LIFE14 NAT/DK/000012
LIFE RAISED BOGS IN DENMARK

LIFE Raised Bogs in Denmark

A LIFE project focused on recreating and restoring raised bogs in Denmark

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This layman's report is part of the reporting efforts within the LIFE Raised Bogs in Denmark project. The purpose of the project is to manage the existing remnants of active raised bogs in Denmark and create conditions for the development of additional areas of active raised bogs. It also seeks to safeguard and expand the number of habitats for the large white-faced darter and the diving beetles Dytiscus latissimus and Graphoderus bilineatus.

The initiatives were carried out in the municipalities of Tønder, Randers, Mariagerfjord, Norddjurs, Rebild and Jammerbugt, as well as at Danish Nature Agency Søhøjlandet, Danish Nature Agency Kronjylland, and Danish Nature Agency Storstrøm. The project was carried out between August 2015 and December 2023.

DISCLAIMERThis report has been prepared as part of the LIFE14 NAT/DK/000012 project, which receives financial support from the European Commission. The opinions and knowledge expressed in the report can under no circumstances be regarded as official positions of the European Commission, nor can the European Commission be held responsible for any further use of the information contained in the report.

Graphoderus bilineatus is very rare in Denmark. It thrives in areas with sunny, warm ponds with no fish and little food.

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INTRODUCTION

In Denmark and around the world, raised bogs are a rare and endangered habitat. Over the past few hundred years, the majority of raised bogs in Denmark have disappeared as a result of drainage, cultivation, and peat extraction. When raised bogs disappear, important habitats for animal species adapted to life in raised bogs are lost, which hurts biodiversity. Meanwhile, the climatic function of raised bogs ceases, as carbon from the atmosphere is no longer stored in peat bogs.

The purpose of the LIFE Raised Bogs project is to safeguard the existing remnants of active raised bogs in Denmark and create the conditions for the development of additional areas of active raised bogs. The LIFE Raised Bogs project also focuses on securing and expanding the number of habitats for the large white-faced darter and the diving beetles Dytiscus latissimus and Graphoderus bilineatus, which are characteristic raised bog species.

According to the European Union's Habitats Directive, Denmark is obligated to preserve or restore favourable conservation status for the special habitats and species covered by the directive. In the EU, a number of Natura 2000 sites have been designated to protect these habitats and species. Active raised bogs are among these special habitat types.

In Denmark, targets and initiative programmes for ensuring favourable conservation status for the habitat types and species in the individual Natura 2000 areas are set out in the Natura 2000 plans. The species and habitats that each Natura 2000 site is designated to protect are listed in the designation basis and are prioritised in Danish nature management.

According to historical maps, raised bogs were widespread in Denmark in the 1920s. Here is a section from the area around King's Bog in Southern Jutland (background map copyright: Danish Geodata Agency).

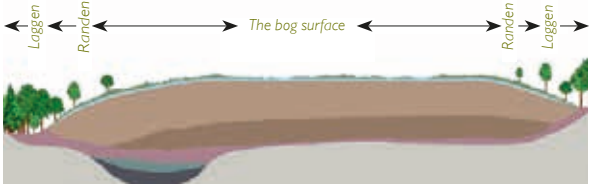
The aim of the LIFE Raised Bogs project is to preserve and improve the condition of 218 hectares of existing active raised bogs, and to create conditions for the development of an additional 429 hectares of secondary active raised bogs, which can be formed in areas that were once active raised bogs. Securing habitats for the three insect species mentioned above and benefiting the climate are also among the project's focuses. In addition to the areas where raised bog projects have been implemented, the LIFE project has included feasibility studies on additional areas.

The LIFE Raised Bog Project is divided into ten project areas covering almost 1,400 hectares in eight Danish Natura 2000 areas. The project areas are distributed among six municipalities and the Danish Nature Agency.

Peat digging in 1915. Raised bogs have been visibly impacted by extensive peat extraction over the years.

ACTIVE RAISED BOGS AND MARSHES ARE IMPORTANT FOR THE CLIMATE AND BIODIVERSITY

Raised bogs are a unique habitat where water management is a function of precipitation alone. Thus, raised bogs are naturally very nutrient-poor and inhabited by frugal flora, such as peat mosses and heather.
As the plants die, they accumulate as peat in the bog, where the layer of peat can be several metres thick. A well-developed natural raised bog rises like a dome above the landscape as its very own ecosystem, with space for rare animals and plants.



Schematic section through a raised bog, partly formed by the overgrowth of a small lake and partly by silting (Moseplejebogen, Fredningsstyrelsen 1985)

- Reed beds
- Gyttja
- The secondary water table
- Younger sphagnum peat
- Older sphagnum peat
- Peat bog with tree stumps

In Denmark, only 5% of the natural raised bogs remain. A similar picture is emerging in the rest of the EU and the UK. The LIFE Raised Bogs project aims to reverse this trend in Denmark by managing existing remnants of natural raised bogs and safeguarding the potential to develop new areas of raised bogs.

If a raised bog is drained, the peat disappears. In essence, this is because peat decomposes when oxygen is introduced into previously water-saturated layers. This releases CO_2 and other greenhouse gases into the atmosphere, and the same happens if the peat is used as fuel. The degradation of raised bogs contributes to global warming. By wetting the remains of raised bogs and other areas, this trend can be reversed so that carbon once again accumulates in the areas in the long term.

Restoring raised bogs has a positive impact on biodiversity and the climate. Another important effect is that wetting agricultural land that was previously marshland will help to reduce nitrogen run-off into the aquatic environment. The lessons learnt from the LIFE Raised Bog Project can easily be scaled up to other projects. For instance, this is the case with the Danish lowland soil initiative, in which 100,000 hectares of peat-rich soils must be wetted by 2030.

Listen to the raised bog podcast:

What is a raised bog?

Bogs and climate?


Holmegaard Mose is part of a large lowland area along the Upper Suså river. The map shows a total area of peaty soils (humus soils) in the area of more than 2000 hectares, as well as the potential for restoring lowlands and retaining carbon — for the benefit of the climate.
Suså
Glumsø
Bavelse Sø
Tybjerglille
Suså
Haslev
Herlufmagle
Skuderløse
Holmegaard Mose
Gelsted
Fensmark
Suså
Suså
Rønnede
Holme-Olstrup
Holsted
Næstved
Tingerup Tykke

RESULTS

Overall, the LIFE Raised Bogs project has managed to achieve the expected results for preserving and improving remnants of active raised bogs (218 hectares) and creating conditions for the restoration of additional areas of active raised bogs — even to a slightly greater extent (442 hectares) than originally planned. The project was carried out within the 10 originally planned project areas, but various challenges meant that one project area had to be excluded; meanwhile, other project areas succeeded in achieving a greater area of restoration than originally planned. The total project area achieved (1,325 hectares) is therefore slightly smaller than planned (1,389 hectares).

The LIFE Raised Bog Project's efforts to improve and restore active raised bogs are centred around two initiatives. An extensive clearing programme has reduced the spread of woody plants. This reduces the evaporation of water from the surface of the moss and improves the moss's ability to retain water. However, the project's expert panel recommended prioritising efforts to improve hydrology over clearing efforts, and consequently, fewer areas were cleared than originally planned, totalling 272 hectares. The effort to improve hydrology has progressed as planned and includes 871 hectares where drainage has been blocked and the water level increased.

Sheet piling dams the water and wets the bog. Photo: Marianne Lindhardt.

Effort	Project goals - hectares	Results achieved - hectares
Project area	1.389	1.325
Clearances	367	272
Improved hydrology	871	871
Forbedring af eksisterende aktiv højmose	218	218
Improvement of existing active raised bogs	429	442

Clearing has been carried out using a variety of methods, including grazing with sheep and hand-pulling conifers and birch trees, as well as mechanical clearing with large machines. The hydrological measures are also highly varied, ranging from simple small wooden shutters for damming the water to complex dikes with non-water-permeable membranes. The work is carried out as gently as possible so as not to disturb the soil conditions.

219 hectares of the total project area is located in Sandels Mose ["Sandel Bog"], which is part of Store Vildmose ["The Great Wild Bog"]. In Sandels Mose, technical studies have been carried out to ascertain possibilities for improving the condition of the bog at a later date.

The project areas also include areas where active raised bogs are not expected to develop. These areas (approx. 235 hectares) form an important buffer between the most vulnerable marsh areas and the surroundings, limiting, for example, the negative impact of nitrogen from agriculture. The area of active raised bogs is based on the Danish Environmental Protection Agency's 2010 survey, which was the basis for the LIFE project in 2014.

Restoration of new areas with active raised bogs typically takes place in areas where there are habitat types that emerged after the raised bog disappeared. These include wooded peat bogs and degraded raised bogs, which are now expected to develop into active raised bogs with an accumulation of peat.
The Danish Environmental Protection Agency surveys habitat types at regular intervals, and the latest survey may differ from the data used in the LIFE project.

Making the project areas wetter has a positive impact on the climate.
The project is expected to reduce emissions of CO_2 (and related greenhouse gases) by 7,000–22,000 tonnes of CO_2 per year. This corresponds to the emissions of 1,000–3,000 residents of Denmark. Over time, this effect is expected to increase as peat accumulates and carbon is stored in the bogs.

Local support for participation in the time-consuming clearing tasks has been of great value to the LIFE Raised Bog Project in areas including Store Vildmose and Holmegaard Mose. In these bogs, there has also been a programme of nature-related tasks carried out by socially disadvantaged citizens.

OBSTACLES AND CHALLENGES

Like most other major Danish nature and environmental projects, the LIFE Raised Bog Project has been challenged by several major obstacles to smooth implementation.

Failures to prioritise nature-, environment-, and climate-related projects means that many projects are delayed, limited, or abandoned, ultimately resulting in failures to meet political targets for improving nature, the environment, and the climate.

To successfully execute the projects necessary to achieve the targets set for nature, the environment, and the climate in the future, opportunities to implement these kinds of projects must improve significantly.

Langemose after the water level was raised. Photo: Anja Daugbjerg Hansen.

The obstacles that stand in the way of executing relevant nature and environmental projects are mainly related to privately owned land. Our impression is that the vast majority of landowners are more than willing to participate in efforts to safeguard biodiversity and the climate. However, while a large majority of the landowners in a project area may be willing to enter into a project agreement, individual landowners who hold a small share of the total project area can still prevent the execution of important projects. Often, constitutional property rights mean that one or a few landowners are enough to interfere with the execution of important, large-scale nature projects.

Important projects inside and outside Natura 2000 areas have had to be cancelled due to opposition from individual landowners. It is intriguing to note that many of the areas that are now agreed to be important to restore for the sake of biodiversity and the climate were cultivated 50 to 100 years ago, despite opposition from nearly half of the landowners.

All project areas in the LIFE Raised Bog Project are located within Natura 2000 areas. Given the funding for the project and the fact that restoring degraded raised bogs is important for both biodiversity and the climate, executing the project should not have been an issue. Unfortunately, that has not been the case. Although Natura 2000 areas have been designated to improve and protect endangered habitats, animals, and plants, executing projects inside Natura 2000 areas has proved to be just as difficult as executing them outside these areas.

— continued...

Langemose before the water level was raised.
Photo: Roar Skovlund Poulsen.

OBSTACLES AND CHALLENGES — CONTINUED

Within the LIFE Raised Bog Project, several project areas were adjusted because landowners did not want their Natura 2000 areas to be included.
It has been particularly difficult to conclude project agreements for the cultivated areas inside Natura 2000 project areas, as several landowners wanted to preserve these areas for intensive agriculture.

Some landowners additionally declined to have their natural areas included in the project. The reasons given by landowners have varied greatly.
Some have justified their opposition with the risk of impacting hunting opportunities or forestry operations on the edges of project areas, while others have indicated that they are satisfied with the existing conditions and therefore do not want change. Although impartial experts were brought in to calculate and establish landowner compensation for impairment of project areas, it has not been possible to conclude agreements with the landowners in all of the planned project areas.

It was ultimately necessary to abandon three project areas within the LIFE Raised Bog Project because it was not possible to conclude the necessary landowner agreements.
Several sub-projects have been delayed due to difficulties in landowner negotiations and slow regulatory processing. It has thus been necessary to submit two amendment applications to the EU and extend the project period by two years.

In the LIFE Raised Bog Project, two areas in Rold Skov and one area in Tuemosen, in Randers Municipality, were abandoned due to landowner opposition. The Store Vildmose project was only executed after funds bought up the project areas, and Hønning Mose and Kongens Mose were delayed by 3 to 4 years because the necessary landowner agreements were only in place after 3 and 2 land divisions, respectively. In addition, difficult landowner negotiations have delayed the execution of projects in Rold Skov and Holmegaard Mose.

The challenges of realising projects on state-owned land are usually minor. This was also true of the state-owned areas in the LIFE Raised Bog Project, where the only issue has been slow regulatory processing, which caused minor delays in the schedules.

A major challenge facing LIFE projects is the difficulty of obtaining the national funding necessary for the projects. An essential prerequisite for making it possible to implement the LIFE Raised Bog Project was the state prioritising efforts to achieve goals for the Natura 2000 areas by prioritising funds in the Finance Act for the 2013-15 period.

Langkær Mose membrane installation, April 2018.
Photo: Anne Gro Thomsen.

Clearing birches and conifers in Tuemosen. Photo: Lars Sandberg.

RESTORATION MEASURES:
RESTORING NATURAL HYDROLOGY AND CLEARING

The overall purpose of the LIFE Raised Bogs project has been to re-establish favourable conditions for the development of active raised bog habitats.
The prerequisites for the development of active raised bogs are that natural hydrology can be maintained with a relatively constant groundwater level close to the surface and that nutrient-poor conditions exist. For all project areas, measures have been implemented to achieve hydrology as natural as possible. In one project area, Holmegaard Mose, measures have also been implemented to cut off nutrient-rich water from the project area.

All the project areas were previously natural raised bogs that have been more or less degraded as a result of peat digging and drainage. As of the start of the project, surveys had identified large portions of the project areas as degraded raised bogs. Preliminary studies showed that there is great potential to restore active raised bogs in these areas by implementing restoration measures that ensure natural hydrology.

A number of methods have been used to achieve the hydrological conditions that favour the formation of active raised bogs. The various project areas have all previously been drained to a greater or lesser extent by digging canals. In order to recreate as natural hydrological conditions as possible in the project areas, a number of methods have been used.

These include the installation of plastic membranes, the creation of peat dams, the insertion of weirs, and the closure of ditches and drainage pipes. In the project areas, trees and bushes have also been cleared to a greater or lesser extent to reduce evaporation and thus create more stable water levels in the raised bog areas.

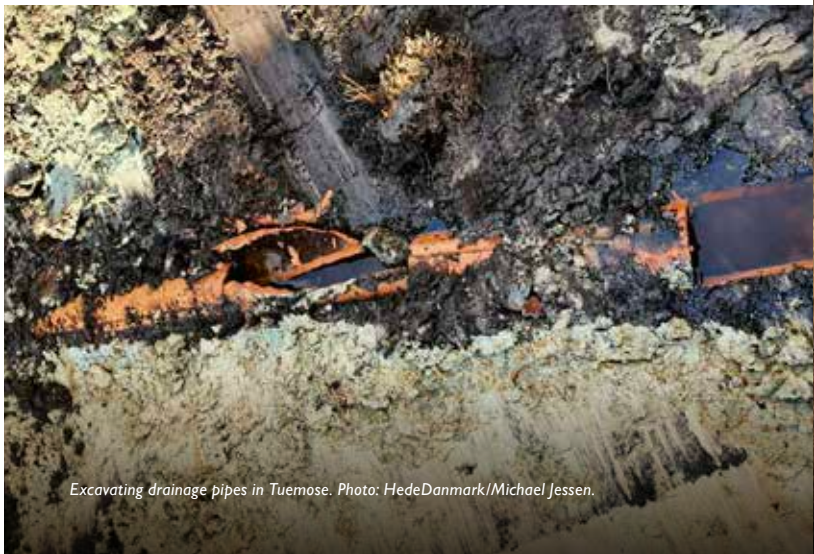
The water level in areas that have been controlled by larger canals has been raised by the insertion of weirs with fixed or adjustable overflow. Smaller channels have been filled in, and drainage pipes and culverts have been blocked. In some project areas where there is a significant drop in the surface over longer stretches—for example, at the edge of project areas—peat dams have been established or membranes inserted to ensure a sufficiently high groundwater level in the project areas. These include the project areas in Store Vildmose, Hønning Mose and Langkær Mose.

The LIFE Raised Bog Project includes, in addition to the efforts for the active raised bog habit type, an effort to create better living conditions for three endangered species: the large white-faced darter and the diving beetles Dytiscus latissimus and Graphoderus bilineatus. This has been done by levelling the steep banks of waterholes in the peripheral areas of the project areas and creating open spaces around the waterholes.

Listen to the raised bog podcast:
Restoring favourable conditions for the development of the active raised bog habitat type.

Restoring the raised bog

Damming the water in Gjesing Mose. Photo: Claus Paludan.



Excavating drainage pipes in Tuemose. Photo: HedeDanmark/Michael Jessen.

RESTORATION MEASURES:
RESTORING NATURAL HYDROLOGY AND CLEARING

Volunteers in Aaby Mose, April 2023. Photo: Søren Rosenberg.

THE PROJECT AREAS

The project targets 8 Danish habitat areas (SPA) and covers a total of 1,174 hectares in Jutland and Zealand. Of these, 714 hectares are privately owned and 460 hectares are state-owned. Today, the 10 project areas have a total of approx. 214 hectares of active raised bog, but the dominant habitat type is various stages of former raised bog; e.g., wooded peat bog and degraded raised bog.

Scan to view film

Presentation of the Life Raised Bogs project

The bog surface, Store Vildmose. Photo: Marianne Lindhardt.

STORE VILDMOSE — #3

The project area in Store Vildmose is 488 hectares and is part of the larger Natura 2000 area of 1853 hectares. The project area corresponds to the area with protected status; cf. § 3 of the Nature Conservation Act. The project includes two sub-areas: Sandels Mose and Aaby Mose in Jammerbugt Municipality. Store Vildmose used to be one of Denmark's largest raised bogs and continues to be among the areas with the largest area of active raised bog. During the project period, hydrological, biological and soil investigations were carried out in both sub-areas. In addition, extensive nature restoration has been carried out in Aaby Mose.

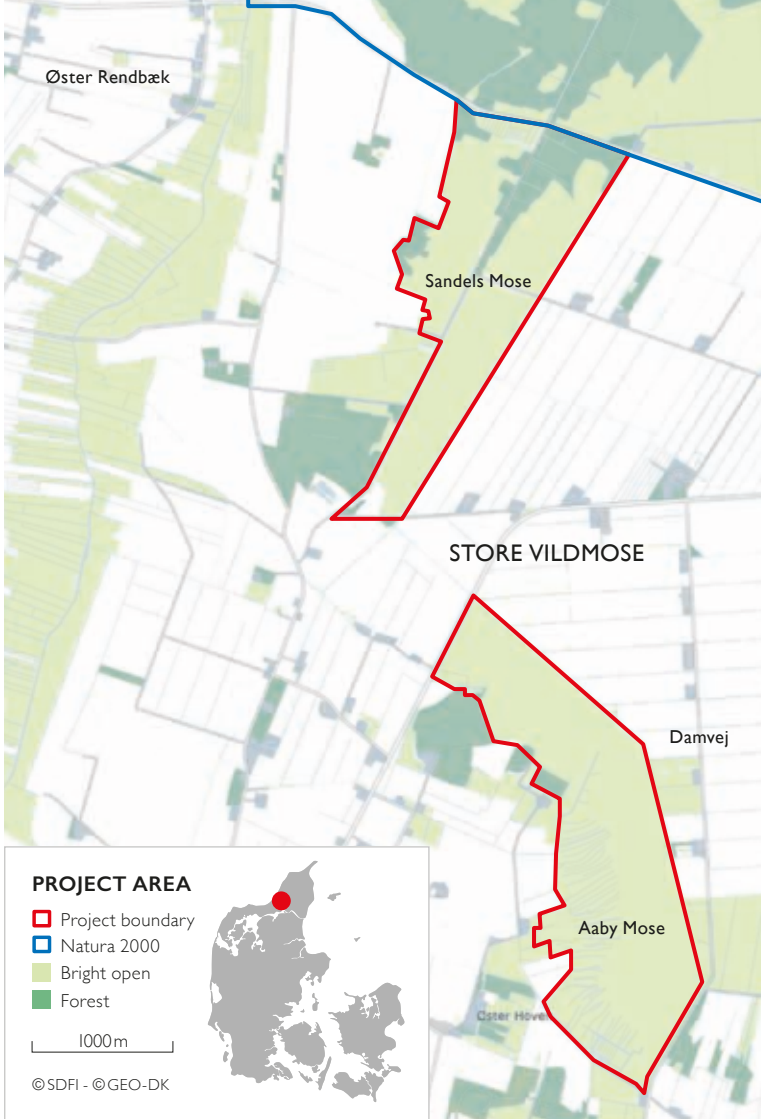
The nature restoration in Aaby Mose has focused on the two biggest identified threats: overgrowth with woody plants and drying. As drying leads to changes in the nutrient content of the peat, CO_2 emissions and changes in the plants growing in the bog, the primary focus has been on improving the hydrological condition of the project area.

Listen to the podcast:

Restoration of Store Vildmose

Improved hydrology is achieved by closing drainage pipes, ditches, and small cracks; crushing pipes; closing ditches and cracks with sheet piling and peat plugs; and inserting membranes. A significant part of the project has involved the construction of a large membrane-based dam on a 3.3-kilometre stretch along the eastern edge of the bog. In addition, a plastic membrane has been inserted between the bog and a new bicycle/pedestrian path along Damvej, and two smaller dams have been installed to close peat ditches and cause water to accumulate in terraces.

In addition to ensuring favourable conditions for active raised bogs, the project in Aaby Mose has included the involvement of socially disadvantaged people and volunteers as part of the execution of conservation activities. In connection with the project, viewing platforms have been installed; access conditions and communication regarding the area have also been improved.



Podcasts about Store Vildmose:

The viper

Cottongrass: white tufts

Small emperor moth

Women of the bog

Sundew: the carnivorous plant

Ancient stepping stones

Viewing tower

Boardwalk and picnic bench by stepping stones. Photo: Marianne Lindhardt.

Volunteers in Aaby Mose, April 2023. Photo: Søren Rosenberg.

Clearing birches and conifers. Photo: Marianne Lindhardt.

Water in the peat bogs at Damhusvej. Photo: Marianne Lindhardt.

ROLD FOREST — #7 & #8

Rold Skov is rich in raised bogs, formed in moist depressions and old lakes. Over time, many of the bogs have either been drained or planted and are now degraded and forested peat bogs. Of the approximately 25 potential raised bog areas in Rold Skov, there was interest from landowners to include 5 such areas in the LIFE Raised Bog Project. Of these, we succeeded in concluding agreements and executing projects in 3 of the areas. These are Hjorts Mose and Langemose in Rebild Municipality and Brændemose in Mariagerfjord Municipality.

The main activities in executing the restoration of the 3 raised bogs have included clearing unwanted growth (birches and various species of conifers) and raising the water level. The raised water level will allow peat mosses to thrive and grow in the bogs again, while limiting new growth of birches and conifers in particular. In the long term, typical raised bog species, such as cranberry, round-leaved sundew, bog bilberry and common cottongrass, are also expected to be favoured by the wetter conditions.

In the project areas, a positive development has been observed shortly after the project's execution. After the restoration of Langemose, studies show that the two characteristic wetland peat mosses that typically form important first successional steps in the development towards true raised bog, feathery bogmoss and flat-topped bogmoss, increased by over 50% compared to the coverage in 2016.
Based on calculations of coverage rates, we can see that Hjorths Mose has a potential for peat accumulation of over 200 m^3 over the next 100 years, while the figure is 125 m^3 for Langemose.

Dytiscus latissimus (female).

In addition to restoring active raised bogs, the LIFE Raised Bog Project has focused on improving the habitat for Dytiscus latissimus, an endangered species that is part of the classification basis for Rold Skov. This species lives in clean forest lakes, and as part of the project, measures have been taken that may improve the potential habitats for Dytiscus latissimus.

Hjorts Mose before clearing, 2016. Photo: Kenneth Slot.

Hjorts Mose peat bog after clearing. Photo: Roar Skovlund Poulsen.

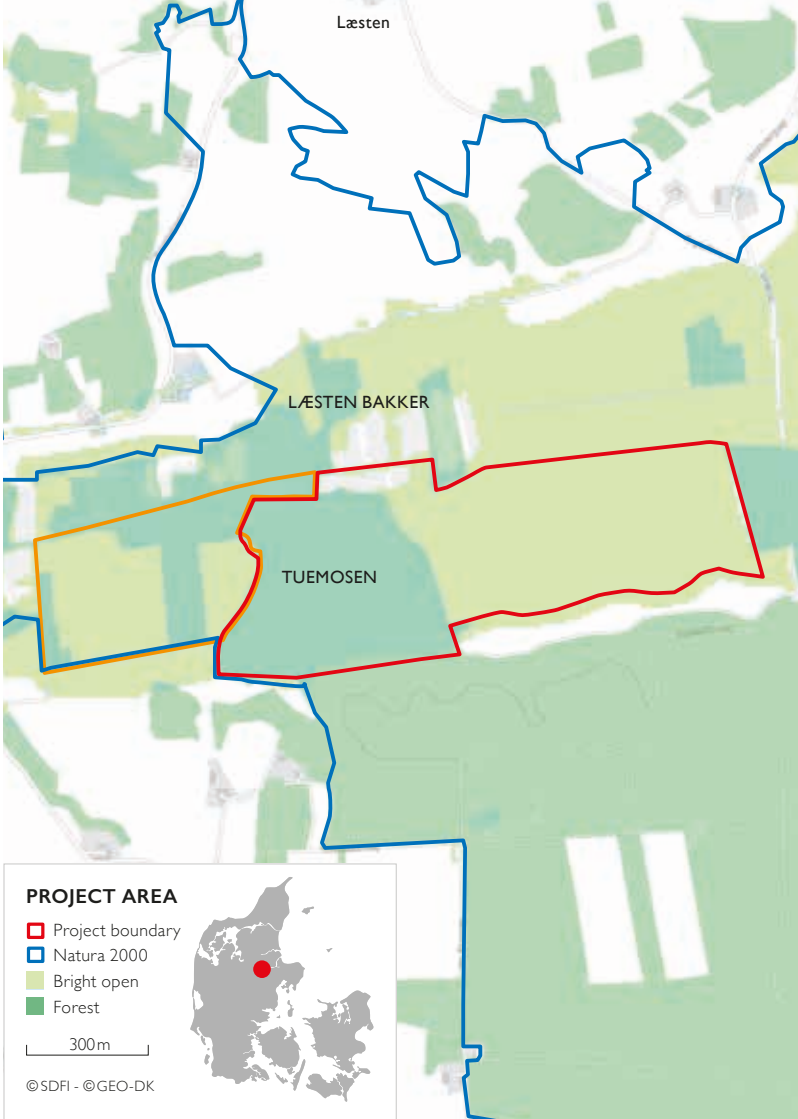
TUEMOSEN — #5 & 6

Tuemosen is nestled between the beautiful Læsten Hills and the large forest areas at Fussingø. The area forms the watershed for the rivers Nørreå and Skals Å, and was previously a large marsh area, including raised bogs. Today, the area consists of wet meadows, bogs and lakes in the former peat bog areas, as well as a pristine forest area (Tuemoseskoven). Vejle Brook cuts through the centre of the bog in an east-west direction. The LIFE project area comprises approximately 40 hectares south of Vejle Brook. The eastern part of Tuemosen is a varied bog area consisting of degraded raised bog and wooded peat bog.

The original project area included the forested part of Tuemosen and private marshland to the west of this area. It was not possible to conclude the necessary landowner agreements for all the privately owned land. Instead, a large meadow area (drained bog) east of Tuemosen has been successfully included. The restoration of this area has included blocking drains and damming two large drainage ditches to the east and west.

The wooded part of Tuemosen is approximately17 hectares and was planted with Norway spruce in1910. However, the forest has been classified as an untouched forest sincethe 1990s. The spruce trees are overgrown; many have fallen, and over time, a more natural swamp forest will take over. The restoration of the wooded area has included unblocking the many small ditches that drained the area, so that natural hydrology has now been restored. With the implemented measures, it is expected that over time, the basis for development towards secondary active raised bogs will be created.

In connection with the restoration of the areas in Tuemosen, measures have also been taken to favour the large white-faced darter, including clearing around water holes to promote the migration of the species.



Ditches in Tuemosen after unblocking. Photo: Jesper Stenild.

Blocking the easternmost ditch in Tuemosen. Photo: Jesper Stenild.

The large white-faced darter.

LØVENHOLM — #1

Gjesing Mose in Løvenholm Skov is located in Norddjurs Municipality in habitat area H43 and Natura 2000 area 47, designated 'Eldrup Skov and lakes and bogs in Løvenholm Skov'. Most of the Natura 2000 area was once part of a very large raised bog complex that stretched for several kilometres across the landscape of Midt-djursland. The project is being carried out in an area called Gjesing Mose.

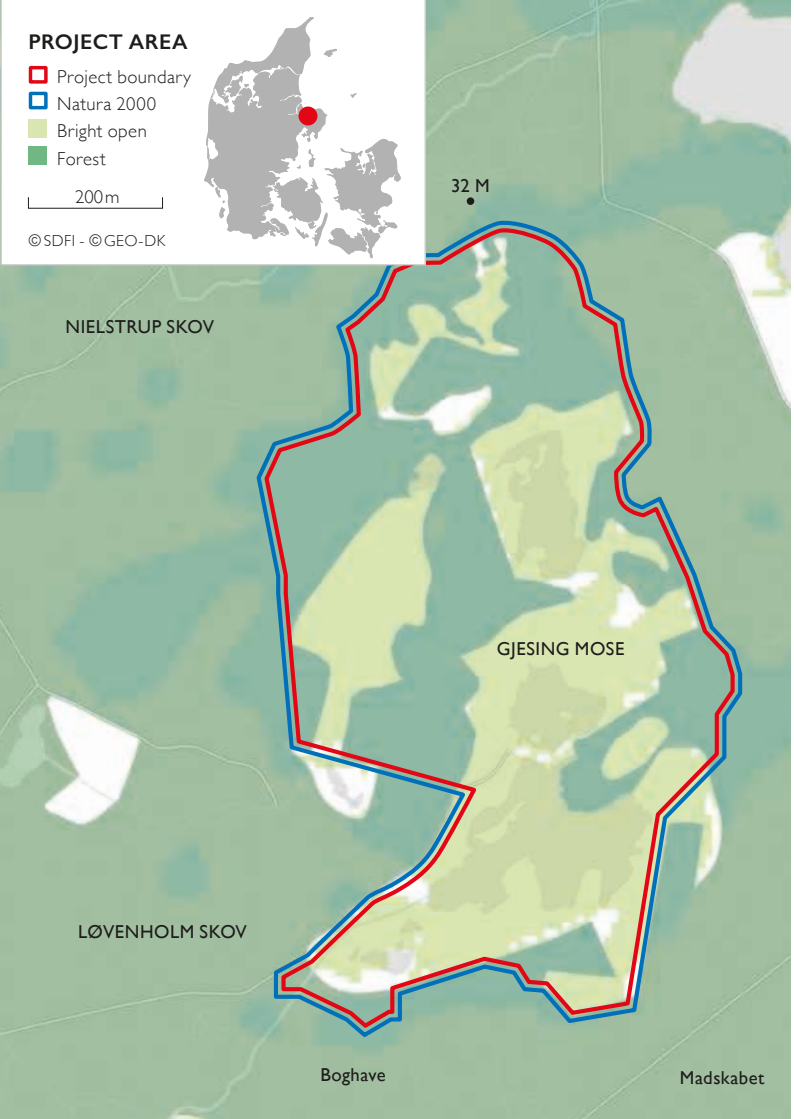
Today, the area contains such habitat types as active raised bog, degraded raised bog, dystrophic lake, floating mat, dry heath, wooded peat bog, and Luzulo-Fagetum beech forest. The majority of these habitat types have emerged in the nature that remains after peat digging in the former raised bogs.

In the northern part of the area, private landowners have dug up peat for their own use in smaller fields and no major drainage has been carried out. This means that in the northernmost part, there are still water-saturated, thick peat layers with vascular plants and peat mosses typical of active raised bogs. The southern part of Gjesing Mose has contained large peat pits, and peat extraction has been much more extensive. Here, peat has been dug up for fuel and peeled away for soil improvement.

The purpose of the efforts in Gjesing Mose has been to create natural hydrology and more open spaces. The change in hydrology has been implemented in a single intervention, meaning that the area is expected to develop into an active raised bog without the need for maintenance. The efforts have also included clearing trees and bushes. To protect the bog from airborne nitrogen,a perimeter zone of trees has been preserved around the recreated active raised bog.

Over time, the project is expected to ensure that approximately 35 hectares of the 62-hectare project area will eventually develop into active raised bogs.

Raising the water level: wetting birches. Photo: Claus Paludan.



Mounds of sphagnum moss. Photo: Malene Krog Sell.

Clearing wood. Photo: Claus Paludan.

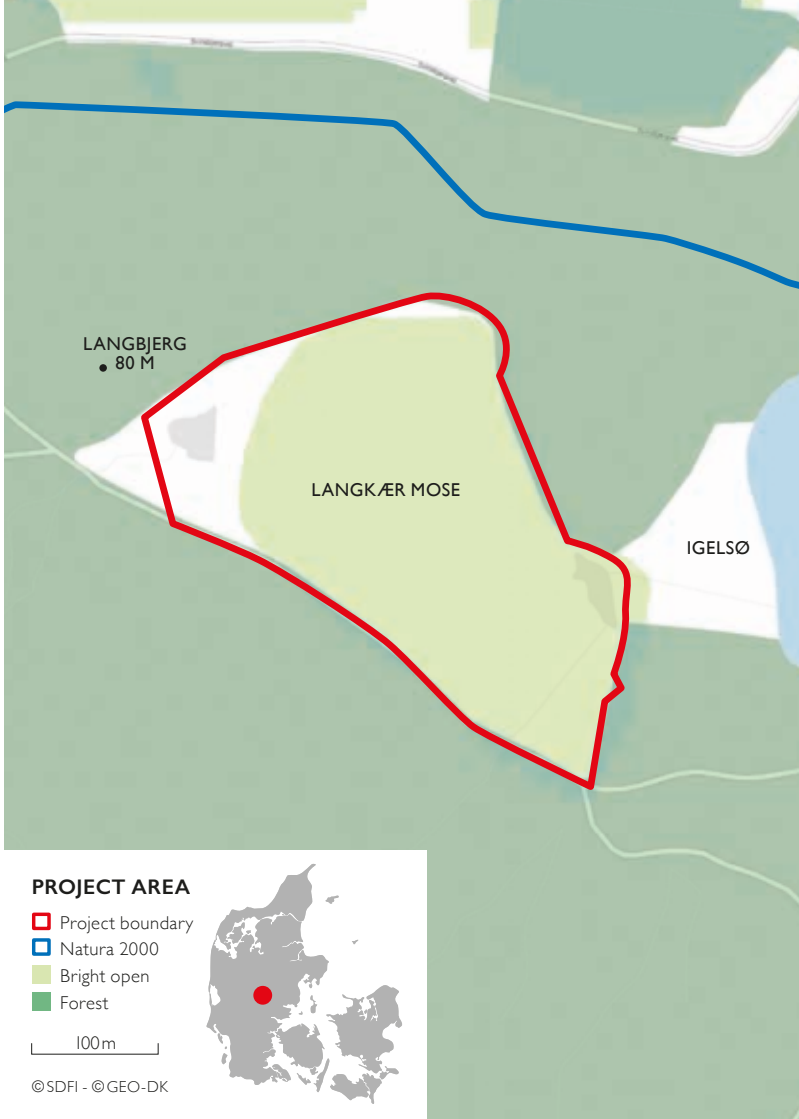
LANGKÆR MOSE — #4

Langkær Mose is a small raised bog southwest of Silkeborg in Velling Skov, owned by the Danish Nature Agency. Drill tests have shown that the raised bog was formed by the overgrowth of a lake and is probably thousands of years old. The peat layer is approx.7.5 m deep in the centre of the northwestern part of the bog. During the 1900s, the bog was drained for use in forestry and grazing, and has only been used for peat digging to a lesser extent.

For Natura 2000 purposes, the raised bog itself has been surveyed as a mosaic of active raised bog and degraded raised bog. Before the restoration, the majority of the bog was either dried out or consisted of excavation areas overgrown with blue willow. In addition, part of the bog was affected by surface water from a stream that follows the course of an old main ditch. There was also a significant overgrowth of woody plants, primarily downy birch.

Following the implementation of restoration measures, including the installation of a membrane and shutters, as well as the clearing of trees and bushes, the water level in the project area has become higher and more stable. The improved hydrology has already resulted in measurable improvements in peat distribution. There has also been a significant decrease in woody plant coverage, a decrease in the coverage of leaf and liverworts, a decrease in the number of problem species and a trend towards an increase in the distribution of positive species.

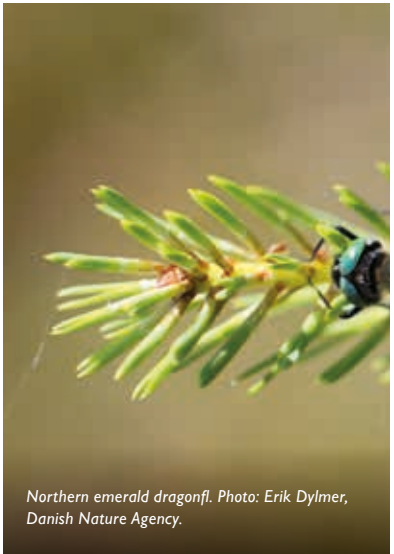
In the raised bog, butterflies characteristic of raised bogs (the cranberry fritillary and cranberry blue) have been recorded both before and after construction. The northern emerald dragonfly, which is associated with raised bogs and floating mats, was rediscovered in the raised bog in 2022 after not being recorded in Langkær Mose since 2012. In addition, a species of spider characteristic of raised bogs, Pardosa sphagnicola, has now also been recorded in the area.



Construction, April 2018 (membrane placement)
Photo: Anne Gro Thomsen.

May 2018 after membrane placement
Photo: Anne Gro Thomsen.

Clearing, 2018 (manual)
Photo: Anne Gro Thomsen.



Northern emerald dragonfl. Photo: Erik Dylmer, Danish Nature Agency.

Pardosa sphagnicola. Photo: Jørgen Lissner, Danish Environmental Protection Agency.

Cranberry blue. Photo: Henriette Bjerregaard, Danish Environmental Protection Agency.

HØNNING MOSE — #9

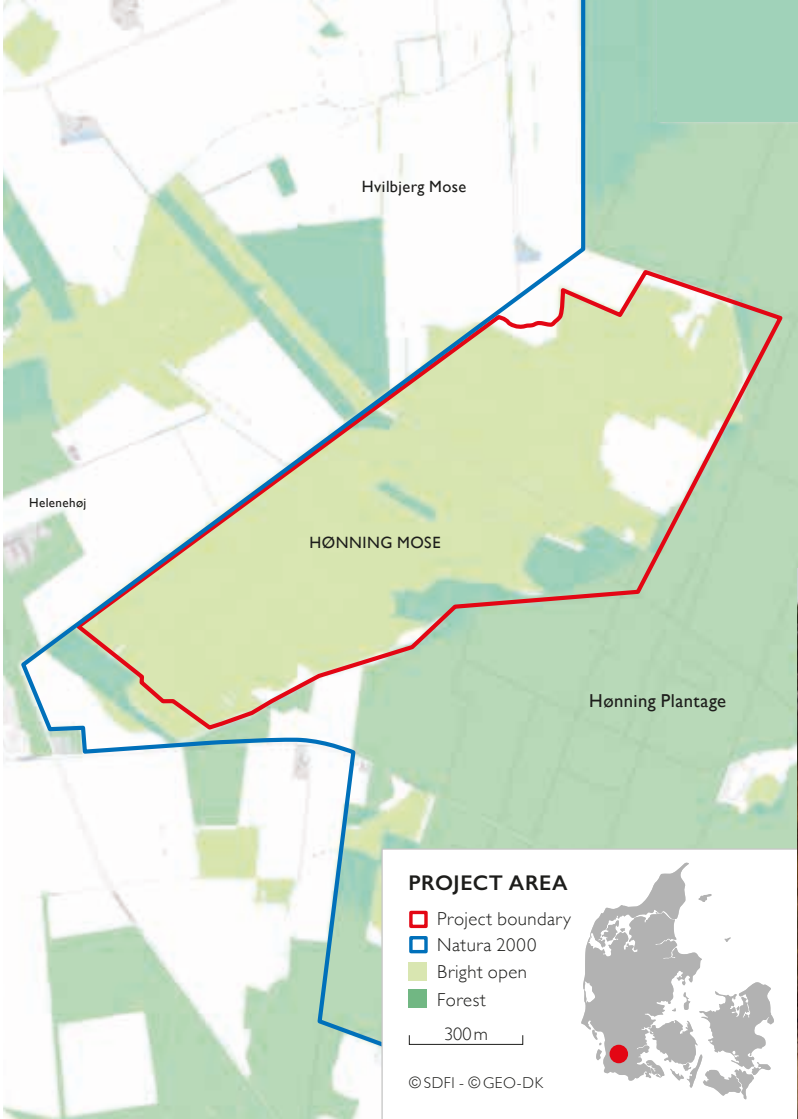
Hønning Mose is located in Tønder Municipality north of Arrild, near Hønning Plantage and Lindet Skov. Hønning Mose has an area of approximately 200 hectares and is part of a larger Natura 2000 area comprising 2,325 hectares of bog, heathland and forest.

The bog area consists of, among other things, degraded raised bog, floating mat, and wooded peat bog. As a result of drainage and peat digging, less than one hectare of the original bog surface has been preserved.
At the start of the project, Hønning Mose was owned by approximately 40 landowners. During the project period, 3 land divisions have been completed. In connection with this, project agreements have been concluded with landowners for project areas with changed drainage conditions.

To restore natural hydrology in Hønning Mose, a 1050-metre dam with a 2-metre-high membrane has been established along the northeastern edge of the bog, and 45 blockages and flow adjustments of pipes and canals have been carried out in the project area.

To limit evaporation from the bog surface, 17 hectares of woodland have been cleared in areas where it is expected that the higher water level will limit the regrowth of woody plants.

The realisation of the project means that the basis has now been created for the development of active raised bogs on up to 120 hectares that are currently degraded raised bogs.



Construction of dam and membrane placement. Photo: Ole Ottosen.

Membrane placement. Photo: Ole Ottosen.

Embankment with membrane along the south-west edge of the bog. Photo: Ole Ottosen.

Adjustable weir. Photo: Ole Ottosen.

KONGENS MOSE — #10

Kongens Mose is located in Tønder Municipality between Tønder and Løgumkloster. The project area makes up a large part of Kongens Mose and, together with Draved Skov, is part of a larger Natura 2000 area of bog and forest. The project area includes approximately 165 hectares, of which approximately130 hectares are privately owned.

At the start of the project, Kongens Mose was owned by approximately 20 landowners. During the project period, 2 land divisions were completed. As part of this, the landowners have entered into wetland declaration agreements for the project areas.

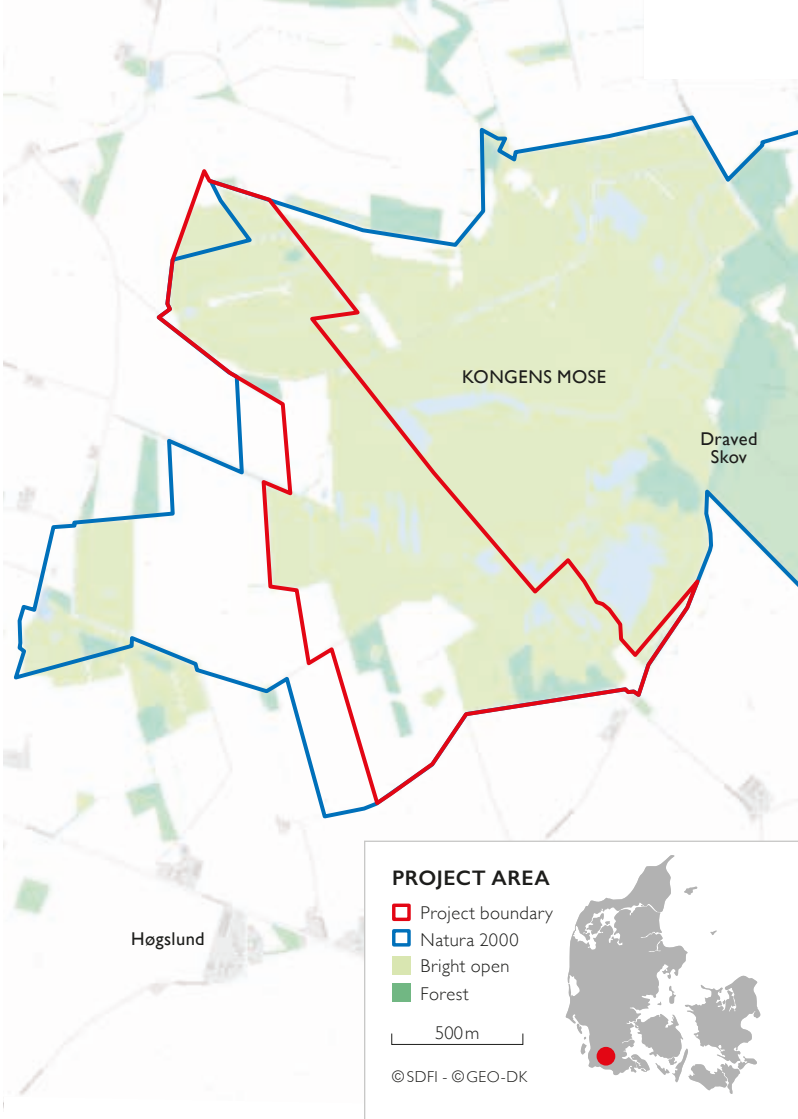
As in many other bogs, Kongens Mose still shows traces of previous peat digging. In Kongens Mose, excavation was very intensive during World War II. During World War I, attempts were even made to cultivate portions of the bog. In the period from 2007 to 2011, as part of a LIFE project, a restoration of the state-owned part of Kongens Mose, located to the northeast of the project area, was carried out.

Approximately 16 hectares of active raised bog have been registered in Kongens Mose, of which 2 hectares are located in the project area. With the realisation of the project, a foundation has been created for the development of active raised bogs in approximately 100 additional hectares of the project area.

The project has involved clearing trees and bushes on over 23 hectares and subsequently blocking pipelines and damming or filling the canals in the project area.

Listen to the podcast:

Restoration of Kongens Mose



Podcasts about Kongens Mose:

The dragonfly and the nymph

The snake in the bog

Sundew: the carnivorous plant

The Russian Quarter

The forest and the bog

Teltkro and peat bits

The Shrike, a.k.a. 'The Butcher'

Damming of large drainage canal at Teltkro. Photo: Ole Ottosen.

Kongens Mose after restoration. Photo: Ole Ottosen.

Tree felling. Photo: Ole Ottosen.

HOLMEGAARD MOSE — #2

Holmegaard Mose is located in Næstved Municipality. It is the largest raised bog in eastern Denmark with 450 hectares, originally even more. Holmegaard Mose is privately owned. Just south of the bog is Holmegaard Glassworks, which still produces industrial glass. The buildings of the old glassworks are home to a museum, Holmegaard Værk. The glassworks has been digging up peat for fuel for 200 years. The many open peat bogs testify to the most recent exploitation during World War II up to the early 1950s.

After Holmegaard Mose became part of a landscape conservation programme in 2009, LIFE projects were carried out in the periods from 2010 to 2013 and 2015 to 2023 to create the conditions for the area to develop into an active raised bog again. To ensure a favourable water level, membranes have been buried along longer sections, and sheet pile has been inserted where leaks have been located. To prevent nutrient-rich water from entering the project area, a large cut-through ditch has been diverted. To reduce evaporation, trees and bushes have been cleared and enclosed on 27 hectares. In order to improve the conditions for Graphoderus bilineatus and the large white-faced darter, light-penetrable shallow banks have been created at 5 peat ditches.

The project has also focused on involving vulnerable citizens in nature conservation in collaboration with Næstved Municipality. Volunteers have been regularly involved in conservation tasks, and in collaboration with Holmegaard Værk and the owner of the bog, efforts have been made to communicate the nature of the bog and nature management to the public. To that end, a small information centre—a so-called "ecobase"—has been built on the museum's grounds at the edge of the bog. In addition, 8 large information boards and a leaflet have been created. Finally, 10 audio stories have been produced that visitors to the bog can stream.

Series of A0-sized information boards.

Podcasts about Holmegaard Mose

Denmark's largest spider: Dolomedes

Birds in the bog

Dragonflies in the bog

Reptiles in the bog

Carnivorous plants

A rare diving beetle

Deer in the bog

Clearing of overgrown raised bogs. Logging machine travelling on felled timber to avoid sinking. Photo: Danish Nature Agency Storstrøm.

Listen to the podcast:

Restoration of Holmegaard Bog

Students from the Forestry and Nature Technology programme clear birch regrowth. Photo: Danish Nature Agency Storstrøm.

Peat sample taken with a drill bit. Photo: Rune Larsen.

HABITAT SPECIES AND OTHER PLANT AND ANIMAL LIFE ASSOCIATED WITH THE RAISED BOG

THE WILDLIFE OF THE RAISED BOG

The project areas in the LIFE Raised Bog Project are characterised by nutrient-poor ecosystems with species adapted to the austere habitats. In five of the project areas, in addition to the restoration of raised bogs, there has also been a focus on securing and improving habitats for three species characteristics of raised bogs: the large white-faced darter and the diving beetles Dytiscus latissimus and Graphoderus bilineatus. The species are associated with areas with open water surfaces in the raised bog.

In the project, banks have been cleared and gentle levelling of the banks along the waterholes has been carried out. Habitat improvements have been carried out at 8 locations, and in addition, the Danish Nature Agency has carried out habitat improvements at another 5 suitable waterholes within the entire habitat area in Rold Skov. This means that the LIFE Raised Bog Project has met its target of at least 11 habitat improvements for the three insect species.

Dytiscus latissimus has not been recorded in Rold Skov during the project period, but there are considered to be suitable habitats for the species. The same is true for the large white-faced darter in Tuemosen near Fussingø. Holmegaard Mose is home to both the large white-faced darter and Graphoderus bilineatus, but the habitat improvements carried out late in the project period have not yet been reflected in larger populations. The species are searched for using both conventional traps and, in the case of Graphoderus bilineatus, analysis of water samples for characteristic DNA.

The short-eared owl often hunts at dusk or in the morning, making it more diurnal than other owls.

Dolomedes, Denmark's largest spider.

The wood sandpiper is rare as a non-migratory bird, but it is seen migrating through Denmark.

Cranes can be found in Denmark both as migratory and non-migratory birds.

Heather in bloom.

HABITAT SPECIES AND OTHER PLANT AND ANIMAL LIFE ASSOCIATED WITH THE RAISED BOG

THE FLORA OF THE RAISED BOG

The vegetation of the raised bog is characterised by the presence of peat mosses (Sphagnum species) and a few other higher plant species, such as heather, species of cottongrass, bog rosemary and cranberry. As the raised bog develops naturally, the dead plant remains accumulate in the bog and peat is formed. In a mature raised bog, the peat layer can be many metres thick. As a result of the implementation of the LIFE Raised Bog Project, monitoring of the vegetation shows increased coverage of peat mosses, which is an important sign that the restored areas are in a positive development towards the formation of active raised bogs. In the long term, increased distribution of the most peat-forming peat mosses, such as red peat moss, is expected. In some project areas, the cover of woody plants has increased during the project period, even though clearings have been carried out. This shows that continued clearing efforts in the years after the project will be important to maintain the project's results.

Sundew with prey.

Variegated peat moss. Photo: Irina Goldberg.

Common peat moss. Photo: Irina Goldberg.

Feathery bogmoss. Photo: Irina Goldberg.

Red peat moss. Photo: Irina Goldberg.

Hare's-tail cottongrass.

Bog-myrtle gives the bog its characteristic smell.

Round-leaved sundew.

The sphagnum greyling is a parasite of sphagnum moss.

Stiff clubmoss.

The large white-faced darter.

Cranberries grow on peat mosses.

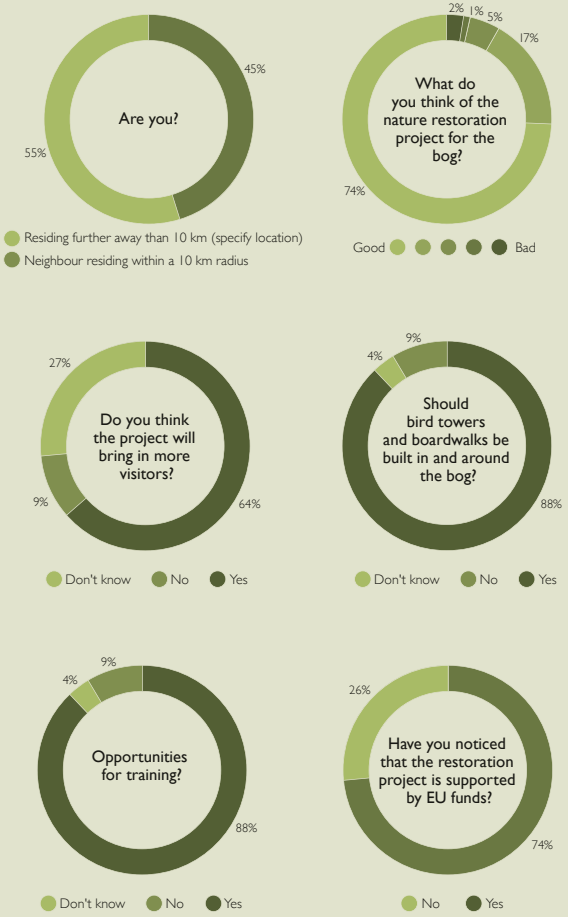
Western marsh harrier (male) collecting nesting material.

COMMUNICATING AND INVOLVING THE PUBLIC

From the beginning of the LIFE Raised Bog Project, there has been a strong focus on providing information about the project and the individual sub-projects.
Relevant information about the LIFE Raised Bog Project and the individual sub-projects can be found on the project website www.raisedbogsindenmark.dk

In most project areas, several public events with guided tours have been organised. At the events, nature guides and project managers have provided information about the individual projects and the great importance of restoring active raised bogs for biodiversity, the climate, etc. In connection with public events at the beginning and end of the project period, surveys were conducted to gain a better understanding of citizens' opinions and wishes for the raised bog projects. Most public tours in the project areas have been well attended.

It can be seen that the participants in the publicly advertised events mainly belong to the older generations. From the results of the surveys, it appears that over 80% of participants are over 50 years old. The surveys also show that almost all participants on the guided tours wanted preservation of vulnerable natural areas, public access to them, and good public facilities. Most of the participants were aware of Natura 2000 and the fact that the EU co-finances the project.



A selection of questions and answers from the survey. 369 people responded.

Nature conservation day in Holmegaard Mose. Photo: Rune Larsen.

Nature conservation days in Store Vildmose. Photo: Marianne Lindhardt.

Packed lunch centre with information boards in Holmegaard Mose. Photo: Danish Nature Agency Storstrøm.

Series of information boards in Holmegaard Mose.

Series of pictograms with QR codes for the podcast in Holmegaard Mose.

COMMUNICATING AND INVOLVING THE PUBLIC

In most project areas, permanent information boards have been erected to provide information about the restoration measures and the purpose of the project. At Holmegaard Mose, a so-called "ecobase" has been built. The ecobase is a covered, open information centre with 8 large information boards, as well as tables and benches that can be used by school classes, kindergarten children, and everyone else.

In connection with the Store Vildmose project, a large viewing platform has been installed in the south-eastern part of the project area, giving visitors a great view of the raised bog. A hiking/cycling path has also been established along the south-eastern edge of the project area for public access. In the northern part of Aaby Mose, an area has been equipped with benches, a boardwalk, and a small viewing platform.

In Store Vildmose and Holmegaard Mose, many voluntary conservation activities have been carried out in connection with the LIFE Raised Bog Project. The volunteer work is carried out on conservation days planned in collaboration with the Danish Society for Nature Conservation. Conservation measures have primarily involved the removal of unwanted vegetation. The experience from Holmegaard Mose showed that participants are committed, and that it is important that volunteers be assigned care tasks where a visible result can be clearly achieved, such as by assigning the volunteers small, delineated bog areas in which to work.

As a new form of information, the LIFE Raised Bogs Project has produced a series of short podcasts that vividly provide information about the special characteristics of raised bogs. Three general podcasts have been created and are available from the project website and from info boards in the project areas. For the Kongens Mose, Holmegaard Mose and Store Vildmose project areas, a number of podcasts have also been created that describe the specific conditions at these raised bogs.

Marianne Lindhardt from Jammerbugt Municipality tells nature conservationists from DN about the Life project in Store Vildmose. Photo: Karen Filskov.

Boardwalk and viewing platform in Store Vildmose. Photo: Marianne Lindhardt.

Autumn tour in Langkær Mose, 2023. Photo: Anne Gro Thomsen.

Information board in Store Vildmose. Photo: Marianne Lindhardt.

CO-OPERATION AND EXCHANGE OF EXPERIENCE WITH OTHER PROJECTS

The LIFE Raised Bogs project is far from alone in its vision and efforts to improve the conservation status of raised bogs. In fact, in recent years, the EU LIFE programme has supported the restoration of raised bogs in many other places in Northwest Europe. Not only from a nature perspective, but also from a climate perspective. The LIFE Raised Bogs project has collaborated with many of these projects to increase shared knowledge and understanding of the ecological functionality of raised bogs and the most appropriate restoration methods.

The LIFE Raised Bog Project has visited raised bogs in Estonia, the UK and Ireland to get a reference point for natural and virtually untouched bogs. This is important knowledge that has been taken into consideration when restoring Danish bogs. Wales and England face many of the same challenges with restoring remnants of raised bogs as Denmark, but the restoration methods are different. For example, 'bunding' is used, which can best be described as digging through a bog in trenches, breaking up the drainage, and then compressing the peat firmly. This creates a barrier in the peat and retains water on the surface of the bog. In Denmark, artificial waterproof membranes are used instead, placed vertically in the peat.

The LIFE Raised Bog Project has also collaborated with similar projects in Denmark, where parallel efforts have been made for the raised bogs in Lille Vildmose in North Jutland and in Horreby Lyng on Falster. In these projects, the bogs are owned by nature funds or are partially publicly owned, providing good opportunities for communication. This is also the case in some of the bogs in the LIFE Raised Bog Project, but some of the project areas are still privately owned, and so opportunities for public outreach are limited.

The LIFE Raised Bog Project has endeavoured to put raised bogs on the agenda in the nature and climate debate. The project has been represented at conferences on the insect life of raised bogs and the climate significance of raised bogs. In particular, this has helped to strengthen international co-operation on the restoration of raised bogs in Northwest Europe and is likely to be of great importance for establishing future projects focusing on the conservation and restoration of peat-rich habitats.

Exchanging experiences on a trip to Wales. Photo: Marie Roland.

Project Manager Robert Duff, Natural England, provides an update on the LIFE Raised Bog Project for Marches Mosses. Photo: Ole Ottosen.

Project Manager Jack White, Natural Resources Wales, provides information about the LIFE Raised Bog Project for Cors Caron. Photo: Ole Ottosen.

Justin Lyons, Natural Resources Wales, provides information on the LIFE Raised Bog Project for Cors Fochno. Photo: Ole Ottosen.

Information exchange regarding Welsh and Danish raised bog projects. Tregaron, 19 June 2023. Photo: Claus Paludan.

RECOMMENDATIONS

The goals set for the LIFE Raised Bog Project have generally been met, and many other positive results have been achieved that support a number of national goals for bio-diversity, climate and the environment.

During the project period, several issues arose, which meant that the execution of many of the projects was delayed and some projects had to be abandoned.

Based on the experiences of the LIFE Raised Bog Project, a number of recommendations can be made.

ENSURING HIGH QUALITY: SECOND OPINIONS AND BEST PRACTICES

In the LIFE Raised Bog Project, all project areas were visited by an invited group of experts together with the project managers as one of the first steps. Based on the recommendations of the expert group, adjustments were made to the project content for many of the project areas. This approach ensures that the technical studies and subsequent detailed designs have the right focus and best practices are applied.

The LIFE Raised Bogs Project has also visited several foreign and Danish raised bog projects and participated in several other events where valuable contacts have been made and experiences exchanged. Visits to Wales and England, for example, have provided new knowledge about methods for restoring raised bogs, which can be valuable for future Danish projects.
It is recommended to organise an experience exchange trip to other similar projects early on in the project so that the latest experiences can be taken into consideration in the final project design.

IMPROVING THE POSSIBILITIES FOR PROJECT REALISATION - LEGISLATION AND COMPENSATION

It may seem strange that it is often very difficult to implement nature-improving projects that are necessary to achieve politically agreed-upon targets for nature, the environment and the climate. Experience from the LIFE Raised Bog Project shows that even within the designated Natura 2000 areas, it can be difficult to implement the necessary nature improvements.

It is recommended that efforts are made to create better conditions and incentive structures for executing projects that are necessary to meet politically agreed-upon goals.

Nature projects inside and outside Natura 2000 areas often have to be abandoned due to opposition from individual landowners. As previously described, this may be due to unrealistic expectations of compensation, or unwillingness to change existing conditions due to hunting interests or similar conditions.

There is no doubt that land consolidation and access to compensatory or supplementary land improves the chances of concluding voluntary agreements. Land consolidation is a well-known tool for farmers, which, in addition to freeing up land for nature projects, can in some cases ensure better levelling of production areas and thus pave the way for larger contiguous nature areas.

In this context, it is recommended that better opportunities are created in advance for the project holder to acquire land in the surrounding area, so that the project can offer attractive compensatory land to landowners who may desire it.

For landowners without agricultural land in particular, it can be difficult to conclude a voluntary agreement with the currently available measures. To ensure the success of future nature restoration projects, the current model for compensation will need to be adjusted, and consideration should be given to whether it should be possible for a single landowner who holds a small area to block a large, cohesive nature project that otherwise has strong landowner support.

In this context, it should be remembered that just 50 – 100 years ago, many former natural areas where nature restoration is now desirable from a climate and biodiversity perspective were drained—despite the objections of a minority of landowners.

Construction of a membrane-based dam in Hønning Mose.
Photo: Ole Ottosen.

RECOMMENDATIONS - CONTINUED

REGULATORY PROCESSING, FRAMEWORK CONDITIONS AND FINANCING

Based on the project's experiences in connection with regulatory processing, it is recommended to devote attention to early involvement of the relevant authorities, so that a mutual alignment of expectations can be established regarding the quality and content of the application materials, as well as the expected processing times.

In order to succeed with these often complex and resource-intensive projects, it is important to ensure that project managers and authorities alike have the right framework conditions to prioritise their efforts.

The LIFE Raised Bog Project has primarily been funded by EU LIFE funds and by state funds, which were crucial for the realisation of the project. The state funding comes from an annual pool of 25 million DKK, which in a previous budget period was earmarked specifically for co-financing LIFE projects.

In order to continue efforts to achieve the goals set out in current and future Natura 2000 plans, it is crucial that the state once again allocates funds for the execution of LIFE projects and thereby increases the possibilities of obtaining EU funds. At the same time, efforts should be prioritised—for example, by drawing up a so-called PAF, as requested by the EU.

INVOLVEMENT IN NATURE MANAGEMENT AND NATURE COMMUNICATION

Raised bogs are a very special kind of nature. Especially in the country's fertile regions, there is a big contrast in moving from the ordinary open countryside into the nutrient-poor raised bogs. Perhaps this is part of the reason why raised bogs seem to have a special appeal in terms of citizen involvement in nature management and their interest in the nature of raised bogs.

Leslet in Holmegaard Mose.
Photo: Danish Nature Agency Storstrøm.

The LIFE project's ability to support the involvement of vulnerable citizens in nature conservation, the formation of volunteer groups and the establishment of new communication efforts around these areas has strengthened the anchoring of the raised bogs in the local community. This is also suggested by the responses to the surveys in the project. It is the project's recommendation that the local project owners endeavour to maintain this commitment in future developments in the areas.

PERSPECTIVE: FOLLOW-UP AND CLIMATE DEVELOPMENT

The LIFE Raised Bog Project is one of several EU-funded projects in Denmark focusing on the restoration of raised bogs, an endangered habitat type. Thus, there are now a few decades of experience with the long-term perspective on nature restoration for raised bogs. At the end of the LIFE Raised Bog Project, there are two important points to emphasise in relation to future work.

Firstly, there will often be a follow-up phase after the initial intervention has been carried out in the LIFE project. This need is described in management plans for the individual project areas and in an After-LIFE plan. For example, experience has shown that a very significant amount of wetting of degraded raised bogs is required to prevent the regrowth of downy birch. Therefore, follow-up repeated clearings may be needed. Furthermore, cracks in old peat layers and invisible leaks mean that raised bogs must be revisited several times to ensure that it they are 'watertight'. The financing options for these efforts should be looked into after the LIFE project ends.

Maintenance of light-permeable habitat types is currently possible with specific subsidy schemes under the Danish rural development programme. However, these schemes do not apply to raised bog habitat types, which is due to the fact that historically, there has not been awareness of any operational needs in raised bogs — not even in a transitional period.

In some places, grazing (e.g., with sheep) can be an effective method in the maintenance phase before the raised bog becomes more or less maintenance-free, as it was originally. However, there will also be a need for a version of the subsidy model targeted at raised bogs and without follow-up grazing. It is recommended that the current subsidy rules be adjusted so that the management of raised bog habitats can also be handled by these schemes, which will be important to support the LIFE initiative.

Secondly, during the project period in the LIFE Raised Bog Project, we have experienced how the extreme climate in Denmark negatively affects the project areas. Persistent drought is particularly problematic for the restoration of active raised bogs because the growth of peat mosses on restored areas stops and, conversely, the tussock-forming species of raised bogs increase in distribution. The planning of future raised bog projects should therefore include hydrological solutions that can limit the negative impact of these drought events.

Store Vildmose. Photo: Marianne Lindhardt.

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