be developed into a structured agricultural landscape with emphasis on species populations and landscape elements. The two marked hollows are to be conserved as valuable small-scale water bodies. Additionally, there is a focus on the water management in the northwestern part of the project site, where nutrient accumulation is to be reduced and the biotope structure of the marked water streams is to be improved.

(Landkreis Oder-Spree, 2022)

Conservation report

In 2020 a detailed conservation report was created for all land that is cultivated by Gut & Bösel. The plan contains instructions for different zones that focus on the protection and conservation of specific habitats and species. The project site lays within a conservation focus zone with small water bodies. The target species are *Bombina bombina* (red-bellied toad), *Hyla arborea* (European tree frog), as well as local avifauna. Insects are mentioned as a general target group (Hanisch and Hofstätter, 2020). The report was examined regarding the project site, additionally the responsible ecologist Mr. Hanisch agreed to a consultation for the project. Further information can be found in the chapter for methodology and in the discussion of this report.

Theoretical background

The following chapter is structured in a way that allows a short but comprehensive understanding of the key elements for this project. First, the syntropic approach for agroforestry is introduced, followed by an overview about conservation ecology and schematic understanding of landscapes. Lastly the conservation potential of agroforestry systems for target species conservation is elaborated.

The syntropic approach for agroforestry systems

The syntropic approach roots in the practice and teachings of Swiss farmer and researcher Ernst Götsch. Rather than a technique he proposes an innovative way of reading and understanding ecosystems holistically and working with them successionally, particularly in form of agroforestry. “Natural processes are translated into farming interventions in their form, function, and dynamics. Thus, we can talk about regeneration by use, since the establishment of highly productive agricultural areas, which tend to be independent of inputs and irrigation, results in the provision of ecosystem services, with special emphasis on soil formation, regulation of microclimate and the favoring of water cycles. That way, agriculture is synced with the regeneration of ecosystems” (Andrade, 2019).

In order to successfully manage syntropic farming systems Götsch has proposed a set of fundamental principles that must occur simultaneously. Sakamoto and dos Santos Rebello have published a book about the principles of syntropy related to agricultural practice. The following list briefly summarizes their eight principles:

(1) Maximizing photosynthesis: Planting in high diversity, density and strata allows the system to become darker and cooler and produce high amounts of starch (and other carbohydrates) which function as energy resource for plants, animals, and microbes. Feeding carbonic, organic material back to soil organisms will enhance soil fertility, which then the vegetation benefits from. Ultimately a cycle, in which a maximum of young biomass is constantly produced, is established.

(2) Imitating natural succession by stratification: Planting in strata imitates the natural layers of a mature forest ecosystem in which plants and trees are able to reach their adult stages so their canopy allows a specific percentage of shade on the corresponding floor leaving adequate amounts of sunlight for all layers to grow.

(3) Covered soil and tense tillage: Choosing demanding crops according to the nutrient levels of the soil, covering soil with mulching material such as fragmented wood chips and pruning leftovers to ensure soil fertility, avoid evaporation and eolian or fluvial erosion.

(4) Selective weeding and pruning: Removing plants from previous succession state (e.g., early stage = grasses, vegetables) to accelerating the system's progress and soil improvements. Supporting the development into an efficient, biomass-producing and nitrogen-fixing succession state (e.g., following stage = pioneer trees, shrubs). Thinning and pruning for a rejuvenation of the system and creating mulching material (s. point 3)

(5) Concentrate energy, generate biomass efficiently: Accumulating recourses by planting in lines or islands, which serve as places of energetic accumulation, adding natural fertilizers, (e.g., dung, rock dust) if needed. Choosing adequate vegetation to grow in between the lines (e.g., *Poaceae* (grasses)) which can be used for mulching and help reducing weeds. Orientating the lines from north to south, according to the relief, topography, and exposure to sunlight

(6) Ecophysiology and environmental, physiological functions of plants: choosing appropriate plant compositions according to adaptation abilities to the environmental conditions (e.g., resilience, tolerance, length of life cycle), cultivating plants as "tools" to use their functionalities, including plants that are non-native to the relevant area

(7) Synchronize plantings, pruning of the edges: Including (crop) structures that are already existing in the relevant area by designating their specific strata and developing the syntropic system accordingly. If necessary, pruning must be applied to surrounding forest edges which will allow enough direct sunlight on the planting system

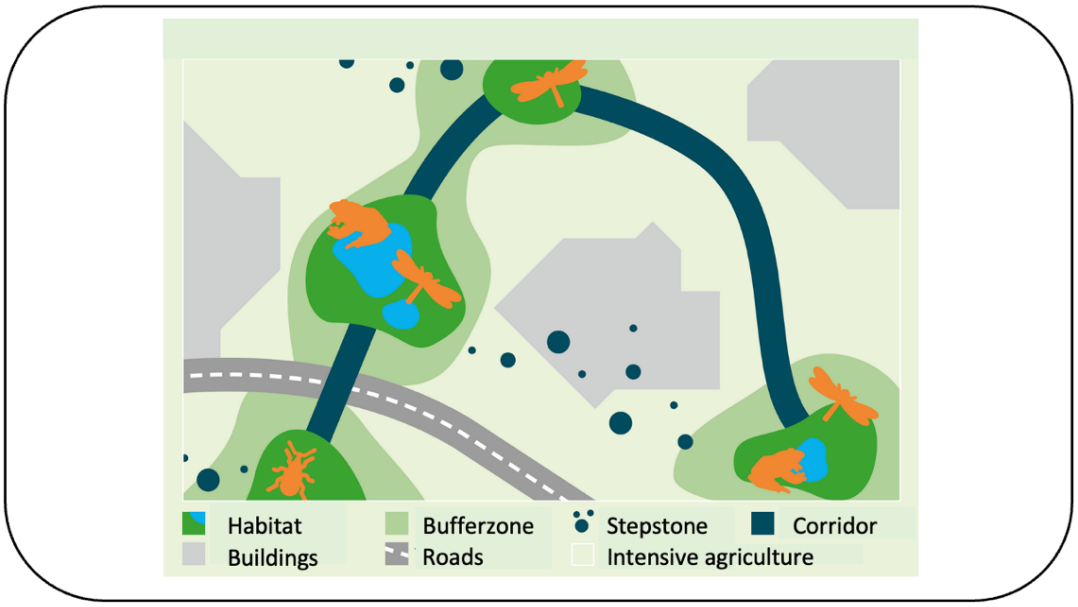
(8) All beings are doing well: Developing a holistic understanding of natural ecosystems, acting with awareness towards all living organism within the system and contributing to its health by optimization of the natural processes, satisfying the needs of all living beings, seeing humans as part of the ecosystem

(Ghiringhello Sakamoto and Ferndando dos Santos Rebello, 2021)

Conservation ecology and schematic understanding of landscape

To describe a landscape schematically in conservation ecology, four terms are used: The *landscape matrix*, *habitats*, *corridors* and *stepstone habitats*. The landscape matrix describes the overall area and has no designated habitat function itself. Habitats and stepstone habitats are living environments for the local flora and fauna, although stepstone habitats are not large enough in size to ensure survival of species permanently and rather serve to enable ranging activities. Corridors are connecting elements between habitats that are man-made for conservation purpose and which enable mobility for the entire species community of a region. The design of corridors in German landscapes has to be adjusted according to the density of settlements and infrastructure and therefore can only be realized up to a certain size, compared to other countries. However, landscape elements that are to serve as corridors yet must provide the following functions: facilitation of movement amongst habitats through suitable vegetation and form, as well as connecting points to two or more larger habitats (Drobnik et al., 2013). The following figure shows the schematic visualization of a landscape provided on the website of the German communal project "Biotopverbund" which is supporting the reestablishment of a functional biotope network in three model regions (Rügen, Benthheim and Freising) (Heinz Sielmann Stiftung, 2022).

Figure 5: Schematic visualization of a landscape



Modified version of Biotopverbund.de, 2022

High numbers in populations size are found in landscapes that are showing a variety of different habitats. A structural diversity within the landscape is necessary to support the segeltal flora, insects, amphibia and bird species. Agroforestry systems are a form of landuse that can help to diversify the landscape. Traditional forms of combined cultivation in Germany were hedges and extensive fruit orchards, agroforestry reintroduces the multifunctional approach. The structural diversity of a landscape can be identified through several indices. Common examples are the size of consistent biotopes, their amount per acre, their form and length of wild edges that serve as habitats or their distance and connecting area size. To counteract the isolation of habitats and subsequently local populations new concepts to build connecting corridors are needed. Particularly in the state of Brandenburg which shows large scale cultivation units and lacking wild edges, reestablishment and conservation of structural landscape elements are an opportunity to revalue and structure the landscape. Well-structured

agroforestry systems are most relevant for conservation purposes. They are established with various tree species, shrubs, and wildflower strips. Different crop rotations within planting rows and within the system lead to staggered harvesting times. On the downside these kinds of systems ask for a lot of flexibility and require high maintenance (Ehritt, 2020).

Potential of agroforestry systems for target species conservation strategies

A. Kaeser developed a checklist that determines the potential of agroforestry systems for *Carabidae* (ground beetles) and avifauna in agricultural landscapes of Mittelland, Switzerland. Her approach shows how the occurrence and number of target species function as bioindicators that allow conclusions about the influence of form, intensity of cultivation and success of conservation management in agroforestry systems. Kaeser names three factors that have a major influence on the potential success of conservation: (1) the site and its current state (cultivation form, local climate, land use and connectivity of the surrounding landscape, structural diversity of the landscape, size of the area, species composition, status of protection), (2) Design of the agroforestry system (tree species, structure of the system, tree density) and (3) Cultivation form of the agroforestry system (agricultural cultivation, tree stripes, intensity, protection or other maintenance). Each factor is examined in detail and put in comparison with the requirements of the target species to their habitats (Kaeser, 2009). Kaesers determination key works with attributes that are specific to the region of Mittelland in Switzerland, yet the overall concept of combining a conservation approach for target species and an ecological analysis of agroforestry systems seems to be promising strategy in order to gain new findings about their correlation.
The object of investigation for the research project is a target species conservation strategy for different species of amphibia and how it can be integrated into planning and implementation of a syntropic agroforestry system. Major reasons for the endangerment of amphibia are the fragmentation of the landscape by roads and increasing density of traffic, as well as intensive agriculture. Many species have wide migration ranges and move long distances throughout the year. Therefore, requirements for amphibia conservation are extensively cultivated areas, that are accessible through amphibia tunnels or biotope corridors and well structures landscapes with hedges and well-developed transition zones, additional to small waterbody networks and natural habitat space (meadows or natural forests). The first target species *Bombina bombina* (red-bellied toad) lives on meadows, grasslands, cropland, sun exposed forest edges, alder swamps, floodplain forests and reed beds. For spawning they use sun exposed ponds that are surrounded by aquatic and swampland vegetation. One example are periglacial hollows, that are filled with water. The adult animals are active between March an October and go into hibernation during the winter months. *Bombina bombina* is listed as extremely endangered species on the red list of amphibia in Germany. Protection strategies focuse on restoration and conservation of their habitats, especially naturally occurring water in the landscape, as well as natural deciduous and mixed forests. To support existing populations a functioning network of water bodies should be reintroduced. The second target species *Hyla arborea* (European tree frog) can be found in floodplain forests, fresh or wet meadows and pastures, hedges, and edges of natural forests. They need a network of well-structured water bodies with different sizes, for example, temporary shallow ponds, deep ponds, dead river arms and lakes shores with reed vegetation. The mating season is between April and October, afterwards animals migrate to their summer habitats. *Hyla arborea* prefers to live on perennial plants, shrubs and on trees (they climb up to 25 m height). They feed on insects, spiders, and small snails. This species is listed as endangered in Germany because their natural habitats are lost, due to intensive agriculture and the drainage of agricultural landscapes. (Glandt and Ley, 2018).

Methodology

The aim of the research project was to give an overview on the conceptual framework of practical implementation for conservation measures that work with ecosystem restoration methods and syntropic agroforestry. The project took place between 24-10-22 and 20-01-23. In preparation for this period a project program was designed in cooperation with the project supervisors Mr. Küsters and Prof. Aschenbrand. During the project regular meetings for a research colloquium with the student of the master class of the University for Sustainable Development took place. Thus, the development of the project was discussed and modified within a peer group.
During the stay on site the practical implementation of the project was carried out and participation in the field work took place. Observation on the working process with new findings were documented in field notes, which were then analyzed and used to report on the conceptual framework which is presented in the result section of this paper. In science, predominantly in ethnographic anthropology, fieldnotes have served as a tool to enrich data collection and provide substantial information for analysis since the beginning of the 20th century. Today, they are understood as an essential component for austere qualitative research. They are used to provide dense descriptions of the object of research and any other relevant context. They can provide facts regarding the close observation of the research environment and its interactions, social environment, relevant interviews, and valuable documents. They also help researchers to reflect up on the study object (Phillippi and Lauderdale, 2017). The fieldnotes were organized in a table which shows the working weeks, the activities and notes and key findings about the project progress. Find the fieldnotes attached to this document. For the planting and seeding systems a list and a graph were created which are presented in the chapter for results.
A photo documentary was carried out to mark the before- and after-state of the project site. The photos were put in order, marked with their gps location, time, weather conditions and annotated with comments about significant changes of the landscape. Find the photo series attached to this document.
To capture the complexity of the project the program was carried out in close contact to the project supervisors Ms. Rosanna Gahler, Ms. Mara Ursprung and Mr. Renke de Vris of the agroforestry department, as well as Mr. Max Küsters, head of the department of data and science and Mr. Max Hanschmann, trainee for conservation at Gut & Bösel. To gain information regarding the evaluation and further development of the applied measures consultations with Mr. Hermann Wiesing, environmental engineer, Mr. Jan Hanisch, consultant for conservation and agriculture and Mr. Claudius Schneider, department for funding management at Stiftung Naturschutzfonds were recorded in protocol. Find the consultant protocols attached to this document.

Finally, literature research was performed to establish fundamental understandings of the theoretical background regarding the project. The applied methodical approach was designed to follow the model of a systematic literature research, yet modification considering the scope of the research project were put into place. “[Systematic literature research] are a way of synthesizing scientific evidence to answer a particular research question in a way, that is transparent and reproducible” (Laume, 2019). Like other research, steps that are involved, when conducting a systematic literature review should cover the identification of a research problem, data collection and analysis, as well as interpretation of results. A review question needs to be formulated, in- and respectively exclusion criteria should be put in place and a protocol, covering the aforementioned two points. Studies are to be located and selected strategically by using electronic databases, checking the reference lists, handsearching relevant journals and through personal communication with experts. Further on, data is collected and checked for its quality, e.g., by consideration of assessment by more than one person. Lastly a data analysis is

conducted followed by the presentation of the results (Egger et al., 2022). The systematic literature research protocol has been attached this document.

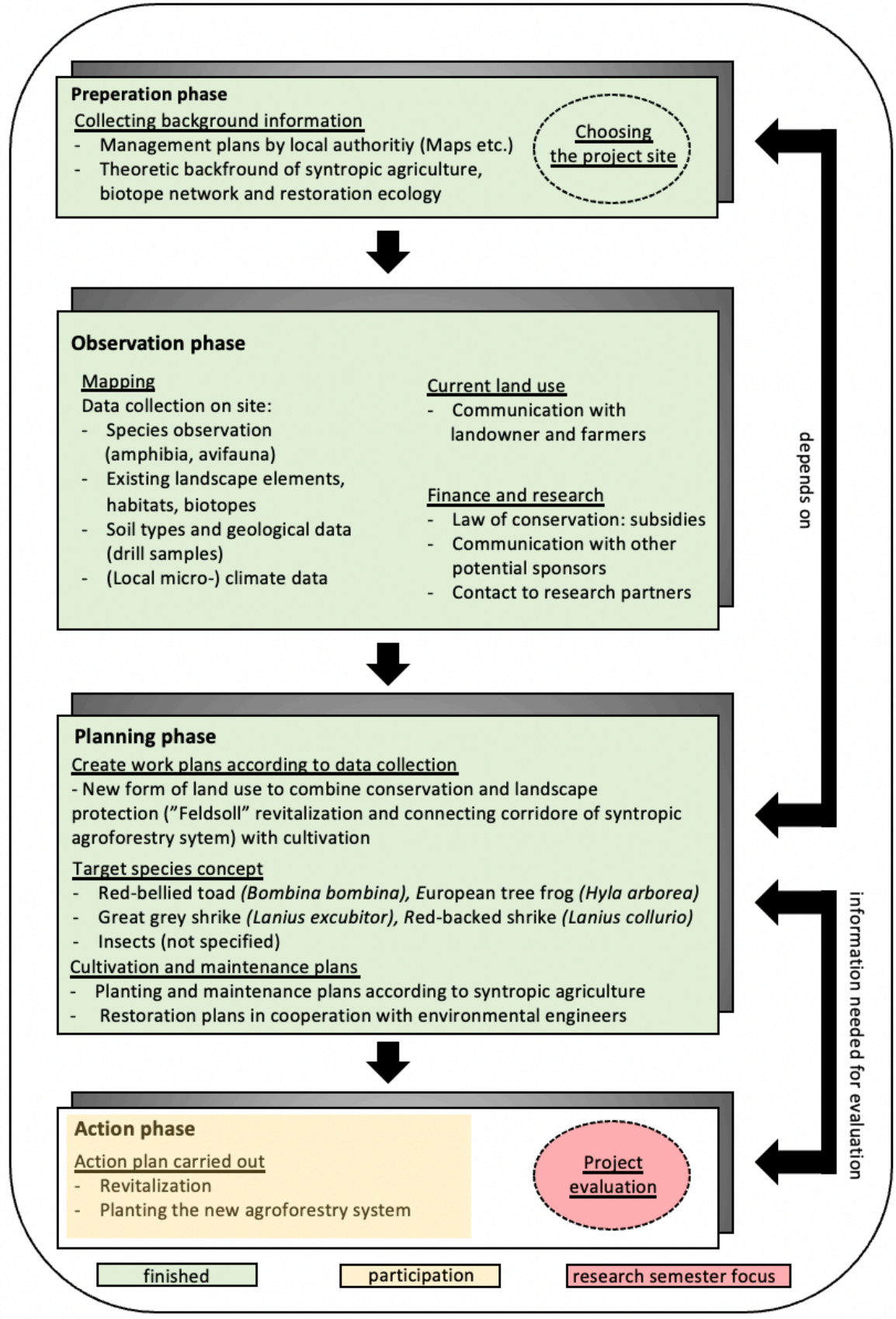
Results

The following chapter shows the results of the research project. Results are presented in form of figures. A short explanation has been added to each figure.

Project plan for the Finck Stiftung GmbH as part of Gut & Bösel (Figure A)

Figure A displays the complete project plan, which was carried out at Gut & Bösel, in order to introduce an agroforestry system which functions as a biotope network corridor. A similar project that was planned by Köß was taken as a model to create a comprehendible and structured map for the project (Köß, 1994). The plan is divided into four phases, which follow each other in time (symbolized by short arrows pointing downwards). Long arrows on the right side of the figure explain the interconnectedness of the different phases. For example, the preparation phase and the planning phase are depended on each other. By the time the research period took place the first three phases were already finished, which is the reason there are marked with green colour. During the research participation in the action phase took place, marked in yellow. Research focus was put on the evaluation and development of the project, marked in red.

Figure 6: Project plan

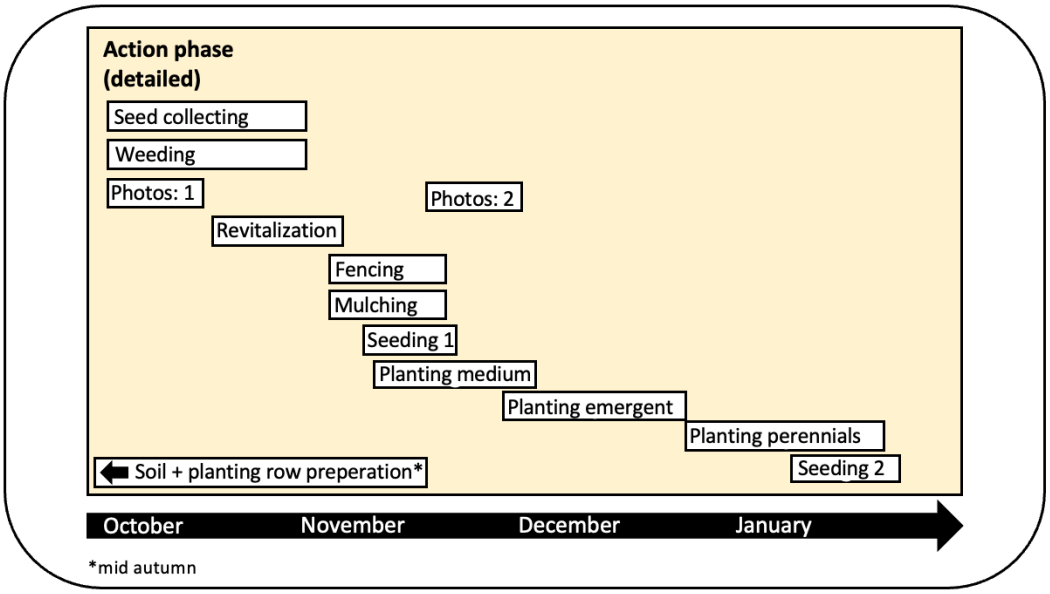


Modified version of Köß, 1994

Action phase in detail (Figure B)

Figure B displays the action phase in detail. The figure gives an overview on all major tasks that were carried out during this phase. Additionally, the timeline on the bottom of the figure unveils the order in which field work tasks were implemented during the research semester. Prior to the start of the research semester the first step of soil and planting row preparation were already carried out, which is why they are noted down at the bottom left of the figure with an arrow pointing towards months that had already past and the point of time when the participation and observation started.

Figure 7: Action phase in detail

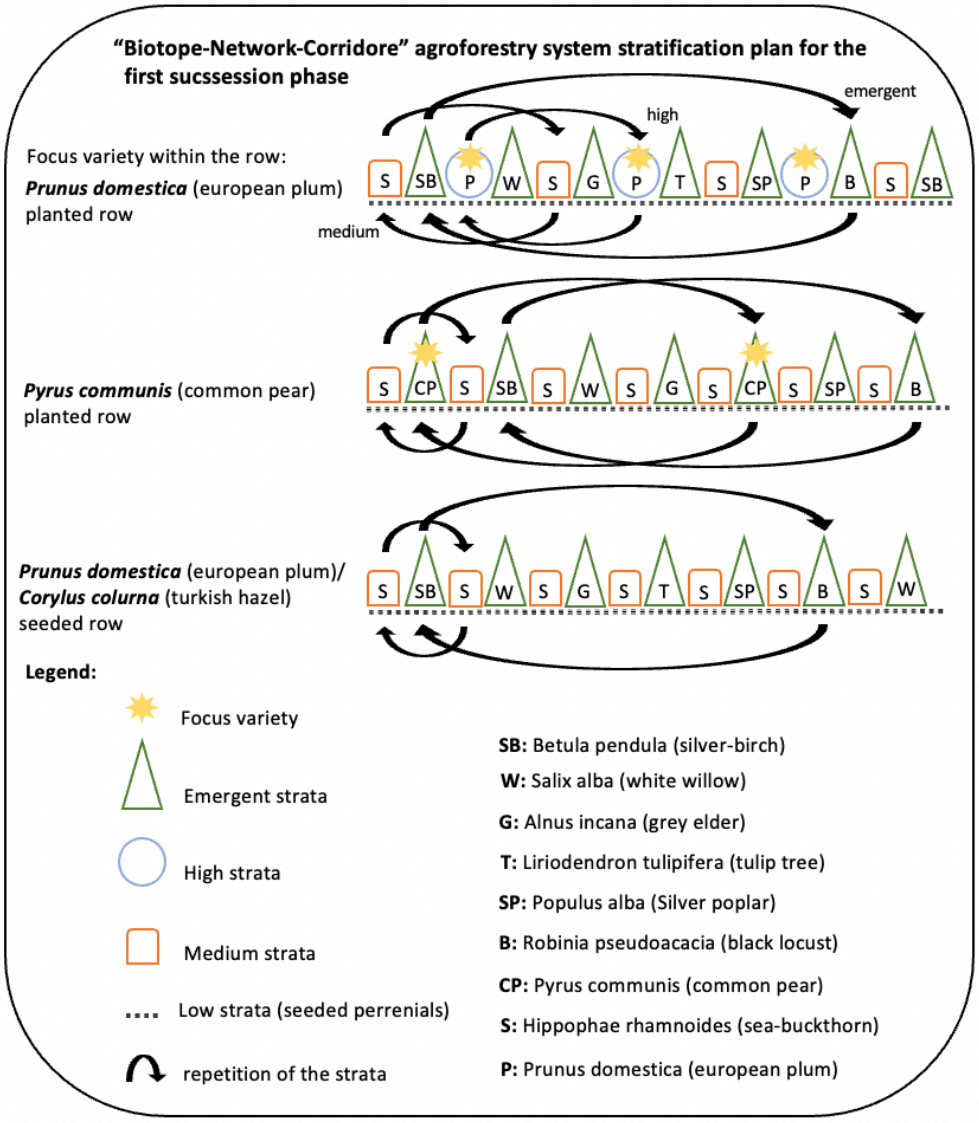


Created by I. M. Engelhardt

Stratification plan (Figure C)

The stratification plan is shown in Figure C. It displays the detailed plan for the first succession phase of the agroforestry system. It is an important tool, which helps to understand the complexity of the system and gives information about the order in which different tree species, shrubs and perennial plants or going to grow. The system contains three different focus varieties within the planting rows. They are shown in the upper part of the figure. The legend on the bottom explains the different symbols which were used to present the focus variety, strata, and the repetition of a specific order of species. The plan also contains a list of emergent tree species, which were planted in the system. Some of the emergent trees are representatives for a mix of subspecies. For the sake of keeping an overview not all subspecies were listed in this figure. A complete planting list, which contains those subspecies, as well as all perennials, can be found attached to this document.

Figure 8: Stratification plan

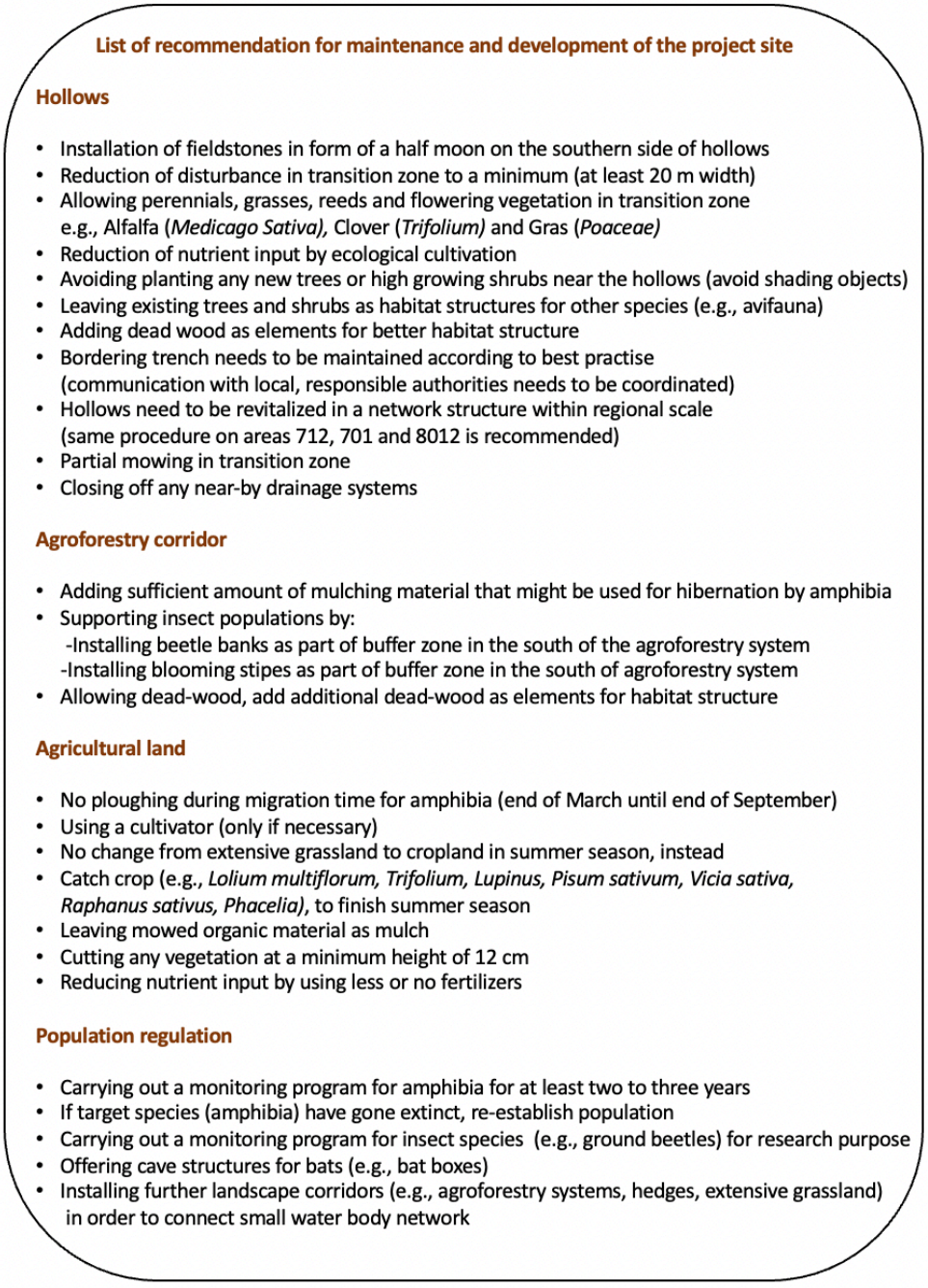


Created by R. De Vries, digital version I. M. Engelhardt, 2022

Project maintenance and development (Figure D)

The last figure is a list of recommendations for the maintenance and development of the project. This list is a summary of conclusions that could be made by evaluating the field notes and synthesizing them with findings from the consultations with different experts. The protocols for the consultations can be found attached to this document. The list has been divided into four different focus subjects for the project: The revitalization of the hollows, the agroforestry system biotope corridor, the surrounding agricultural land, and population regulation. In this way all recommendations can be carried out independently from each other and from financial and material resources. There is no hierarchy or order within the list, following the same purpose. The list was created as a document for employees of Gut & Bösel and contains only bullet points to make it comprehensible and easy to work with.

Figure 9: List of recommendations



List of recommendation for maintenance and development of the project site

Hollows

- Installation of fieldstones in form of a half moon on the southern side of hollows
- Reduction of disturbance in transition zone to a minimum (at least 20 m width)
- Allowing perennials, grasses, reeds and flowering vegetation in transition zone e.g., Alfalfa (*Medicago Sativa),* Clover (*Trifolium)* and Gras (*Poaceae)*
- Reduction of nutrient input by ecological cultivation
- Avoiding planting any new trees or high growing shrubs near the hollows (avoid shading objects)
- Leaving existing trees and shrubs as habitat structures for other species (e.g., avifauna)
- Adding dead wood as elements for better habitat structure
- Bordering trench needs to be maintained according to best practise (communication with local, responsible authorities needs to be coordinated)
- Hollows need to be revitalized in a network structure within regional scale (same procedure on areas 712, 701 and 8012 is recommended)
- Partial mowing in transition zone
- Closing off any near-by drainage systems

Agroforestry corridor

- Adding sufficient amount of mulching material that might be used for hibernation by amphibia
- Supporting insect populations by:
  -Installing beetle banks as part of buffer zone in the south of the agroforestry system
  -Installing blooming stipes as part of buffer zone in the south of agroforestry system
- Allowing dead-wood, add additional dead-wood as elements for habitat structure

Agricultural land

- No ploughing during migration time for amphibia (end of March until end of September)
- Using a cultivator (only if necessary)
- No change from extensive grassland to cropland in summer season, instead
- Catch crop (e.g., *Lolium multiflorum, Trifolium, Lupinus, Pisum sativum, Vicia sativa, Raphanus sativus, Phacelia)*, to finish summer season
- Leaving mowed organic material as mulch
- Cutting any vegetation at a minimum height of 12 cm
- Reducing nutrient input by using less or no fertilizers

Population regulation

- Carrying out a monitoring program for amphibia for at least two to three years
- If target species (amphibia) have gone extinct, re-establish population
- Carrying out a monitoring program for insect species (e.g., ground beetles) for research purpose
- Offering cave structures for bats (e.g., bat boxes)
- Installing further landscape corridors (e.g., agroforestry systems, hedges, extensive grassland) in order to connect small water body network

Created by I. M. Engelhardt

Discussion

One of the main intentions of this paper is to display the process of implementing conservation field work in combination with regenerative land use techniques. The aim is to show the conceptual framework and instruments for environmental planning and implementation. By using multiple methodical approaches during the three-months research period this aim could be achieved. Application of a systematic literature research and interpretation of existing environmental data, such as maps of the local county were combined. Communication between the researcher and the project supervisors took place. Therefore, a good understanding of the theoretical background for syntropic farming and

ecological restoration could be developed. Next, participation in the fieldwork and an observative protocol with field notes enabled the researcher to gain experience during the action phase of the project. Results were eventually mapped out in the project plan (Figures A and B), as well as the stratification plan (Figure C). Figures A shows that performance of the project was carefully planned, because the different phases are interconnected and depend on each other. It is therefore advisable to apply strategic project management and plan according to seasonal limitations. Particularly the first two phases for preparation and observation should be completed well ahead (1 year to 6 months in advance) before the planning phase can start. Awareness should be developed for the mutual influence of the different phases and buffering time for any contingencies should be included in the project plan. For any of the phases a different combination of skill set might be needed. This means that expert knowledge from external sources might be helpful for the gathering of initial data and trained staff is important to carry out the implementation of the project. Errors or inaccuracy in task completion are one major risk when working with unexperienced staff or changing team constellation. It is advisable to have teams work under supervision and offer theoretical knowledge to staff, such as workshops or literature. Both were provided at Gut & Bösel.

In general, plans for a biotope corridor on small scale must be specific to the local, natural environment. Conservation goals for a specific area must be formulated very precisely, to uphold measures for protection of species and biotopes against other forms of land use. Positive effects for the local flora and fauna can only take place when their habitats are preserved (Milde, 1991). Combining conservation with regenerative forms of land use, such as syntropic agroforestry, give a new turn to the traditional way of thinking in divided land use and open new dimensions for integrated conservation work. Yet, the ecological efficiency of agroforestry systems does not happen automatically, but rather depend on their individual design, the site, and the surrounding landscape. System design is variable, which means different characteristics and qualities can be emphasized. Surrounding landscape, existing habitats and structural elements should be considered and included into the design. It is also important to develop an understanding of the dynamics and aging process of agroforestry systems because their properties for habitat space change with the development into a more and more complex system (Reeg, 2010). The project presented in this paper complies with these criteria. The preparation and planning phase took place well in advance, allowing to gather all relevant information needed. Theoretical knowledge about syntropic agroforestry and monitoring results were combined to create a project plan. To develop a biotope corridor a project site was chosen that connects two existing, large biotopes. The neighboring areas and the network of small water bodies and other structural elements, like the alder biotope, were included in the project design. A target species plan for amphibia and birds was formulated specific to the potential of the area. All trees, shrubs and perennial plants were chosen carefully, considering the natural vegetation in Brandenburg. The syntropic approach works with a strategy that puts emphasis on the functionality of the different strata, as well as the individual species. For example, to prepare the soil on site and the system for the fast development of biomass and photosynthesis the emergent strata for the first succession phase were planted using tree species, which are nitrogen fixing and fast growing, such as *Populus alba* (silver popular), *Populus tremula* (aspen), *Alnus cordata* (Italian alder) or *Robinia pseudoacacia* (black locust). These trees are functioning as “mother trees” and create a healthy microclimate for more delicate grafted target species, like *Prunus domestica* (European plum), which will grow in the high strata and for emergent tree species, that were seeded into the system e.g., *Quercus robur* (common oak), which have a slower development but a longer life cycle. Using local seeds produces a late succession which is adapted to local climate conditions and therefor more resilient. The early succession of the emergent strata produces mulching material, whereas the late succession, which will grow from seeds eventually provides timber, when the system reaches its climate state. Any deadwood that develops within the system can host insects and other animals and functions as habitat

structure. Meanwhile the low and high strata can be used for production of fruit, berries, and nuts e.g., *Hippophae ramnoides* (sea-buckthorn) in early succession and *Corylus colurna* (Turkish hazel), seeded for late succession. Fruits are also an important food source for wild animals. Another important part is played by the low strata. Just as the woody plants each perennial species is strategically used for their properties. For example, *Synphytum* (comfrey) is used to loosen up deep soil layers due to extensive root systems. It provides high biomass production for mulching material that contains minerals, which the plant transports to their leaves from underground. Low strata plants also function as ground coverage and reduce weed pressure. The planting rows of the system are established in form of a keyline design, which follows the natural geomorphology of the landscape and helps to store water in the landscape. The linear structure of the planting rows also functions as orientation lines for migrating animals. The vertical strata create an enormous structural diversification of the landscape. A syntropic agroforestry system hence show high potential to fulfill the requirements needed to function as a biotope corridor. A mature system can facilitate movement of species amongst different habitats through suitable vegetation and structure. The project site in Alt Madlitz also is a connecting point for two large habitats.

Figure B display the action phase in detail. All work steps happened in an order thus, they built a sequence. Any steps were carried out in a way, which create optimal growing conditions. For example, tree saplings are trimmed at their roots and stem, to enable the root system to grow straight, avoiding tangling. They then feed the tree in the first warm period after plantation, without losing too much water by evaporation (Bayerische Landesanstalt für Wald und Forstwirtschaft, 2022). They get dipped into a liquid mix consisting of hydrogel, EMs (effective microorganism, created at the farm), micronutrients, mycorrhiza (grown at the farm), phaeophyceae, polyuronide and swellable montmorillonite clay that mitigate them from a shock and protects the roots from drying out in the sandy soil (Muñoz & von Both, 2023). Technical details, customized to the project site conditions are an important ingredient for a well-functioning management plan. In the future the project site will be maintained dynamically and according to the different succession phases of the system. For this purpose, stratification plans are developed. Figure C shows the state of the stratification for the first succession phase which is currently developing. Similar stratification plans will need to be developed for later succession phases when the system develops into more mature states. The agroforest develops into highly divers and well structured, extensively cultivated land, which addresses conservation goals, as well. To find out, whether it covers the same functions as a biotope corridor, suitable research methods should be applied which are used in conservation research. Commonly used methods are:

- Marking animals and catching the same individuals in predetermined time slots
- Application of telemetry: active or passive radar analysis
- Using selective traps which are showing the direction of migration
- Genetic or demographic analysis for non-isolated and isolated populations
- Long-term monitoring for the same research locations
- Testing suitability of habitat for specific vegetation by test planting withing the corridor
- Behavioral ecology analysis of target species within landscape matrix and edges of habitats
- Translocation: study individuals' behavior after removal of the initial habitat
- Working with modeling

(Drobnik et al., 2013).

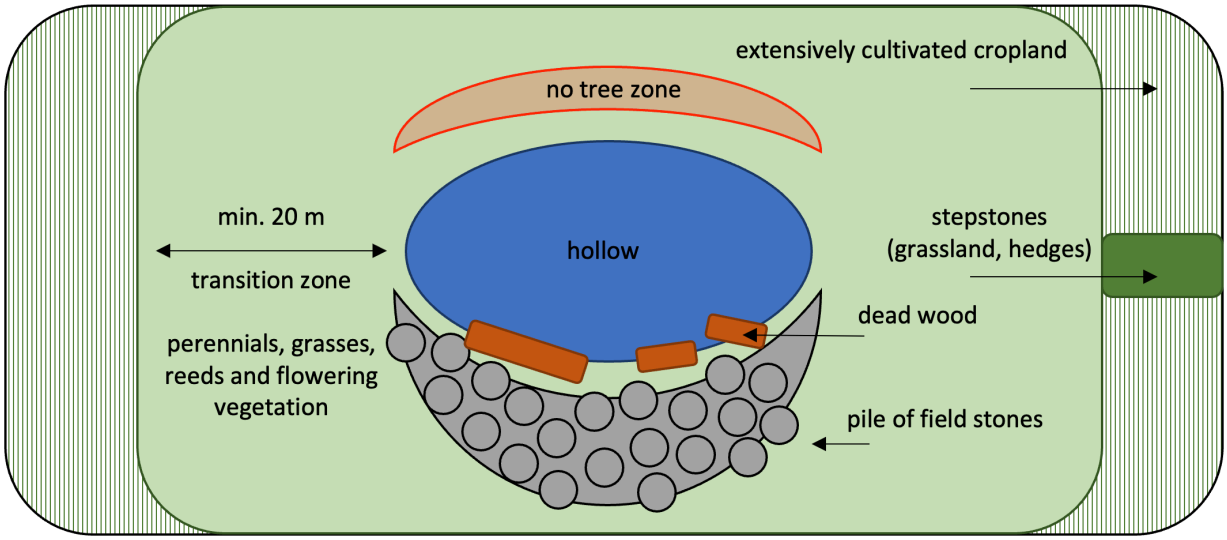
Figure D displays specific recommendations for further development of the project site. This part of the process is categorized as "project evaluation" in figure A. Köß defines this step as "success monitoring"

in her project plan for fundamentals and conceptualization of a small-scale biotope network corridor. She suggests iterated monitoring and data analysis at the end of the project cycle to ensure evaluation and enable further develop (Köß, 1994). The recommendations summarize information from all existing management plans, the conservation report by Mr. Hanisch and results of the literature report, as well as the protocols of consultations with Mr. Hanisch, Mr. Wiesing and Mr. Schneider. The following paragraph discusses the results.

The first monitoring for amphibia should take place two years after the initial establishment of the agroforestry system and the revitalization of the hollows. Ideally a technically simple and low-cost monitoring program, which captures the variety and number of species at the project site should be carried out. The ministry for regional development, environmental protection and consumer protection has published a protection program for *Bombina bombina* (red-bellied toad) and *Hyla arborea* (European tree frog). Quantitative data needs to be collected, to allow any conclusions about the current state of a population for both species. Conditions of the necessary habitat space are to be monitored, as well (Ministerium für ländliche Entwicklung (MLUV), 2009). The program is available online and can be used as guideline for monitoring. Over a period of 12 months, monitoring should be carried out three times, which allows to cover spawning times and active months for adult animals. To prepare for the monitoring program it can be helpful to collect existing data about migration routes. Following data should be collect the following data: (1) Identification and counting of spawn balls, (2) identification and counting of larvae and (3) sighting or hearing of adult animals. Areas that should be investigated into are: water surface of all hollows at the project site, shore of the water bodies, dead wood structures near the water bodies, additionally the alder biotope and agroforestry biotope – a suitable method could be systematic grid sampling. To find out if the agroforestry system is used as a corridor, selective amphibia traps can be installed, which not only allow counting of adult animals but also indicate the direction of their migration. However, such fences are costly and should be considered at a point of time when a stable population can be guaranteed. Any monitoring for the agroforestry system only makes sense once the system has developed into a mature state. It would be helpful for Gut & Bösel to find partnerships with NGOs (e.g., NABU Brandenburg or AGENA) to find experts that could share knowledge and voluntary carry out monitoring sessions (Protocol 3, Scheider). Monitoring should be carried out at least two to three years to check if the population of target species recover. In case the population has gone extinct, but all habitat conditions are suitable, it is necessary to reintroduce adult individuals into the habitat (Protocol 1, Wiesing).
At the project site no ploughing should be applied during the end of March and the end of September, which is migration time for amphibia. Instead, a cultivator might be used, if necessary. Consequently, there shall be no change from extensive grassland to cropland in summer season, a catch crop is to be sowed. Any cut organic material is to be left for mulching, additionally to live vegetation with a minimum height of 12 cm, covering the ground. Within the transition zones around the hollows mowing is only to be done partially. Hibernation structures for amphibia should be installed, together with a buffer zone around the hollows which should contain flowering vegetation as summer habitat for amphibia, insects and other animals. Caution is to be taken to ensure a steady water level/water dynamics in small-scale water bodies by reducing soil disturbances. For better water quality and less silting the nutrient input is to be reduced, by using less or no fertilizers. Connecting landscape elements (e.g., fallows or extensive grassland) should be installed to join small waterbodies, which are visited for spawning. Any drainage systems near small waterbodies are to be closed off. Simultaneously those landscape elements will provide sufficient food supply for amphibia. Additional corridors (e.g., extensive grassland or hedges) to forested areas, which are used as winter habitats by amphibia, should be installed. Object which are shading, particularly the southern side, of the hollows are to be removed

(Hanisch & Hofstätter, 2020). Optionally “beetle banks”, linear mounds where grasses and flowers grow can be installed on the southern side of the agroforestry system. They are breeding habitats for insects and help amphibia to orientate within the landscape. Figure 9 shows a visualization for the development strategy of the hollows. Naturally developing dead-wood structures should not be removed, because they are structural habitat elements for insects. In summary different strategies, that combine the extensive use of less disturbed areas, together with structurally and biodiverse vegetation will create optimal conditions to support species conservation at the project site (Protocol 2, Hanisch).

Figure 10: Visualization for development of the hollows



Conclusion

Transforming homogenous cultivated landscapes back into structurally divers and natural environment will help to secure the survival of endangered species. Establishing biotope corridors will allow them to migrate between different habitats and allow genetic diversity. Well-functioning ecosystems are more resilient towards disturbances, yet the production of agricultural products and conservation strategies often find themselves in conflict. Regenerative and extensive forms of land use, like syntropic agroforestry, therefor show a high potential to integrate conservation goals. They work with an innovative, holistic perspective and a deep ecological understanding of ecosystems and their functions. Syntropic agroforestry systems are long-living, dynamic food production systems. Their ecological effectiveness for species conservation is an interesting field for research.

On their farmland Gut & Bösel and the Finck Foundation are opening the opportunity to study potential benefits of agroforestry systems within a regional context. This paper documents the establishment of such a system step by step. Reviewing this pioneer project will hopefully help to increase knowledge about its potential for conservation work. With more knowledge eventually processes can be optimized, and errors minimized. Nevertheless, long-term monitoring programs are an important tool to control the ecological effectiveness of conservation work. Particularly for Biosphere Reserves Management land use

transformation, sustainable cultivation forms and integrated conservation open new ways of interaction between human and land.

Final personal reflection

Joining a hands-on project for a 12-week research period was a great opportunity to get an insight to applied conservation work. Especially being outside and participating in the fieldwork helped me to get a deeper understanding and feeling for the landscape around Alt Madlitz. I could gain some theoretical knowledge about ecosystem restoration and regenerative agriculture, which I believe to be two important topics for Biosphere Reserves Management. In the future I can see myself working in the field of restoration ecology, therefor the research semester was a good opportunity to get some experience in this field. It was very interesting to get to know the perspective of farmers on land use and landscape transformation. Stakeholder communication and cooperative management are an important part of managing any region. Therefor it is important to be able to understand everyone views. (Re)establishing a functional biotope network is a task that has become crucial for species conservation in Germany and other places in Europe. Corridors are always manmade and often they consist of vegetation that is not used for cultivation. They syntropic approach allows to think out of this box, which makes it appealing to landowners, farmers, and conservationists. I personally enjoy reinventing traditional ways of land use and applying them in innovative ways, to meet the challenges, we are facing in times of climate change and biodiversity loss.

I highly recommend for anyone who is interested in this field to step outside and join working in the fields. It is a great opportunity to experience nature in a way that is less recreational but interactive. Additionally, it is fun to work in a team of people who are all, in one way or the other, fascinated and inspired by regenerative work. For my personal research project, it was more than suitable to split the work into 50 % field work and 50 % research. This way I could make the most of my time and gain a lot of new knowledge.

A big thanks goes to Gut and Bösel and the Finck foundation who have made this opportunity available for me.

Personal Statement / Affidavit

I, Inga Marieke Engelhardt, student ID: 14209097
hereby certify that I have written
the Research Semester Report:

Establishment and Conservation of Connecting Landscape Elements for a Functional Biotope Network

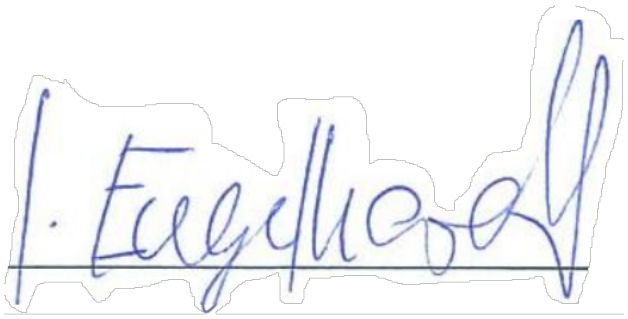
Implementing Methods of Regenerative Agriculture: Cultivation of Agroforestry and Ecosystem Revitalization

As part of a case study in Alt Madlitz in Brandenburg, Germany

handed in on the
29-01-2023

independently and that I have not used any sources or aids other than those indicated. All information provided by third parties (verbatim or in spirit) is duly substantiated. The Research Semester Report has not been submitted in this or a similar form to any other examination body.

29.01.2023, Nosara, Costa Rica



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Attached documents

1. Protocol for the systematic literature research
2. Fieldnotes
3. Map of development plan
4. Photo documentary
5. Aerial photos
6. Planting list
7. Consultation protocols

1. Protocol for the Systematic Literature Research

Modified version according to (Lamé, 2019) and (Egger et al., 2022)

1. **Formulate review question**

What does the **conceptual framework** for a project look like, that aims to implement methods of ecosystem restoration and regenerative agriculture (more specifically syntropic agroforestry) for a functional Biotope Network?

Why is this review necessary? What question needs answering?

- Putting the project „Biotope-corridor" in Alt-Madlitz" into context (where, what, who, how, when)
- Finding other projects that worked on biotope network connections with agroforestry, is this a innovative approach in Germany?
- What are the specific requirements of the local fauna (data already exists) to their habitats/habitat corridors
- Which landscape features and design elements can be added to the already existing management /project plans to improve them?
- Which data is necessary to evaluate the success of the project?
- How can the content of the project be shown to externals (educational purpose, marketing purpose, consulting for farmers)
- What is the purpose of the project, why is it necessary to conduct this project, what are the current challenges that agriculture / conservation work is facing?
- Which strategies do exist to face these challenges?
- Is there a way to measure the ecological effectiveness of agroforestry systems?
- Which connection does this project have to Biosphere Reserves?
- What is syntropic farming/agriculture and how can it help conservation work?

2. **Define inclusion and exclusion criteria**

- **Including:** scientific work around agroforestry in **moderate climate**, data that already exists on this project or similar projects, instruments of the German conservation law, maps, international literature, non-scientific literature which has been published by trusted sources (e.g. Ernst Götsch), literature that informs about landscape elements that are very similar to agroforestry systems (e.g. short-rotational-plantation or hedges), English and German literature

- Methodologic quality: educational purpose, consulting, case studies, scientific lit., grey lit., websites, dissertations and above, working papers of the project

- **Excluding:** case studies on **subtropical and tropical climate** that contain information, which cannot be generalised and applied to moderate climate (e.g. planting strategies with non-native flora in Germany)

Research key words

German and English,
in alphabetical order
Agrarholz
Agroforst+Verknüpfung+Biotopen
Alt+Madlizt
Amphibien+Rote+Liste,
Amphibienschutzmaßnahemen
Beetlebanks+effectiveness+agriculture
Biosphärenreservate
Biosphere+Reserves+Conservation+Development
Biotopkartierung+Brandenburg
Biotopschutz
Biotopverbund+Brandenburg+Biosphärenreservate+Erfolgskontrolle-Biodiversität
Biotopvernetzung
Brandenburg+Geologie
Brutvögel+Rote Liste
Bundesamt+für+Naturschutz+Karten
Ecological+restauration+revitalization
Environmental+monitoring
Erfolgskontrolle+Naturschutz
Ernst+Götsch
Fertilizer+synthetic
Großschutzgebiete+Biodiversät
Landschaftskorridor
Landschaftsprogramm+Brandenburg+Artenschutz
Landschaftsrahmenplan+Oder+Spree
Landwirtschaft+Beratung
Laufkäfer+Rote+Liste
Maßnahmen+Schutzmaßnahmen
Modelprojekt+Naturschutz+Brandenburg
Monitoring+Biotopvernetzung
Naturschutz+Landschaftspflege+Brandenburg
Naturschutzfachplan
Naturschutzgebiete+Brandenburg
Naturschutzmaßnahmen
Kurzumtriebsplantage
Participant+observation
Potentielle+natürliche+Vegetation+Brandenburg
Praxisleitfaden+Amphibienschutz
Projektplan+Gut+und+Boesel
Renaturierung+Soll+Revitalisierung
Rewildering+project+Germany
Renatutierung+planen
Renaturierungsökologie
Rote+Liste+Insekten
Soll, Feldsoll+Revitalisierung
Specific species e.g. (Neuntöter)
Stratification+syntropy
Syntropic+agroforestry
Systematic+Literature+Research
Wildbienen+Rote+Lite

3. **Locate studies**
   Develop a search strategy aimed at covering the broadest possible range of sources relevant to your research question. Sources include scientific databases, but also study registers, academic repositories for theses, reference lists and citation lists of included articles, books, communications with experts, and possibly searching the 'grey literature'.

- Web search: "scholar" and "proquest", use the "snowballing" effect (searching bibliographies of relevant articles for more literature)
- Research at the university library of HNEE
- Within the project: what data is already available?
- Geodata: maps provided by the county of Oder-Spree, Brandenburg viewer, Geoportal Brandenburg
- Expertise of supervisors and communication with coworkers and external experts

4. **Select studies:**
   Assess the studies identified by your search strategy to decide if they meet the inclusion criteria.

- This step was carried out

5. **Assess study quality**
   Use a pre-defined method for assessing the quality of included studies.

- reconciliation with project supervisors

6. **Collect data**:

- Personal literature catalogue using Mendeley reference manager and word
- 1. working paper that shows: Author, date, title, relevant citations and key words
- 2. Working paper that contains content-related structure for the written report

7. **Analyse and present results:**

- This step should be carried out in the first part of the research semester report by synthesizing all relevant information (Introduction, Introduction to the place of research, Theoretical background, Methodology)

8. **Interpret results**
   Consider the limitations of the review, the strength of the evidence it surfaced, how the research question is answered, and what areas for future research have emerged.

- This step should be carried out in the second part of the research semester report (Results, Discussion, Conclusion, Final Reflections)

2. Fieldnotes

Week 1: 24.10-30.10.2022

Weather conditions:
warm, sunny, no rain, no wind

Activities:

1. Arrival
2. Getting to know the project site and new colleagues
3. First part photo documentary for revitalization
4. Weeding
5. Seed collecting
6. Meeting and discussion with supervisor
7. Access to internal workpaper for conservation

Notes:
-Project is larger than expected,
Systematic view needed on regional management
-Sighted: *Capreolus capreolus* (Roe deer) in hollows
-Weeds in planting rows due to long break between soil/row preparation and planting (= not ideal!),
-Main weeds: *Elymos repens* (Couch grass), *Lamium* (Dead nettles), *Capsella bursa pasturis* (shepherd's purse), *Lupinus* (Lupine), *Stellaria media (chickweed)*

Planting row before weeding

Week 2: 31.10-06.11.2022

Weather conditions:
warm, sunny, no rain, no wind

Activities:

1. Construction work for hollow – revitalization
2. Second part of photo documentary (same as above)
3. Excursion with co-worker to extended grassland biotopes, visit to bird and bat boxes
4. Seed collecting in areas near project site
5. Weeding
6. Literature research

Notes:
-Revitalized hollow has water accumulation on the clay ground, strands of sandy substrate, removed organic material needs to be added back into system?
-Grassland biotopes show potential to be turned into wetlands
-Sighted: *Buteo buteo* (Common buzzard), *Triturus cristatus* (Crested newt)
- Bird and Bat boxes already installed, together with poles for bird of prey
-Seeds need to be dried and stored in cool environment and protected from mice and other animals
-Literature research for Syntropic farming: new scientific field, a lots of experiments

Triturus cristatus (crested newt)

Week 3: 07.11-13.11.2022

Weather conditions:
cool temperatures, little wind, no rain

Activities:

1. Fence installation
2. Mulching with extra layer of straw (added to fragmented wood chips)
3. Literature research and report outline
4. Meeting with co-worker to discuss development of conservation strategy + Remote sensing

Notes:
-Fence for biotope connection = controversial, yet necessary because saplings won't survive first growing period because of C*apreolus capreolus* (Roe deer) populations
- Insects as new focus?

Fence installation

Week 4: 14.11.-20.11.2022

Weather conditions:
cool temperatures, little wind, little rain

Activities:

1. Fence installation
2. Access to planting plans
3. Preparation of planting rows
4. Sowing seeds
5. Pruning at older planting system
6. Meeting and discussion with supervisor

Notes:
- Very divers + high number of seeds in the mixture
- Chestnuts and oaks are individually sowed out because they need a deeper hole in the ground (three different experiments with soil from a nearby forest – one row without, one row all mixed, one row only chestnuts)
- Note on maintenance:
Pruning is necessary, 2x a year
*Planting plan in separate document

Seeds for dark germinators

Week 5: 21.11-27.11.2022

Weather conditions:
cold temperatures, windy, no rain

Activities:

1. Second part of photodocumentary for "Hollow"-revitalization
2. Planting sea buckthorn
3. Building and installing permanent observation plots

Notes:

-Permanent observation plots need point for fixation of camera, photos need to be taken best from central point of "Hollow" to see the difference, good weather conditions are necessary for pictures
-photo documentary for revitalization in separate document

Permanent observation plot

Week 6: 28.11-04.12

Weather conditions: cold temperatures, windy

Activities:

1. Planting emergent strata (mother trees)
2. Consultation with Hermann Wiesing
3. Building an installing bird of prey stakes

Notes:

-Samplings need to be kept in holes covered with soil to prevent roots from exposure to low temperatures, important! When taken out from ground samplings are covered with wet gunny sacks there are dipped in Algium: based on phaeophyceae, polyuronide and swellable montmorillonite clay for better growing of roots, to mitigate planting shock, to avoid roots from drying out, regulate absorption capacity of nutrients and water, improve symbiosis with mycorrhiza and growing hormones, protecting against parasites
-Organization of planting process: working in line with at least 4 people; front person handing out samplings, according to planting plan, 3 people planting
-for planting: using a spade to dig a small hole, trees are pruned at roots and main shoot and dipped into Algium mix, saplings need to be covered at least 2.5 cm above roots, roots need to be straight and not curled up, willow sticks need to touch solid ground layer
-separate protocol for consultation with H. Wiesing

Stakes for bird of prey

Week 7: 05.12-09.12

Weather conditions:
Cold temperatures, no wind, no rain, little snow

Activities:

1. Planting emergent strata (mother trees)
2. Harvesting roots (comfrey) of *Symphytum asperum* and *Raphanus sativus (*horse radish) to seed fragments of roots into planting rows
3. Consultation with Jan Hanisch

Notes:
-Planting process needs to be organised in a way that samplings are not exposed to very low temperatures (limit -2° C) – time management is key here
-Adding *Symphytum* (Comfrey) for underground biomass and upbringing of minerals that are stored in deep layers of soil
-Adding *Raphanus* (Horse radish) for their taproots that help to loosen up the soil in deep layers
-separate protocol for consultation with J. Hanisch

Planting the emergent strata

Week 8: 12.12-16.12

Weather conditions:
Moderately cold, windy, rain, muddy terrain

Activities:

1. Planting emergent strata (mother trees)
2. Working on the report
3. Continue to harvest roots

Notes:
-planting process works well,
goal: to finish planting before Christmas

Arial photo of project site
(by H. Wiesing)

Week 9: 19.12-23.12

Weather conditions: very cold, windy, rain, muddy terraine

Activities:

1. Work process on hold due to very cold temperatures in the beginning of the week
2. Planting emergent strata
3. Planting low strata
4. Maintenance of tools, shed and cars
5. Working on the report
6. Meeting with supervisor to plan three last weeks of the research project: inventory can only take place after all planting has been finished

Notes:

-work process is depended on weather conditions and had to be put on hold due to very cold temperatures (-10°) and frozen ground, saplings need protection against cold temperatures (soil coverage), harvested roots need to be put in storage

- muddy ground conditions make access to project site difficult

Perennial plant selection

Week 10: 26.12-30.12

Christmas holidays

Week 11: 02.01-06.12

Weather conditions:
Mild temperatures, no wind, a lot of rain

Activities:

1. Planting low strata
2. Removing field stones

Notes:
-complications because of ordered plants: numbers are too low, therefor extra plants need to be ordered and taken from the nursery, process is slowed down
- muddy ground conditions make access to the project site very difficult
-Field stones need to be removed to prevent damage on agricultural machines in spring

Removing Field Stones

Week 12: 09.12-13.01

Weather conditions:
Mild temperatures, windy, rainy

Activities:

1. Planting low strata
2. Arranging mulching material

Notes:
-some work must be put on hold due to heavy rain
-Mulching material needs to be rearranged manually because it has been distributed irregularly

Rearrangement of mulching material

Week 13: 16.01. – 20.01.2022

Weather conditions:
Cold, windy, no rain

Activities:

1. Seeding light germinators
2. Arranging mulch material

Notes:
-three different versions: without mulch on top, with straw on top, with fine chipped wood on top

Seeding light germinating plants

3. Map of development plan

Created by J. Hanisch, 2020; translated with deepL (Kutylowski, 2022)

4. Photo documentary before and after

First date: 27.10.2022, 10.45 – 11.45 am, sunny, mostly clear, 21° C, precipitation: 0%,
Second date: 23.11.2022, 11.00 – 12.00 am, sun, clouds and snow, 5° C, precipitation: 0%
Photos taken by Maren Schultze and Inga Engelhardt

Photo point 1: 52.39716/14.24286

First: preparation for planting rows along elevation lines with mulching material, towards SE, 90°, reference: wooden stake

Second: Preparation for planting and seeding, fence installed

First: Preparation for planting rows along elevation lines with mulching material, mark for pear rows with white flag in place, towards S, 90°, reference: wooden stake

Second: Fence installed, mulching material on all rows

First: Preparation for planting rows along elevation lines with mulching material, towards W, 90°, reference: wooden stake

Second: Fence installed, mulching material on all rows

Photo point 2: 52.39558/14.24433

First: Hollow B (“Feldsoll”) (right) and Hollow A (left) from above, before construction work, towards E, 90°, reference: top of perch

Second: After construction work

First: Hollow B from above, before construction work, towards SW, 90°, reference: top of perch

Second: After construction work, with soil piles that were removed from the hollows (right), newly compressed driving lanes towards hollow

First: “Biotope network” agroforestry system, “dry trench” and edge of “alder biotope” from above, towards W, 90°, reference: top of perch

Second: preparation for planting and seeding in progress, fence installed, all planting rows covered with mulching material

Photo point 3: 52.39366/14.24436,

First: view towards Hollow A, before construction work, towards E, 90° reference: edge of the field

Second: after construction work, newly compressed driving lines

First: Hollow B, towards S, 90°, reference: edge of the field

Second: After construction work

First: Hollow B, towards W, 90°, reference: edge of the field

Second: after construction work

Photo point 4: 52.39304, 14.24497

First: view towards Hollow A, towards E, 90°, reference: edge of field, halfway between Hollow A and Hollow B

Second: after construction work, newly compressed driving lines

Photo point 4: 52.39304, 14.24497

First: area between Hollow A and Hollow B, towards S, 90°, reference edge of field, halfway between Hollow A and Hollow B

Second: After construction work, buffer zone remains intact

First: view towards Hollow B, towards W, 90°, reference: edge of the field, halfway between Hollow A and Hollow B

Second: after construction work, newly compressed driving lines

Photo point 5: 52.39401/14.23760

First: view towards “elder biotope”, towards N, 90°, reference: old oak tree at the dirt road

Second: After construction work, piles of removed soil

Photo point 6: 52.39269/14.23994

First: view on “elder biotope” and “perch”, towards N, 90°, reference opposite of “perch”

Second: no visible changes after construction work

Photo point 7: 52.39722/14.25133

First: Hollow C, towards W, 90°, reference road on eastern tip of hollow

Second: after construction, same distance

Second: after construction, close up to shore, with water collection

Photo point 8: 52.39999/14.24858

First: Hollow D, towards E, 90°, reference: dirt road at western tip of hollow

Second: after construction work, compressed driving lanes, higher vegetation remains intact

Photo point 9: 52.39970/14.24919

First: Hollow D, towards E, 90°, reference: edge of the field

Second: after construction work, higher vegetation remains intact

Photo point 9: 52.39970/14.24919,

First: Hollow D, towards W, 90°, reference: edge of the field

Second: after construction work, shore vegetation remains intact

5. Arial photos

Photos taken by Hermann Wiesing
First: Hollow B at photo point 3 (52.39366/14.24436) beginning of restoration work

Second: Hollow after construction work, restoration of hollow, compressed driving lanes

6. Vegetation list

Focus variety	Emergent strata	High strata	Medium	Low strata	
Prunus domestica (European plum)	**Planted** Early succession -Petula pendula (silver pirch), topped up with Gleditsia (honey locust) -Salix alba (white willow) -Alnus incana (grey elder) -Liriodendron tulipefera (Tulip tree), topped up with Gleditsia (honey locust) -Alternating mix: Populus alba (silver popular)/ Populus tremula (aspen)/ Alnus cordata (Italian alder) -Robinia pseudoacacia (black locust) **Seeded** Late succession -Quercus robur (common oak) -Quercus rubra (northern red oak) -Fraxinus excelsior (European ash) -Acer negundo (box elder) -Acer platanoides (Norwey maple) -Acer pseudoplantanus - Castanea sativa (sweet chestnut) (sycamore maple)	**Planted** Grafted Prunus domestica (European plum)	**Planted** Hippophae ramnoides (sea-buckthorn)	**Planted** -Mix of artemisia; vulgares (common mugwort), absinthium (wormwood) -Echinacea (coneflowers) -Malvaceae (malva) -Clinopodium vulgare (wild basil) -Mentha (mint) -Levisthicum officinales (lovage) -Leucanthemum (daisy) -Rumex sanguienus (blood sorrel) -Hyssopus (hyssop) -Silphium perfoliantum (cup plant) -Synphytum (comfrey) -Cochlearia amaracia (horsereddish) **Seeded** Dark germinators -Helianthus anuus (Common sunflower) -Malvaceae (malva) -Ficia faba (broad bean) -Pastinaca (parsnips) -Carum carvi (caraway) -Foeniculum vulgare	(fennel) -Daucus carota (wild carrot) -Calendula arvensis (field marigold) -Ravanus sativus (Daikon) -Raphanus raphanistrum (reddish) -Plantano lanceolata (ribwort plantain) **Seeded** Light germinators -Mix of artemisia; vulgares (common mugwort), absinthium (wormwood) -Digitales pupurea (foxglove) -Mix of Oenothera (evening primrose) - Anthryscus sylvestris (cow parsley) -Hypericum perforatum (St. Johns wort) -Silene dioica (red campion) -Verbascum (mullein) -Amaranthus (amaranths) -Rumex (docks) -Tanacetum vulgare (tansy) -Solidago (goldenrods)

Focus variety	Emergent strata	High strata	Medium	Low strata
Pyrus communes (common pear)	**Planted** Grafted -Pyrus communes (common pear) Not grafted -Betula pendula (silver-birch) -Salix alba (white willow) -Alnus incana (grey elder) -Alternating mix: Populus alba (silver popular)/ Populus tremula (aspen)/ Alnus cordata (Italian alder), topped up with Salix alba (white willow) -Robinia pseudoacacia (black locust) **Seeded** Late succession -Quercus robur (common oak) -Quercus rubra (northern red oak) -Fraxinus excelsior (European ash) -Acer negundo (box elder) -Acer platanoides (Norwey maple) -Acer pseudoplantanus (sycamore maple)	-	**Planted** Hippophae ramnoides (sea-buckthorn)	**Same as above**

Focus variety	Emergent strata	High strata	Medium	Low strata
Prunus domestica (European plum) + Corylus colurna (Turkish hazel)	**Planted** -Petula pendula (silver-birch) -Salix Alba (white willow) -Alnus incana (grey elder) -Liriodendron tulipefera (Tulip tree), topped up with Gleditsia (honey locust) -Alternating mix: Populus alba (silver popular)/ Populus tremula (aspen)/ Alnus cordata (Italian alder) -Robinia pseudoacacia (black locust) **Seeded** Late succession -Quercus robur (common oak) -Quercus rubra (northern red oak) -Fraxinus excelsior (European ash) -Acer negundo (box elder) -Acer platanoides (Norwey maple) -Acer pseudoplantanus (sycamore maple)	**Planted** Grafted Prunus domestica (European plum) **Seeded** Corylus colurna (Turkish hazel)	**Planted** Hippophae ramnoides (sea-buckthorn)	**Same as above**
grafted	**early succession**	**late succession**	**Dark germinators**	**Light germinators**

7. Consultant protocols

Protocol 1: Consultation with Hermann Wiesing,
Engineer and Expert for "Feldsoll" - revitalization
21-11-2022, 15.30 h

Mr. Wiesing works as an environmental engineer and consultant for "Feldsoll"-revitalization in northeastern Germany. His company planned and carried out the revitalization of four "Feldsölle" at the agricultural business "Gut und Bösel" at Schlossgut Alt-Madlitz.
He is asked to give some consultation about the further development of the project and how optimize it. The following protocol summarizes his advice on specific topics and measures regarding the project.

Contact Information:

Agrar- und Umweltplanung
Dipl.-Ing. Hermann Wiesing
Am Molkenberg 7
14778 Beetzsee OT Radewege

Stacking Fieldstones:

- Fieldstones can be stacked near the "Feldsoll" or on its edge, if there is enough material at the working site
- This applies only to the surrounding areas that are not used for agriculture, more precisely to the transitions zone between the "Feldsoll" and the next agricultural field
- Fieldstones should be in the south of the "Feldsoll", exposed to sun and without shading the waterbody
- Amphibia can use these places to sunbath

Plantation:

- Currently the transition zone for the „Feldsoll", which is not used for agriculture is covered with different perennial plants, grasses, reeds and a few smaller trees, these conditions are good for the revitalization process and should not be disturbed or changed, the process should be supported by less activities in the near environment
- Blooming stripes are optimal segetal flora next to a "Feldsoll" and should be established if not already existing
- Ecological agriculture is the best form of cultivation to reduce/stop the nutrient accumulation in the "Feldsoll", therefor any intensive agricultural activities must be converted into extensive forms additionally to the buffer zone
- The transition zone should ideally have a minimum width of 20 m, this can vary according to the form of cultivation
- It should be avoided to plant new trees in close surrounding of the project site, they can cause a shading effect on the water body and are holding water in the ground that will then not go into the hollow, if trees are planned to be planted, they should only be planted at the northern side of the "Feldsoll". If trees are already existing next to the "Feldsoll" they are an established and valuable biotope, breeding and feeding ground for bird species and therefore should not be removed

Deadwood:

- Ideally the construction work should not remove any peat substrate from the hollow, if mummified wood is found, it should be left inside the hollow and can continue to decompose
- Mummified wood is often found in placed where the "Feldsoll" had periodically dried out in the past, it shows that these landscape feature undergo their own dynamics

Population Regulation:

- In case the populations of amphibia have gone down, it is advisable to monitor the project site for a period over 2- 3 years and see if the populations will grow back
- Particularly Bombina bombina will return quiet quickly, since the animals have a well-functioning instinct to find waterbodies
- If the population of protected amphibia is extinctic, it can be necessary to reestablish them into the habitat, once the habitat is suitable
- However, in the recent years there have been dramatic changes in the climate, leading to dry periods and decrease of 90% of the population rate in some regions of Brandenburg
- Bombina Bombina might use the mulching material of the agroforestry system for hibernation in winter, they orientate at structure elements within the landscape and might use the agroforestry system and the alder area to move in between their habitats, agroforestry systems therefor are a beneficial structural element for conservation and protection of amphibia

Protocol 2: Consultation with Jan Hanisch,
Consultant for conservation and agriculture
24-11-2022, 15.00 h

Mr. Hanisch works as a consultant for agriculture and conservation measures. His company composed the conservation management plans for the agricultural business "Gut und Bösel". He was asked to share some information about the current conditions of the project site how it can be developed. The following protocol summarizes his advice on specific topics and measures regarding the project.

Contact Information:

Agrarlandschaft GbR
Jan Hanisch and Johannes Hofstätter
Am Lindenpark 8
16225 Eberswalde

Agroforestry system:

- Beetle banks in combination with an agroforestry system are a great option to protect and conserve insect populations: breeding habitat for insects and orientation lines for amphibia, they should be the buffer zone to the surrounding areas, ideally additionally to booming stripes/integrated blooming structures, should be in the south of the agroforestry system, exposed to the direct sun with no shade

- Agricultural maintenance and cultivation techniques can be found in the management plan
- Allow the agroforestry system to build deadwood, which is not removed, add deadwood as habitat structure elements for insects, deadwood shows better ecological qualities within the agroforestry system than fieldstones

Hollows "Feldsölle":

- Stacking fieldstones for sunbathing in the south of the hollow
- Stacking dead wood in and around the hollow to create more structure, add biomass (often more available than stones)
- No trees should be planted nearby (particularly in the south of the water body) to avoid shade on the water body, amphibia larva need warm water in order to be able to undergo their metamorphosis
- For the buffer zone: minimum of 10 m, optimal 20 m with Alfalfa (*Medicago Sativa),* Clover (*Trifolium)* and Gras (*Poaceae)*. This mix is affordable and easy to use, because it is common in agricultural cultivation, it is possible to get subsidies with "Ökoregelung 1 Ackerbrache and KULAP Pufferstreifen an Gewässern", monetary loss of used areas will be balanced
- Additionally, perennial plants are beneficial for some amphibia e.g., European tree frog (*Hyla arborea)*, more flowers are beneficial for insects

Widening the concept for insect species (e.g., bees, ground beetles)

- The current species of amphibia and birds that the management plans are focusing on are flagship species that automatically cover the needs of a lot of insect species anyways
- The combination of different strategies: areas that are less disturbed = agroforestry, "Soll"-revitalization, extensive cultivation, together with blooming stripes, beetle banks, deadwood structures and stacked field stones would be an optimal setting to support insects
- Monitoring programs for insect would be an interesting field to explore
- Any measures to support insect need to be in the southern part of the area without any shading (particularly important for agroforestry system planning – calculations on the shading of older systems)

Bats

- To support bats "cave structures" should be offered, e.g. in form of batboxes
- Bats orientate on high structures for their flying routes within the landscape
- Bats benefit from high amounts of insects in the landscape

Trench

- It is crucial to support good communication with the responsible water and soil protection authorities
- Trench should be maintained according to the best ecological practice

General Advise:

- For amphibia (for *bombina bombina)* it is crucial to understand the entire area that is cultivated by "Gut und Bösel" and surrounding areas as one big system, therefor hollows ("Sölle") in different plots need to be revitalized progressively in the next years
- Link to the management plans and figures that show examples travel routes of *bombina bombina*
- Areas 712, 701, 8012 should be developed further, meaning revitalization of the hollows ("Sölle")
- In areas that are currently used as grassland (west of project site) water level can be higher, but it would not be relevant for amphibia, because species are reliant on small scale water bodies

Protocol 3: Consultation with Claudius Schneider
Stiftung Naturschutzfonds Brandenburg, Funding Management
10-01-2023, 15.00 h

Claudius Schneider works in the department of funding and management at Stiftung Naturschutzfonds in Brandenburg. This foundation coordinates conservation work in the state of Brandenburg and has the aim to protect and conserve natural landscapes, wild habitats, and species.

Contact information

Claudius Schneider
Fördermanagement
Stiftung Naturschutzfonds Brandenburg
Heinrich-Mann-Allee 18/19
14473 Potsdam
Tel.: (0331) 971 64 865

Monitoring

- Advisable to do a technically uncomplicated monitoring program
- It should be captured which species are at the project site
- Working with "abundance classes" and "succession control" – further information about this methodology can be found in the info sheet provided by Stiftung Naturschutzfonds
- First monitoring should ideally take place two years after revitalization
- Every two years or at least one to two times within 6 years monitoring should be continued
- Three dates should be used for monitoring within one year (the more dates within one year, the more precise results will be), depending on climate, spawning and active months should be covered: 1. Monitoring between February and March (for *Rana temporaria*, common frog and *Rana arvalis*, moor frog), 2. Monitoring between end of April and end of May (for *Bombina bombina*, red bellied-toad and *Bufo Bufo,* common toad), 3. Monitoring in June (for larvae of *Hyla arborea*, European tree frog and *Bombina bombina*, red bellied toad)

- three monitoring sessions allow the cover of the full species spectrum
- If the target species and methodology are formulated at the beginning, different people can perform the monitoring
- Data that is collected: identification and counting of spawn balls, identification and counting of larvae and sighting or hearing of adult animals – depending on the aim of the monitoring
- The target area is depended on the financial capacity and human recourses of the agricultural business
- There is possibly data available about migration routes, this data should be researched in advance to the monitoring program
- Areas that should be searched: water surface of all hollows at the project site, shore of the water bodies, dead wood structures near the water bodies + additionally alder biotope and agroforestry biotope – method could be systematic grid sampling, however there are no standardized methods for areas that are surrounding small water bodies
- To investigate in to the question whether the agroforestry system is used as a corridor amphibia fences can be installed, they indicate the direction of migration, however such fences are quiet costly
- Any monitoring for the agroforestry system makes sense once the system has developed into a mature state

Hollows

- Development of the hollows depends on the initial state
- There should be as many shallow water surfaces as possible
- Tips can be found in the "Artenschutzprogram" for the state of Brandenburg
- No vegetation for some species e.g. *Epidalea calamita,* natterjack toad
- Dead wood structures and fieldstone piles can be helpful
- *Hyla arborea*, European tree frog needs *Phragmites australis*, reeds or *Salix cinera*, common sallow

Funding options and partnerships

- Stiftung Naturschutzfonds supports compensation and replacement actions but only the initial measures
- Long-term maintenance and development are not covered for small water bodies but there are support packages for buffer zones of waterbodies and streams in "Landwirtschaftsförderung"
- Development is depended on form of cultivation, extensive cultivation will support conservation success
- It can be helpful to find partners like universities (University for Sustainable Development Eberswalde), Ngo's (e.g., NABU Brandenburg), local experts for amphibia or AGENDA (data collection for amphibia conservation)

Additional notes

- Target species concept works for a wide range of animals, for insects target species are not used, because insects typically settle according to the circumstances and ecosystem that is provided
- Bats are profiting from revitalization of small water bodies networks, because they use them for hunting grounds and orientation