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Inland wetlands of the Northern Iberian Peninsula: Management and restoration of peatlands and wet environments

Restoration actions implemented as part of the European project
LIFE TREMEDAL

(2) Basque Country and Navarre

Restoration actions implemented in Gipuzkoa as part of the European project LIFE TREMEDAL

JAIZKIBEL

The restoration and maintenance work performed on the habitats with the potential to form peat at the Jaizkibel site has focused on hydrographic correction, recovering the natural vegetation, installing infrastructures for livestock management and improving typical wetland habitats. It should be pointed out that exchanges of information with local farmers led to modifications of some points in the initial plan.

Work was performed at the Jaizkibel site last winter and spring to control the excessive growth of herbaceous and woody plants in four acid wetlands fenced off in 2007. Nearby plantation forests, which cast shade over the wetlands, were also removed and a lot of work was carried out in the entire area to reduce non-native flora (*Baccharis halimifolia*) and to plant small quantities of replacement plants in those areas treated.

Hydrological correction work

The initial evaluation of **Jaizkibel-6** showed that the water table remained a long way from the surface at the end of autumn. A small river course crossing the site was embedded approximately one metre from the surface of the wetland. This was linked in with the opening of an outlet at the base of a dyke which sealed the wetland. According to locals, no water used to flow from the base of the dyke a few decades ago and a pond used to form. It was concluded that this hydrological change was affecting the general state of the wetland and, more specifically, the populations of *Cladium mariscus* and *Thelypteris palustris*.

Sluice gate installed and closed to evaluate its performance. The water does not run through the base outlet (blue circle), but flows over the small dyke.

On the basis of this information, a sluice gate was fitted on the base outlet, the administration of which is now being adjusted according to the effects observed. The idea is to keep it closed during the dry months (May to October) and to open it during the rest of the year to permit drainage and leach elements dragged along by the torrent and prevent the wetland from clogging up.

Recovery of the natural vegetation

The intended purpose was to control invasive non-native flora. Not only the wetlands affected, but also the entire coastline of the SAC have been treated both chemically and mechanically to prevent recurrent regrowth.

Given that the initial evaluation of **Jaizkibel-2** revealed that the site seemed suitable for woodland, it was decided to allow it to evolve into swamp woodland with willows and alders.

The population of *Cladium mariscus* was greatly affected by the hydrological changes at **Jaizkibel-6**, while the invasive species *Baccharis halimifolia* was prospering. Once the new

sluice gate had been installed, 500 *Cladium mariscus* seedlings obtained ex situ at the Arizmendi facility were planted out.

The entire wetland was thoroughly searched for *Baccharis halimifolia* to ensure that it was free of the plant. Those examples found were selectively treated by applying glyphosate with a brush.

Finally, given that simply ridding the wetland of examples was no guarantee that the plant would not reappear in the habitat in the future, it was also eliminated from the entire area surrounding Jaizkibel.

Baccharis halimifolia was treated along the entire coastline of the SAC. Work was performed on all the heathland near the cliffs, covering those areas which were on the verge of being left bare with different species of plant: *Quercus pirenaica* where conditions proved ideal.

Treated *B. halimifolia* formations. The adjacent formations show no effects of the selective treatment worthy of note.

Given that the technique for the elimination of *B. halimifolia* is the same as that used to eliminate the exotic species of South African origin *Helichrysum orbiculare*, the presence of which was widespread on this heathland, this plant was also treated.

Infrastructures for livestock management

It was necessary to fence off four acid wetlands in 2007 to relieve them of the effects of livestock, which had seriously damaged some of them. However, a complete absence of livestock would lead to an excessive proliferation of herbaceous species, choking other more interesting species which belong in small wetlands of this kind (sphagnum, insectivorous plants and other plants exclusive to these habitats), which could become rare and even disappear altogether.

Actions have now been implemented to reestablish a suitable density of livestock and, in order to do this, the fences have been modified and direct action has been taken on the vegetation.

Detail of the area added to the original site, with a permanent monitoring quadrat.

At **Jaizkibel-1**, one of the sites most disrupted by livestock, the wire mesh has been removed –leaving the posts- from the northwest, northeast and southeast sections, leaving the fencing in the west area, which borders with the course of the river. The fencing which needs to be left is easily distinguishable because it continues upstream and the wire is thicker.

The moderate entry of cows and horses has reduced the density and height of the herbaceous vegetation, producing some of the desired effects, such as the isolated expansion of the small cushions of sphagnum which had appeared in previous years. The livestock also favours the reappearance of meadow species, particularly the grass *Holcus lanatus*, which had scarcely been observed for some time.

The existing fencing at **Jaizkibel-2** has been left and extended to the adjacent waterlogged ground to allow homogenous restoration of the site.

Habitat improvement

The objective is to reinforce the presence of species typical to the ecosystems affected. Plants have been distributed in areas cleared as a result of other work (control of areas gone to brush or containing non-native species) to enhance the competitiveness of the masses of autochthonous species native to the wetlands.

At **Jaizkibel-2**, a site which has improved surprisingly well over the last few years (it had been severely trampled by livestock), brambles and other vegetation which had overgrown the entire site have been cleared, leaving the autochthonous trees (willow and ash trees) and those species of greater interest (*Osmunda regalis*). Work has chiefly focused on *Rubus* and the *Alnus Cordata* planted in the area in the past.

Forestry debris removal in progress (unchopped debris), with part of the wetland in the background.

The management of **Jaizkibel-3** is a prime example of the special conditions at play at the Jaizkibel site which markedly condition the actions implemented there. Conservation needs to be reconciled with both the erratic farming activity performed and the owner of the land, the Ministry of Defence, which uses it as a firing range and training area.

The initial plan of constructing a livestock corridor providing access to the sensitive areas (above all for *Quercus pirenaica*) without the need to open all the fencing was rejected by the actors involved. It was thought that the livestock would find little incentive to reach those areas in which it was hoped that the vegetation could be improved. The corridor would also prevent access to the bounded area from the patch of pine trees, where the livestock usually grazes, particularly in the winter. This is because the outer fencing is in a poor state of repair and the livestock can pass through it.

The strategy of managing the density of livestock, therefore, was refocused on two other lines of action: the selective clearing of unpalatable vegetation and the removal of trees.

Forestry clearance work was performed over an area covering approximately 30 metres from the outer perimeter of the wetland without any major hitches. The plant debris was chopped up and left in piles at the site, not being removed from the area.

Vegetation was also selectively cleared within the wetland itself and around those areas in which trees had been felled to make the site more attractive to livestock.

In order to prevent the displacement of heliophilous species of interest by larger species at **Jaizkibel-4**, conifers were felled in order to create a border of 30 m around the wetland and areas of gorse were selectively cleared.

As at **Jaizkibel-3**, the modifications to the fencing initially planned were ruled out.

The local farmers have intensively cleared vegetation from and around **Jaizkibel-5**, a site which was in acceptable conditions at the start of the TREMEDAL project.

Access to Jaizkibel 4 through the plantation, with the sign indicating that work is under way as part of the LIFE TREMEDAL project.

USABELARTZA

Corrective action was taken in previous years in the Usabelartza area, which is home both to areas with peat-forming potential and a true mire, in order to recover the functioning of the hydrological system.

Monitoring of the effects of these measures (sealing off drainage ditches and work on the forest track to return the water which used to naturally feed the peatland to its course) is on-going.

While no increase in waterlogging in the wetlands above the sealed ditch can be observed, the fact that plant life is taking hold in the area of bare land resulting from the ditch-sealing work carried out is encouraging.

A significant rise in the presence of sprouting sphagnum, rushes and other mire-habitat plants is being registered with each trip made to survey the site.

Greater waterlogging in the actual mire area at the Usabelartza site can also be observed. This is chiefly put down to the elimination of a large proportion of the exotic conifer plantation which used to surround the basin which supplies the mire, which must have drawn off a good part of the water supply.

Dykes to check the water in the ditch of the Usabelartza track.

Amphibians make use of the small pools formed by the dykes in the ditches at the Usabelartza site. Detail of *Rana temporaria* spawn

ARREO

Control of non-native species

The work performed to control non-native species (invasive fish and crayfish) is coming on at a good pace. Work to control the presence of Red Swamp Crayfish (*Procambarus clarkii*) started again this summer. Last year's campaign closed with a significant volume of examples captured: more than 47,000, weighing 1,300 kg.

These figures have already been passed in the current campaign, which is still in progress, thanks to improvements in the techniques used to catch the crayfish: 60,000 examples, weighing more than 1,500 kg.

These data confirm that the techniques employed are working well, although the dynamics of the population, considered in conjunction with the rate of capture, would lead one to think that the environmental problem that this species constitutes will be difficult to solve in the short term. It is encouraging to note that the work performed on the brook at the Lake means that it is unable to serve as a point of connection with the River Ebro, thereby rendering this path of entry ineffective for future recolonisation.

Tests have also been performed to improve the capture of crayfish, such as changes in the frequency at which the bait is replaced, how it is presented in the traps and the location of the traps with regard the shore. Further tests are planned for this year, including comparisons between several types of bait.

In addition to catching the greatest possible number of crayfish, interesting data has also been gathered on the species' seasonal evolution, its sex ratios, the proportions of sexually active (form 1) and inactive (form 2) males, and the proportions of females with eggs, females with larvae (L1 and L2) and females without either. A large presence of intersex individuals has been noted, namely females with certain secondary sexual characteristics which belong to males. This could be related to a high rate of endogamy.

These methodological aspects and contributions concerning the biology of the Red Swamp Crayfish will shortly be presented at LIFE POTAMOFAUNA's National Symposium on the Conservation of Autochthonous Crayfish , to be held in Olot in September.

Work to **control invasive fish** got under way earlier this year, starting in spring. This means that the catches from all of last spring and the start of summer can be added to the figures registered for last year's campaign, which now reach a total of more than 26,000 fish caught, representing a total weight of one tonne removed. The evolution of the Black Bass (*Mycropterus salmoides*) and Common Carp (*Cyprinus carpio*) populations is promising, while the difficulties encountered when trying to catch Percasol (*Lepomisgibbosus*) make effective control in the short term a more complex business. There is a significant juvenile population of this invasive species which takes refuge in the vegetation, making it inaccessible to fishing equipment.

As a result, a novel technique is being devised as part of the project based on the effects of electrotaxis on fish. It consists of creating a non-harmful, non-narcotic electric field in the reedbed to mobilise the fish towards the electrode in deeper water, beyond the reedbed, where a trap similar to a crayfish trap with several chambers lies in wait.

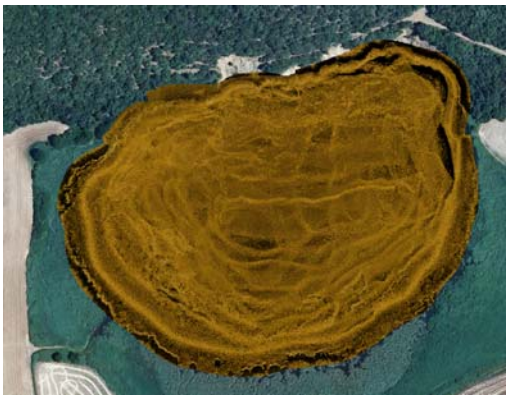
Although it is too soon to publish results regarding the catches achieved with this new system, underwater video recordings made during initial tests have registered the behaviour of a group of fish confined to a pen measuring approximately 10 m^2 which includes a stand of helophytes when subjected to differing types of electric field.

Another line of work addresses the study of aquatic vegetation. While great and rich partly submerged plant cover has been observed (helophytes such as reeds, bulrushes, rushes, etc.), very little cover of plants more related to pure water environments has been noted. The presence of submerged plants is limited to filamentous green algae, mainly found on the banks and in among the reed stalks, and a very low density of charophyta.

The initial hypothesis is that this low cover in areas which would seem suitable is related to the high density of non-native fauna in the Lake of Arreo – Caicedo de Yuso. In the image taken using high-resolution sonar, significant consumption of plant stalks which never emerge –probably by crayfish– can indeed be appreciated.

This intensive grazing would lead to a greater growth of phytoplankton due to the increased availability of nutrients, in turn leading to less transparent water, ultimately exacerbating the conditions for plant growth.

In the study, which combined sonar techniques with underwater filming, areas in which aquatic vegetation could potentially develop in the present situation were contrasted and the current species composition was described. This will provide a reference for future monitoring of plant development in response to actions taken to combat invasive aquatic species in the Lake.



Routes of the sonar study performed in the lake.

Restoration actions implemented in Navarre as part of the European project LIFE TREMEDAL

Hydrological correction work

The aim of this work at mire sites in Navarre was to delay the release of water from the wetlands and raise the water table in certain areas in order to create zones with different degrees of water density (from small permanent pools to temporarily waterlogged areas, wet grasslands, etc). Three techniques have been used to achieve this:

Construction of dykes using wooden planks.
Thick planks (7-9 cm thick) with tongue-and-groove joints were positioned across the water flow at strategic points previously selected on the basis of a detailed survey. These structures were reinforced and secured to the ground via wooden posts set in staggered formation. Clay was added to enhance their impermeability.

At the **Belate Mire**, for example, where dykes of this kind had not been used before, 4 have been built.

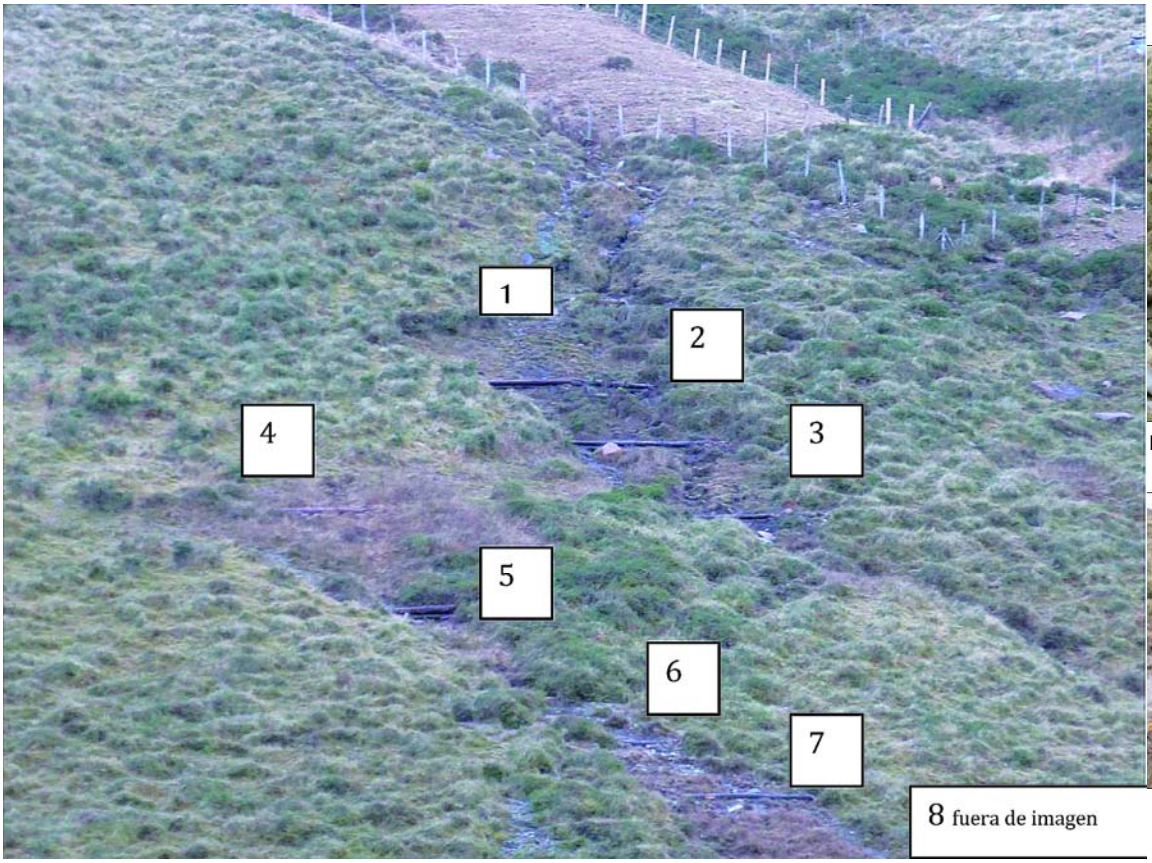
From left to right:
Wooden dyke showing its clay reinforcement.
Effect of the structure, which retains the water on one side and favours waterlogging in the surrounding area on the other.
Wooden posts in staggered formation to secure the dyke to the ground. In this case, stones have been added downstream to prevent erosion caused by the falling water.

8 wooden dykes have been erected at the **Lixketa Mire.**

Plant development upstream from the dyke one year after installation.

Construction of dykes using tree trunks.

8 dykes have been built at the **Alkurruntz Mire** to a height of approximately 30-40 cm above ground level. The use of trunks in hard-to-access areas with steep slopes, as was the case, made dyke construction easier because the material could be rolled downhill practically all the way to the area of action.



Dykes 1, 2 and 3

Dyke 7

Dikeen banaketaren ikuspegi orokorra. Irudian ere ageri da hezegunea ur-hartunetik eta landaredia kendutako eremutik bereizten duen itxitura.

In order to restore the area affected by all-terrain vehicle traffic at the **Maulitx Mire**, motor vehicle traffic has been prohibited and 3 dykes made using tree trunks have been installed on 3 sections of the track which runs though the wetland. In each case, small dams were built by hand using trunks with diameters of 20 cm, reinforced with earth.

Left: The main outlet point from the wetland, which waterlogs a section of track covering 150 m^2.
Right: Wooden poles divert the water from the track to a flat area of 500 m^2 with great potential for the development of peatland vegetation. The vegetation monitoring plot is also visible.

Construction of earth dykes and filling in outlet channels.
In addition to wooden dykes, earth **dykes** have been built and certain sections of the outlet channels have been filled in at some mires. This work was performed by hand using shovels and wheelbarrows. All the earth used came from the excess generated by the track correction work. Work began by removing the plant layer in the area to be filled in. The sods were kept for later use. The earth was deposited in layers of 20 cm and compacted (by hand) until the required level was reached. The sods set to one side were then put back on top of the area filled in to prevent erosive processes.

Earth dykes have been built and the outlet channel has been filled in, for instance, at the **Belate Mire**, where two pre-existing main outlet dykes have also been reinforced to allow livestock to cross the wetland more easily. This action has considerably improved the wetland's water retention capacity, raising the water table and favouring the flooding of a large area of ground.

From left to right:
Earth dyke: The dam effect produced can be observed.
A channel plugged and dispersed by earth. The water surfaces and waterlogs a large strip of land.
Earth dyke at the head of an outlet channel and its effect. The sods placed on top of the dyke are clearly distinguishable.

The effects of the dykes made from planks, trunks and earth, and the filling-in of outlet channels proved immediate: water is now retained by the dykes, favouring the waterlogging of the channels and raising the water table throughout the entire area.

Prevention of threats and correction of impact as a result of track use

The tracks existing in the mire environments pose a threat to their conservation. Consequently, TREMEDAL has included work to correct these negative impacts in Navarre.

The track leading to the fencing around the **Belate Mire** has been corrected, improving two wheel ruts so that all vehicles can use them and no new ones need be formed; a base of ballast up to 40 cm thick has also been laid to improve the points where the track crosses brooks.

Improvements made to the track in Belate.

At **Lixketa,** a ford has been created where the track crosses one of the water outlets from the mire. The work consisted of laying material (ballast and gravel) and compacting it.

The action taken at the **Maulitx Mire** involved installing three small barriers consisting of two 1-m posts with sections of 12 cm made of treated wood, secured with concrete. The distance between the posts, 1 m, prevents motor vehicles from accessing the area. The posts are joined by two round wooden fence rails.

The drainage of the track which goes around the wetland has also been improved on a section with a steep slope by digging crosswise drainage into the earth.

From left to right:
Barrier to prevent vehicles from passing.
Crosswise drainage to divert torrent water to the track drainage system.

Recovery of the natural vegetation

Plant material belonging to different species was gathered from some of Navarre's mires and wetlands. This material was replanted in growing trays with blond peat (100% natural substratum) and placed in the shade at the Miluce nursery (Pamplona). The results have proved satisfactory (practically no failures) and some of the plants have grown quite considerably.

The species collected from the **Belate Mire** and produced in the nursery are: *Eriophorum angustifolium; Carex echinata; Erica tetralix; Sphagnum spp.; Narthecium ossifragum;* and *Carex hostiana.*

Left: Plant material being collected at the Belate Mire.
Right: State of *Carex echinata* plants after two months in the nursery.

The species collected from the **Xuriain Mire** and produced in the nursery are: *Sphagnum capillifolium* and *Juncus squarrosus.*

lLeft: Sphagnum recently planted in trays at the Miluce nursery in 2014.
Right: Sphagnum at the end of the winter 2014-2015

Infrastructures for livestock management

In order to make livestock farming in mire areas more compatible with the conservation of these spaces, LIFE TREMEDAL proposed a range of measures. These mainly consisted of the installation of infrastructures to assist livestock management without harming the conditions of the wetlands: fencing, gates, etc.

A rustic wooden fence has been erected at the **Belate Mire** to replace a previous less substantial one. The track to the fence has also been improved.

Alkurruntz Mire: Detail of the fence separating the wetland (right) from the water intake and tank (left). Part of the cleared area can also be distinguished.

A new fence measuring 120 metres has been erected at the **Alkurruntz Mire**, dividing the existing fenced-off area into two zones: one with the main part of the wetland and the other with the water intake and tank.

A rustic wooden fence consisting of vertical posts was chosen. The posts were driven into the earth every 2 m to depths of up to 50 cm, meaning that the final height of the fence is 1.2 m, sufficient for the intended purpose.

Work was completed by fitting 4 lengths of galvanised double-strand barbed wire and a length of smooth wire at the top, secured with wire staples and fitted with systems to prevent birds and bats from colliding with the fence.

Access to the inside of the enclosure has also been improved by fitting two wooden gates.

Xuriain Mire: Wooden perimeter fence.

A rustic fence has been erected at the **Xuriain Mire** using split wooden pickets measuring 1.8 m. The posts were driven in to a depth of up to 50 cm every 1.5-1.8 metres, making for a final fence height of 1-1.3 m, enough to prevent the passage of livestock.

Work was completed by fitting 2 creosoted planks horizontal to the vertical posts with self-tapping screws and two lines of barbed wire. The latter are positioned between the ground and the first plank to prevent sheep from passing. The fencing, which measures 1,100 m, has two gates and two stiles.

Once month after erection of the fence, plant species, such as bilberries and heather, could be seen to be sprouting.

A nearby pothole where the presence of a species of flora of interest rare in Navarre, *Gentiana burseri*, had been spotted, has also been closed off.

Perimeter fence erected at **Mendaur**

Arxuri Mire: One of the fences, in the area where *Spiranthes aestivalis* was detected.

Arxuri Mire: Second fence, in the part of the mire where greater livestock presence was registered.

Belate Mire: Cleared area on Giltxurrinarri.

At the **Mendaur Mire**, a 147-m fence similar to those installed at the Arxuri and Xuriain Mires has been erected. The fence consists of wooden posts every 1.5 metres and two creosoted planks fitted horizontally.

The fence was completed with two lines of barbed wire between the ground the first plank to prevent sheep from passing. A wooden gate has been fitted to control the access of livestock to the wetland. Unless impact is observed at the wetland as a result of the presence of livestock, the gate will be left open all year round.

Two small wooden fences have been erected at the **Arxuri Mire**, one measuring 100 m in the area in which the presence of *Spiranthes aestivalis* was verified, and the other measuring 110 metres around one of the main peat deposits frequently used by livestock. The aim in the second area is to analyse the impact of livestock (trampling and grazing) on the development of species typically found in peat environments in the area.

Following the model used at the other mires, the fence consists of vertical acacia pickets every 1.5 m, joined by creosoted planks. The fence has a height of more than 1.2 m, meaning that it prevents the passage of livestock.

Two lines of barbed wire between the ground the first plank prevent sheep from passing.

Each fence has a wooden gate with which to manage the access of livestock to the wetland.

Both gates have been left closed in order to monitor the development of vegetation on the peat deposit, particularly that of the orchid *Spiranthes aestivalis*.

Habitat improvement

In order to strengthen the rich diversity of plant life living in peat environments, TREMEDAL has encouraged the recovery of wetlands by felling reforestation trees, selective vegetation clearance, the removal of the debris generated by clearance and laying protective natural-fibre mesh.

Selective clearance work has been performed at the **Belate Mire**, focusing above all on the rushes (*Juncus effusus*), which had become prolific due to the reduction in the density of livestock over recent years. Selective scrubland clearance has also been carried out at the two small springs on the nearby slopes (on the right-hand edge of the road heading to Baztan and on the slopes of Giltzurrinarri), two small areas of great interest from a vegetation point of view.

A wet area with great potential for the development of vegetation of interest, previously reforested with *Chamaecyparis lawsoniana*, has also been recovered on the slopes of Urdanbidegi, in the vicinity of the **Belate Mire**. The actions consisted of cutting down 36 cypress trees (later used to build the livestock crossings in Belate and the dykes used to restore the Alkurruntz wetland) to allow light to reach the spring and creating small dykes with some of the trunks, reinforced with earth, to improve water retention at the site. Finally, the entire area was fenced off to prevent livestock from entering it.

These actions led to the creation of an area with the potential to develop vegetation characteristic of peat environments covering approximately 260 m². Within an year, a significant change in the type of peat-environment vegetation had been registered.

Another improvement action consisted of cleaning and removing the debris from felling trees on the slopes of Urdanbidegi, where sphagnum and other species typically found in peatlands had been detected. The accumulated debris came from a nearby forestry exploitation site in an area of reforested *Chamaecyparis lawsoniana*.

Selective vegetation clearance work has been carried out on the central promontory of the **Alkurruntz Mire** using motorised brushcutters. The clearance work, which was selective and uneven in nature, was carried out more intensely in those areas with edaphic humidity.

1,500 m² of natural-fibre mesh has been laid out in highly eroded areas where the peat is not protected by plant cover at the **Xuriain Mire**. Before the mesh was fitted, the land was prepared, removing as many sharp edges and stones as possible. Sections of mesh measuring 2 x 5 m were then laid out in grid formation. The mesh was secured using ground staples and stones to hold it down properly.

Belate Mire: Cleared area.

Belate Mire: Dyke made of tree trunks.

Alkurruntz Mire: Cleared area photographed in spring 2014. Grass development can be observed in areas previously occupied by *Ulex europaeus*.

Xuriain Mire: Natural-fibre mesh protecting eroded areas at the Xuriain site. The mesh is secured with corrugated steel rods and local stones.

Work to improve the compatibility of uses

Another LIFE TREMEDAL objective was to make different uses compatible in the different peat-forming environments. Action has been taken in this regard at the **Belate Mire** in Navarre, where 2 livestock crossings have been built with earth and tree trunks over the outlet channel on the Baztan side of the mire, dividing the grazing land into two halves. The idea was to stop livestock from crossing, and thereby jeopardising, the wooden dykes in place since 2008, thanks to which the area had become more waterlogged. These dykes have now been reinforced and the waterlogged area has increased and the vegetation has improved.

Finally, rubbish was collected and removed from certain points in the wetland and its surrounding area: the right-hand side of the road heading to Baztan, near the small fenced-off wetland, and the slope next to the path leading to the wetland (old bridge).

Belate Mire: Recently constructed livestock crossing with right-hand side flooded

Belate Mire: The livestock crossing some time later.

Highlighting the value of the area

One of the objectives set by the LIFE TREMEDAL Project was to give visibility to the accomplishment of its mission and, consequently, to the mires themselves. One way in which this has done has been by installing information panels aimed at the general public at visible, easy-to-access locations near the sites.

In the case of the Belate Mire, which is next to a road and, therefore, easy to reach, the panels about the mire and the Natura 2000 network installed in 2008 have been restored.

Information panels with sheltering roofs have also been put up at other accessible sites and plinths identifying the project have been installed at more remote and less popular sites. Both the panels and the plinths come with a QR code via which the public can access full information about LIFE TREMEDAL online.

An exhibition on the project has also been designed and is currently open to the public at the Bertiz Natural Park. It is hoped that it can be taken to other facilities and locations in Navarre.

The guided tours organised complete the activities carried out to publicise the project and the mires themselves.

From left to right, top to bottom: Exhibition on the project at the Bertiz Natural Park. Information panel. Identification plinth.

Sphagnum papillosum

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