LAYMAN'S REPORT

Nature restoration at *Lille Vildmose*

LIFE project 2011-2019 – Denmark's largest raised bog project

Ministry of Environment and Food of Denmark
Nature Agency

Aalborg Kommune

LIFE10 NAT/DK/000102

Tofte Mose
Photo: Mara Pakalne

Introduction

Lille Vildmose is the only place in Denmark where you can experience both the majestic golden eagle and the white-tailed eagle with their fledglings at the same time, and nowhere else will you experience such diverse nature as in the two natural forests of *Høstemark Skov* and *Tofte Skov*. However, most unique of all in *Lille Vildmose* are the large areas of the unique type of bog called a 'raised bog'. *Lille Vildmose* is home to more than half of all the raised bog area in Denmark and to by far the most well-preserved areas, with *Tofte Mose*, and its approx. 2,000 hectares of bog, as perhaps the most unique natural habitat in Denmark.

Raised bogs are today a rare and endangered natural habitat type due to farming, draining, overgrowing and eutrophication. This also applies to *Lille Vildmose*, where thousands of hectares of raised bog have been excavated and the majority of existing raised bogs are in the process of overgrowing or draining.

To improve and protect the rare natural habitats in the EU, in 1992 the EU adopted its Habitats Directive. According to the Directive, raised bogs are among the most endangered habitat types in the EU. Raised bogs are a so-called priority natural habitat type.

Because of the large occurrence of raised bogs at *Lille Vildmose*, the site has been designated as a Natura 2000 site. Denmark is obligated to protect and improve the status of nature in Natura 2000 sites. Hence, the LIFE *Lille Vildmose* project was launched. The project was carried out in the period 2011-2019.

The concept behind the LIFE project was primarily to protect the remaining areas of raised bog, including the raised bogs known as *Portlandmosen*, *Paraplymosen* and *Høstemark Mose,* as well as the northern margin of *Tofte Mose*.

Cover photo: Cotton grass in former peat-cutting trench
Photo: Jan Skriver

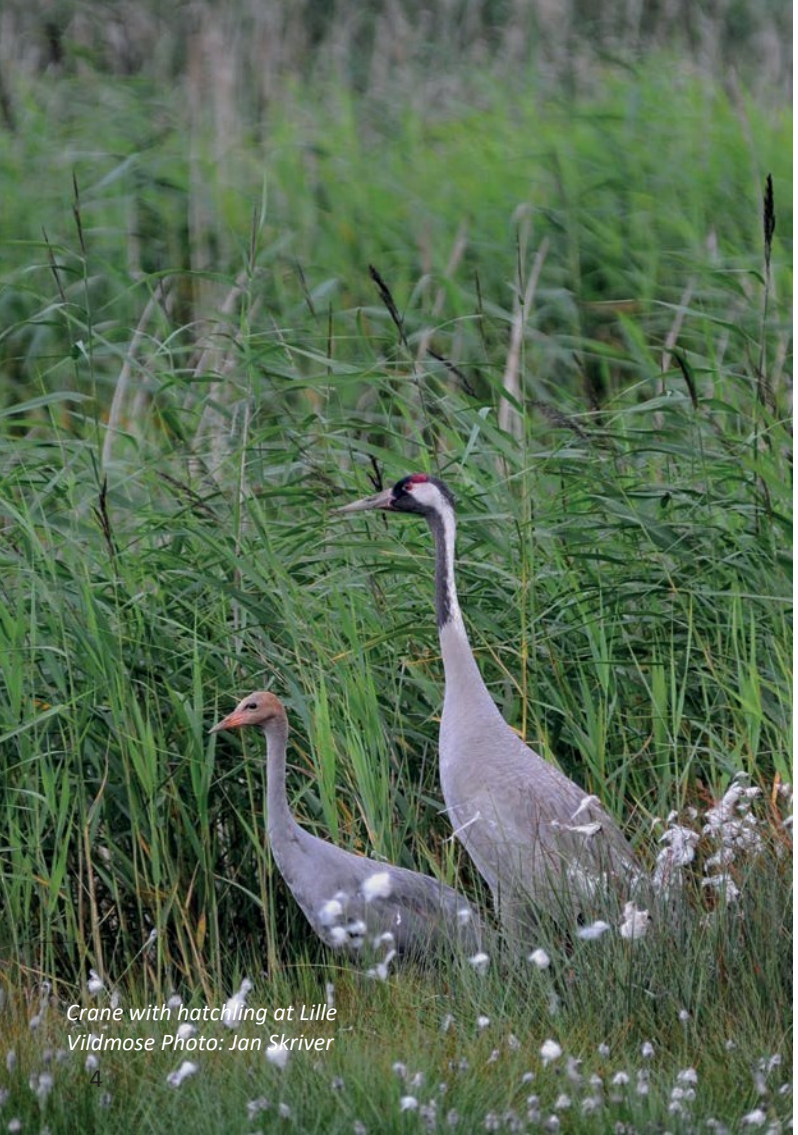
This was ensured through hydrological initiatives including the establishment of large dams along the edges of the bog. Secondarily, the idea was to connect the remaining areas of raised bog ecologically by establishing optimal hydrological and biological conditions throughout the area known as *Mellemområdet*. At the start of the project, these areas were drained, abandoned peat-harvested areas. Finally, the project aimed to create the right conditions for long-term and optimal conservation of the 2,000-hectare *Mellemområdet*. This was accomplished by establishing a 27km-long and more than 2m-high wildlife fence and by introducing red deer. The intention was to create what would more or loss amount to a natural multi-species grazing system, where large ecologically important species such as red deer, elk, European bison, wild horses, and more could eventually play a natural role in rewilding the site.

The project was a collaboration project between the Danish Nature Agency, the Aage V. Jensen Naturfond and the City of Aalborg. Furthermore, several other collaboration partners and contributors were also involved, including the Danish Ornithological Society - BirdLife Denmark, the Lille Vildmose Centre, Vildmoseforeningen (Friends of Lille Vildmose) and Lille Vildmose Naturfond.

LIFE is the EU's funding instrument for the environment, nature and climate. The programme provides support for projects which contribute to implementing EU climate and environment policy. The project at *Lille Vildmose* belongs under LIFE Nature, which is aimed specifically toward nature protection and nature restoration in Natura 2000 sites.

In the case of *Lille Vildmose*, this means creating a favourable conservation status for active raised bogs and for several species that rely on the raised bog as their natural habitat.

Red deer in Birkesø hollow
Photo: Jan Skriver



Crane with hatchling at Lille Vildmose Photo: Jan Skriver

Natura 2000 site

Lille Vildmose is a part of the European Natura 2000 network of natural habitat types. According to the Natura 2000 plan for *Lille Vildmose*, the natural habitat types (such as bog woodland) in the area today because of draining and peat harvesting, will be replaced by interconnected areas of active raised bog.

The total project area is 7,824 hectares. The whole area contains approx. 2,000 hectares of active raised bog, 250 hectares degraded raised bog and 190 hectares of bog woodland. Furthermore, the central part of the project area also contains grazing areas (*fenner*) and cultivated fields.

The designation for the Nature 2000 site also covers a number of animal and bird species. These include otter, black stork, golden eagle, crane, short-eared owl, and wood sandpiper. The LIFE project aims to improve habitat conditions for these species through various actions launched under the project.

Lille Vildmose

Paraplymosen
Høstemark Skov
Høstemark Mose
Portland-mosen
Mellemområdet
Dokkedal
Kongerslev
Birkesø
Tofte Sø
Tofte Mose
Tofte Skov
Øster Hurup

Natura 2000
Projektområde

0 2 4 8 km

Common sundew thrives in the raised bog
Photo: Jan Skriver

Active raised bogs

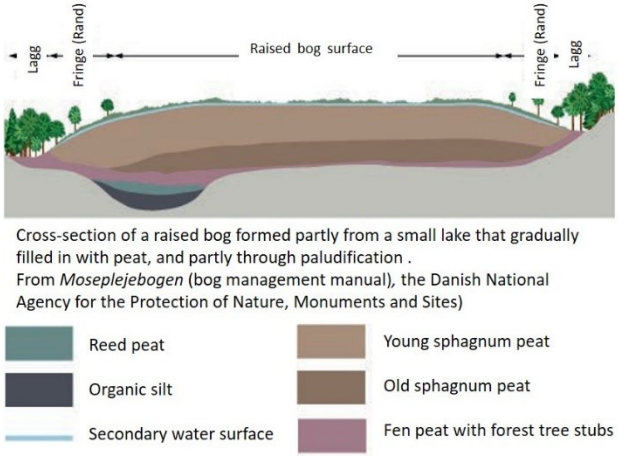
Raised bogs are among the few habitat types that are self-sustaining and that can remain unchanged over a very long time. Raised bogs used to cover large areas of Denmark, but most of these areas have disappeared due to drainage, peat cutting and farming. *Lille Vildmose* is a unique exception. The area today holds approx. 83% of the total preserved raised bog area in Denmark. *Lille Vildmose* is moreover the largest remaining area of active raised bog in the North European Plain.

Pristine, raised bog habitats are stable ecosystems with peat layers made primarily from peat mosses (sphagnum). Raised bogs only occur where precipitation exceeds evaporation, and raised bogs lie above the water table and therefore only receive water from precipitation.

Raised bogs are naturally nutrient-poor and acidic environments, home to only a few, indigenous species. Raised bogs are defined by their vegetation mix, hydrology or by their ability to accumulate peat from sphagnum.

The formation of peat is the most important characteristic of raised bogs. The peat serves as a sponge that holds onto the water.

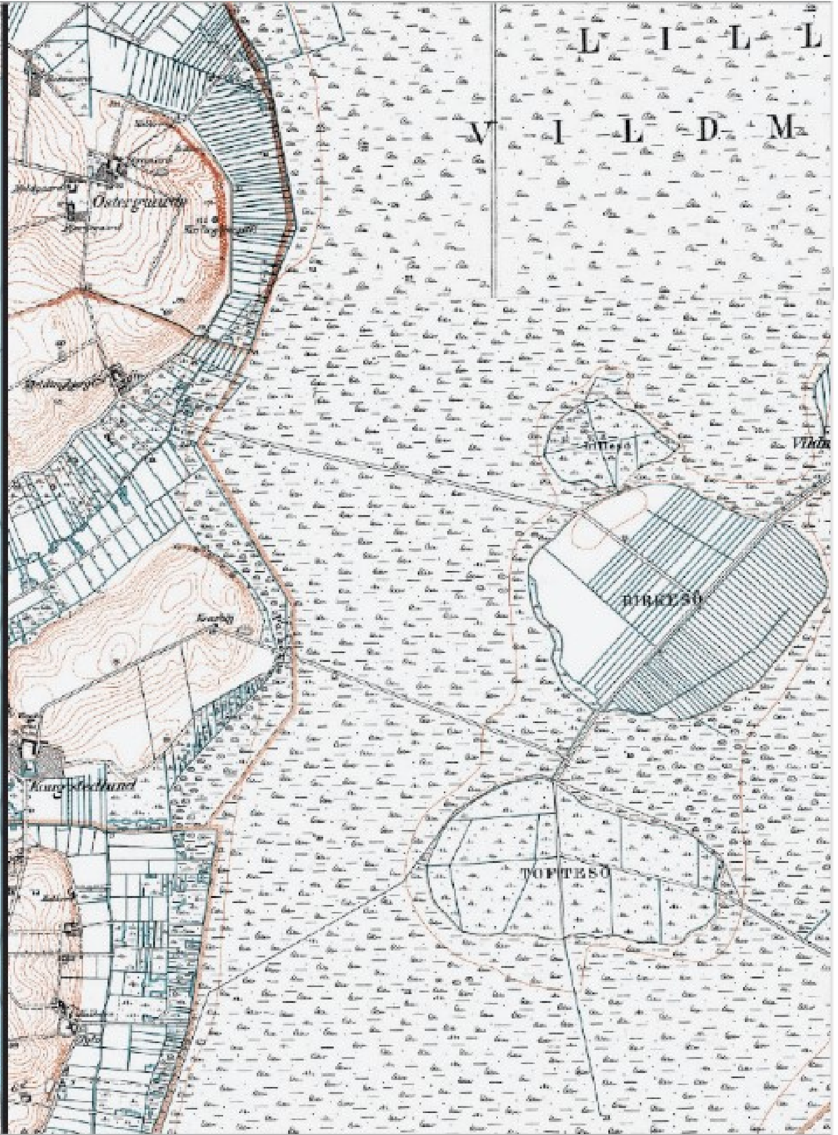
In order to return *Mellemområdet* at *Lille Vildmose* to active raised bog, the first important step was to ensure the right conditions for peat-forming sphagnum vegetation. The right conditions were established through various activities described in more detail below. As a result, the conditions in *Mellemområdet* are expected to become favourable enough for sphagnum to establish itself over the next couple of years. However, it will take several hundreds of years to fully restore the naturally active raised bog.



Cross-section of a raised bog formed partly from a small lake that gradually filled in with peat, and partly through paludification .
From *Moseplejebogen* (bog management manual), the Danish National Agency for the Protection of Nature, Monuments and Sites)

Peat mosses act as sponges, retaining rainwater and they acidify their surroundings
Photo: City of Aalborg


LILLE
VILDMOSE
TOFTE SKOV


L I L L
V I L D M
BIRKESÖ
TOFTESÖ

Historical map of *Lille Vildmose*

Lille Vildmose is a very young raised bog. It was formed in the period from around 400 AD, when peat mosses started to grow in a shallow reed marsh in a former coastal lagoon behind islands and beach ridges along the current Kattegat coast. In only 400 years, the peat mosses grew to cover an area of approx. 55km^2, depositing so much peat that the top-most vegetation was no longer in contact with the groundwater. Around the year 800, the raised bog was a reality. The bog continued to grow, reaching a peat layer of up to 5 meters when the first drainage project was completed in 1761-69, which involved draining the four central lakes.

Up through the 1800s, trenching and peat cutting took place along the edges of *Lille Vildmose*. Most of the bog was left untouched as raised bog up until 1937, when the state began to drain and farm a 28km$_2$ area in the central parts of the bog north of the lakes.

The old topographical map is based on the General Staff topographic department's land survey from 1879-80 (corrected in 1937 and again in 1943), and the northernmost part of the map shows the expanse of the raised bog at the time of the commencement of the comprehensive drainage activities. The bog is surrounded by intensely farmed land with many drainage trenches and with cutover areas from peat cutting along the margins.

The map shows the four drained lakes and the Langelinie road from *Birkesø* to *Kongstedlund*, which was established in 1876 as the first road across the bog. In 1931-36, came *Vildemosevej* from *Birkesø* to *Kongerslev*. The map also shows the two new roads, *Hegnsvej* and *Møllesøvej*, and partly also *Ny Høstemarkvej*, which was commenced in 1937. Because of the update in 1943, the map also shows the first drainage trenches in the northern part of the bog as they appeared in 1943. At this time, the western part of the bog had been sold to the large cement-producing company, Aalborg Portland, which carried out extensive peat extraction in the area during the war.

Old topographical map, 1937

Great egret at Lille Vildmose
Photo: Dorte and Flemming Sørensen

A LIFE project to restore raised bog areas at *Lille Vildmose*

The intensive drainage and peat extraction that have taken place at *Lille Vildmose* over the past 250 years cannot be continued if the goal is to restore the active raised bog.

When water is drained from a raised bog, the peat begins to decompose. Nutrients are released, and the soil becomes less acidic. This makes the soil attractive for birch and other trees, and the trees dry out the remaining bog even more. Some of the initiatives in the LIFE project include clearing trees and scrub to prevent overgrowing. Drains and trenches were blocked in several places to stop the drainage, and one of the lakes (Birkesø) has moreover been restored, all of which helps to create the best conditions for restoring the raised bog.

Roe deer in the water-filled peat-cutting trenches
Photo: Esben Buch

Clearing tree growth

In Denmark, raised bogs are among the very few natural habitat types that are naturally free of trees. The primary reason for this is the extremely nutrient-poor conditions that characterise natural raised bogs, because they only receive nutrients from rainwater.

When raised bogs are drained, nutrients are released in the topmost peat layers. This creates the right conditions for nutrient-loving species, including trees and grasses. Once the trees have taken hold, the draining and the poorer light conditions quickly displace the species unique to the raised bog, e.g. peat mosses.

Draining peat is therefore the reason raised bogs are overgrown by trees. Getting rid of and preventing tree growth must be accompanied by actions to establish the right conditions for the peat mosses, or in other words, restoring the optimal hydrological conditions in the bog.

At *Lille Vildmose*, large parts of *Portlandmosen* and some parts of *Paraplymosen* have become overgrown with birch trees as a result of drainage and peat extraction. The LIFE project included clearing 180ha of trees and scrub on *Portlandmosen*, and up to 30ha on *Paraplymosen*.

This was done by hand to protect the vulnerable bog surface as much as possible. In order to inhibit birch regeneration as much as possible, *Portlandmosen* was cleared twice per season for two consecutive years, i.e. a total of four clearances.

The extensive clearances and a raised water level in and around the bog area are expected to establish better growth conditions for peat mosses, so that the raised bog can once more be free of trees and instead fill with natural raised-bog vegetation.

Top: Birch on Portlandmosen
Bottom: Portlandmosen after clear-cutting
Photo: City of Aalborg

Sheet pile wall in Mellemområd
Photo: City of Aalborg

Raising the water level

In connection with several decades of sphagnum extraction, the bog area in large parts of *Lille Vildmose* has been subject to extensive drainage. As a result, these areas have extensively dried out and become overgrown.

The project carried out restoration of the raised-bog areas through various initiatives to raise the water level. This was through

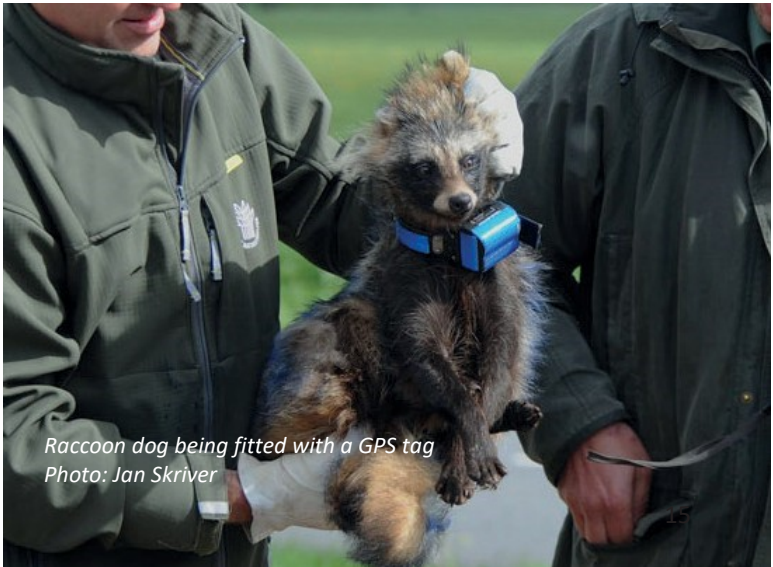
- Raising the water level at *Høstemark Fenner*, *Mou Fenner* and *Purker Fenner*
- Covering several drainage ditches with peat, e.g. at *Portlandmosen*
- Establishing approx. 1,000m of dams in the northernmost part of *Paraplymosen* in an east-west direction
- Establishing eight smaller stretches of dams along the *Ny Høstemark* road
- Establishing several retaining works, e.g. at *Smidie Fenner* and *Paraplymosen*

Predator control

It was necessary to control populations of raccoon dog, mink and red fox at *Lille Vildmose*. All the species mentioned constitute a significant risk to birds that breed on the ground, such as hen harrier, crane and short-eared owl. Racoon dogs and mink are undesirable, invasive species. The aim was to rid the area of raccoon dog altogether and to reduce the population of mink as much as possible. The red fox is native to *Lille Vildmose* and should therefore be allowed to stay in the area. However, the population of foxes had to be kept in check relative to the population of birds.

Twenty traps were set out at *Lille Vildmose* to catch the foxes. Controlling raccoon dogs at *Lille Vildmose* was coordinated with another LIFE project. This other project used the so-called 'Judas' technique of catching, sterilising, fitting with a GPS-based tag and then re-releasing a raccoon dog into the area. The tagged raccoon dog will then reveal the position of any mate it subsequently finds. Five artificial dens were dug/established in the project area for fox control. During the second half of the project period, a couple of feeding stations were set up and equipped with wildlife cameras. If a raccoon dog passed by the feeding station, it would be caught on the wildlife camera, and it was possible to shoot the animal the next time it passed by.

By 1 November 2019, at total of 65 red foxes, 51 raccoon dogs and 10 mink had been culled as part of the project.



Raccoon dog being fitted with a GPS tag
Photo: Jan Skriver

Sphagnum
Photo: City of Aalborg

Demonstration project - planting sphagnum

Sphagnum mosses are the most important group of plants on the raised bog. Sphagnum mosses are what turn into peat in the raised bog. They store the water like a sponge and acidify the bog environment. These functions are very important in restoring the raised bog. Because the preserved raised bog areas at *Lille Vildmose* are rather scattered, it would take a very long time for the sphagnum to immigrate to the cutover areas naturally. By distributing sphagnum, restoration of the raised bog can be speeded up by many years. The goal of the LIFE+ project is to generate more knowledge about how a project of this kind can be planned and implemented at a larger scale.

In collaboration with Pindstrup Mosebrug A/S, a larger pilot project was carried out on land north of *Lillesø* - a total of approx. 10ha. The nutrient-rich topsoil was removed prior to spreading fresh sphagnum. The sphagnum plants were finely chopped before they were mechanically spread across the pilot area. The sphagnum plants were harvested from *Paraplymosen*.

Spreading sphagnum in the trial area
Photo: Leif Lyngsø

Fencing Mellemområdet

In preparation for future nature management of *Mellemområdet*, an approx. 27km wildlife fence was installed. The wildlife fence was installed around an area of approx. 2,100ha between *Høstemark Skov*, *Tofte Skov* and *Tofte Mose*. Wildlife fencing is essential for efforts to ensure appropriate grazing with red deer and elk, etc., where the areas to be grazed are mainly open habitat types. The purpose of wildlife fencing was to safely enclose the grazing animals, while allowing other wildlife to access and exit the area via natural and artificial wildlife corridors.

Furthermore, to allow visitors to freely access *Mellemområdet*, five cattle grid passages were established along public roads into the area. The cattle grids were fitted with five gates for vehicles as well as 5 for visitors.

Several gates for management purposes were also installed and equipped with solar-powered alarm systems. The common fence to *Tofte Skov* and *Tofte Mose* was fitted with three electric wires to keep wild boars from escaping.

The fencing materials were transported to the installation site by special machinery with balloon tires designed to drive over the very wet raised bog. Robinia fencing posts were installed using special machinery also equipped with balloon tires.

Installation of fence at Mellemområdet
Photo: City of Aalborg

Rolling out Bentonite membrar
Photo: City of Aalborg

Dams to protect Tofte Mose

As a result of many years of peat extraction, there is wide-spread water seepage from the north-eastern and north-western edges of the intact raised bog area of *Tofte Mose*. To stop this widespread seepage of water from the bog edges, approx. 4,000m of dam was established.

An approx. 1,600m dam was established along the north-eastern edge. The dam prevents seepage of water from the raised bog corresponding to an area of approx. 50ha. Furthermore, the dam has caused an open water table on the bog side of the dam of approx. 3.5ha.

An approx. 1,050m dam was established along the north-western edge of the raised bog. This dams up water from the bog corresponding to an area of approx. 50ha. This dam also caused an open water table on the bog side of the dam.

Dam at the north-eastern margin of Tofte Mose
Photo: City of Aalborg

The Birkesø pavillion
Photo: Jan Skriver

Birkesø

Birkesø used to be a natural part of the original landscape of *Lille Vildmose*. However, the lake was drained as early as in 1761 to make way for more farmland. The restoration of *Birkesø* is an important element in efforts to restore *Lille Vildmose* to its natural hydrology and in efforts to protect *Tofte Mose.* The northern part of *Tofte Mose* is today threatened by drainage to the low-lying grassland area in the former *Birkesø.* The restoration of *Birkesø* will help halt the drainage of *Tofte Mose*.

Birkesø is a shallow lake with an area of 130ha and an abundance of birds. Three flat islands were established to provide nesting for ground-nesting birds. One of the islands and its birds can be observed from a lookout pavilion on the northern edge of the lake.

Because the original access route to the observation tower by the neighbouring lake *Tofte Sø* is now flooded, a new access route was established west of the lake through *Purker Fenner*, and a footpath was marked off along the lake's northeastern dike, running from the lookout pavilion to the observation tower at *Tofte Sø*.

Birkesø and bird islands
Photo: Jan Skriver

Follow-up on project initiatives

The water level has increased significantly at *Lille Vildmose* as a result of the LIFE project. The water level is being monitored automatically at several locations throughout the area, and the high-water-level periods have grown significantly longer than previously. This bodes well for the possibility to develop a coherent vegetation of peat mosses and for the possibility to develop the area into an active raised bog. The botanical conditions were monitored before and after implementation of the project initiatives, and there is much to suggest that peat mosses are already more widespread in the area than before the project.

Nature restoration at *Lille Vildmose* has turned the area into one of the most outstanding bird locations in Denmark. Reestablishment of the hydrology has added more dynamics to the area, and this is evident in varying occurrences of birds from year to year. This includes breeding birds such as crane, marsh harrier and bittern, as well as migratory and wintering birds. Younger, non-breeding cranes stay at the bog throughout most of the year in flocks of between 30 and 80 birds.

The large colony of black-headed gull (approx. 2,000 pairs) that relocated from the peat-cutting trenches in the northern part of *Lille Vildmose* to the newly restored *Birkesø*, attracts many other species that exploit the protection offered by the gulls' presence. This includes all four species of grebe as well as avocet, redshank, common and little ringed plover, tufted duck and several species of surface-feeding duck. In 2018, when the water level was very low, as many as 260 spoonbills were counted in a single day in the month of August. Several thousand ducks and geese moreover visit *Birkesø* during migration periods and during the winter season, including species such as wigeon, shoveler, gadwall, greylag goose, Canada goose, taiga bean goose, barnacle goose and greater white-fronted goose. Some days, tens of thousands of birds have been counted.

The birdlife at *Lille Vildmose* is being monitored and counted by a group of caretakers organised by the Danish Ornithological Society - BirdLife Denmark. BirdLife Denmark was a co-signatory of the application for this LIFE+ project and its signature committed the organisation to counting and registering birdlife in the area as a part of the project. Numerous data from the counts now exist, and these have been published in the annual reports from the project, *Nordjyllands Fugle* (annual publication on birds in Northern Denmark), and in the status reports from the Aage V. Jensen Naturfond.

Although the clearing has been meticulous, it is difficult to avoid regrowth of trees on the raised bog altogether. It will therefore be necessary to carry out supplementary, manual clearing until the restored areas can manage on their own and remain open habitats.

Deer and elk play a major role in this context. Currently, several areas are still being grazed by cattle. However, as populations of red deer and elk gradually increase over the years, the cattle will be phased out, and a natural dynamic will be in place in the areas with open habitat.

The impact of deer and elk on the natural dynamics in the bog will be registered continuously, and the movements, behaviour and wellbeing of the animals will also be monitored.

The project collaborates with the University of Copenhagen on surveys of the dynamics in the new *Birkesø*.
Water level, sediments, water chemistry, fish species composition, vegetation, etc, are being monitored and analysed by a national project to gain more knowledge about the water quality and biodiversity of the new lakes.

The results will be published in scientific journals over the coming years.

Greylag geese arriving at Birkesø
Photo: Jan Skriver

Cooperation and public events

The project has focussed on involving and briefing landowners, visitors, scientists and other specialists, and the project would not have been feasible without the cooperation of these people. The project organisation was divided into an advisory group, a project group, a focal group and an expert group.

The project was officially launched in May 2012 by Ida Auken, former Danish minister for the environment, and Janez Potocnik, former European commissioner for the environment, in connection with the celebration of the 20-year anniversary of the Habitats Directive and thus of the LIFE instrument. Since then, work by the project organisation has included more than 100 meetings, workshops and inspections in the project area.

The project has instigated more than 60 guided tours/events/talks for a total audience of more than 5,500 people.

The caretaker group set up under Lille Vildmoseforeningen (Friends of Lille Vildmose) has held two annual conservation days that were spent clearing vegetation from raised bog surfaces, spreading sphagnum, and other hands-on activities for anyone with an interest in conservation of the bog. The children and young people who took part were awarded stylish diplomas. There were 25-85 participants on each of the days.

In August 2017, there was a BioBlitz event in the project area, when participants competed to find the greatest number of species within a 24-hour period. A total of more than 850 species were found.

The project period also saw the establishment of a Facebook group celebrating the nature and beautiful landscape of *Lille Vildmose*. The group today boasts more than 10,000 members.

Lille Vildmose was the first wetland in the history of the Ramsar Convention to take account of the new Ramsar requirement for climate regulation. This took place in August 2013, and the site has since been highlighted for its pioneering efforts.

Welcoming now former European Commissioner for the Environment Janez Potocnik and Danish Minister for the Environment Ida Auken
Photo: The Lille Vildmose centre

New experiences at *Lille Vildmose* - visitor facilities

The project has added even more visitor facilities, and thus new opportunities for experiencing the area, to the already large number of excellent facilities at *Mellemområdet*, such as board-walks and observation towers.
A footpath was established through a corner section of *Portlandmosen* overgrown with birch trees. The footpath provides an additional access route to *Kællingbjerg*, a tall limestone slope offering a formidable view of the entire project area. The project established a re-designed version of an old fire lookout. The tower offers an amazing 360-degree panorama view that was previously not possible from that height. There are parking grounds, funded by so-called green growth funds near both the footpath and the lookout.

The LIFE project also had a 'crane's nest' built at the northern end of *Portlandmosen*. The crane's nest is a simple construction with a large circular bench where a group of people can sit down for a rest and a view of the many peat-cutting trenches in *Portlandmosen*.

Moreover, several picnic tables and benches were set out throughout *Mellemområdet.* The tables are fitted with a map of the area indicating the many nature restoration initiatives in the project.

Finally, a pavilion was built by the shore of the new lake *Birkesø.* The pavilion has been designed so that it can be used for dissemination purposes by the Lille Vildmose centre and so that visitors can observe the birdlife at *Birkesø* at close range, which is made possible because the pavilion is designed with a special type of one-way glass so that the birds can be observed undisturbed at closer range. The pavilion has been decorated with many, beautiful bird illustrations, and two large binoculars are available for visitors to experience the new lake and its inhabitants.

Birdwatching from Tranereden
Photo: Jan Skriver

Wooden boardwalk through
Portlandmosen
Photo: City of Aalborg

Centrally placed, the fire lookout offers an amazing view of the area
Photo: City of Aalborg

Visitors on the stairs leading up to the top of Kællingberg Klint
Photo: Jan Skriver

A bittern on soft bedding
Photo: Jan Skriver

Practical information

The City of Aalborg, the Aage V. Jensen Naturfond and the Danish Nature Agency are the formal partners in the project. Other partners include Lille Vildmose Naturfond, the Danish Ornithological Society - BirdLife Denmark and Lille Vildmose-foreningen (Friends of Lille Vildmose). The project is being funded by the European Commission under the LIFE scheme, which is an EU support scheme for initiatives in the area of the environment and nature at European level.

The project aid number is LIFE10 NAT/DK/000120. The most important documents and reports from the project are available on the project website. Here you can read more about the background for the project, the natural habitat types of the area, technical reports on clearances and increased water level, as well as memoranda and reports on developments regarding vegetation and birdlife.

Whooper swans crossing Ny Høstemarkvej
Photo: Dorte and Flemming Sørensen

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Back page photo: Portlandmosen
Photo: City of Aalborg