

Results of a monitoring survey of bog woodland



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Results of a monitoring survey of bog woodland

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EXECUTIVE SUMMARY

This document reports on the first year of a monitoring survey which assessed the structure and functions and future prospects of Annex I woodland type: 91D0 Bog woodland.

Bog woodland, a priority habitat, is a very distinctive habitat dominated by downy birch (*Betula pubescens*) and *Sphagnum* species. Three distinct sub-types can be recognised according to their location: on raised bogs; on cutaway; within sessile oak (*Quercus petraea*) woodlands.

Nine bog woodlands from all three sub-types were monitored between October 2011 and October 2012. These sites were assessed at three levels: plot level; multi-plot level; and site level. Structural data collected included: canopy height; canopy cover; birch, dwarf-shrub, ling heather (*Calluna vulgaris*), bryophyte and *Sphagnum* cover. At the multi-plot level diameter at breast height (dbh) of birch trees, regeneration of birch and the amount of dead wood were assessed. Future prospects were assessed by noting the pressures, threats and impacts, both positive and negative, occurring throughout the Annex I woodland area. Additional but general information was gathered from another five sites

Sites were scored Favourable (green), Unfavourable – inadequate (amber) and Unfavourable – bad (red) depending on the outcome of the two parts of the assessment. All sites passed for Structure and Function but two sites failed for Future Prospects. One of these sites appeared to be drying out and the other was suffering from overgrazing and regeneration was absent. For the Overall Assessment therefore seven sites were assessed as Favourable (green) and 2 sites as Unfavourable-inadequate (amber). Despite this generally favourable result the long-term future of the sites is not clear as there is a possibility that bog woodlands are intrinsically transient communities and may be a seral stage to another habitat type, e.g. raised bog, oak woodland.

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INTRODUCTION

Rationale for the survey

Annex I habitats are habitats of European importance which are listed under Annex I of the EU Habitats Directive (92/43/EEC). Under Article 17 of the Habitats Directive, all EU Member States who are signatories of the Directive have a legal obligation to report on the conservation status of the Annex I habitats that occur within their boundaries. These reports are produced every six years. The next round of reporting, covering the period 2007-2012, is due in 2013.

The Bog Woodland Monitoring Survey to assess the structure and functions and future prospects of Bog woodland, a priority habitat, was undertaken in October 2011 and July to October 2012. In addition, further information was obtained as part of the Raised Bog monitoring survey (Fernandez et al 2013).

Habitat Characteristics

Bog woodland is a very distinctive woodland type. The definition presented in the Interpretation Manual of European Habitats (European Commission 2007) is as follows: 'Coniferous and broad-leaved forests on a humid to wet peaty substrate, with a water level permanently high and even higher than the surrounding water table. The water is always very poor in nutrients. These communities are generally dominated by *Betula pubescens*, *Frangula alnus*, *Pinus sylvestris*, *Pinus rotundata* and *Picea abies*, with species specific to bogland or, more generally, to oligotrophic environments, such as *Vaccinium* spp., *Sphagnum* spp., *Carex* spp. (*Vaccinium-Piceetea: Piceo-Vaccinienion uliginos* (*Betulion pubescentis*, *Ledo-Pinion* int. al.))'. Four sub-types are listed of which only the *Sphagnum* birch wood type occurs in Ireland. This vegetation type agrees closely with the purple moor-grass/tormentil (*Molinia caerulea-Potentilla erecta*) type of the birch-purple moor-grass (*Betula pubescens -Molinia caerulea*) group of Perrin et al. (2008).

For the purposes of this survey, woodland dominated by birch in the canopy with a *Sphagnum* cover > 25% is classified as bog woodland. This includes some areas which are transitional to carr but species indicative of ground-water influence should only be minor constituents.

Downy birch (*Betula pubescens*) is the dominant species and typically there is a thin shrub layer consisting mostly of willows (*Salix aurita*, *S. atrocinerea*). *Pinus rotundata* and *Picea abies* do not occur on raised bogs in Ireland and alder buckthorn (*Frangula alnus*) is very rare. Scots pine (*Pinus sylvestris*) occurs locally, especially on raised bogs, but is not a constant species. The dwarf shrub and field layers may be poorly - to well-developed. Typical dwarf shrub species include ling heather, and typical herbs include purple moor-grass (*Molinia caerulea*), soft rush (*Juncus effusus*) and broad buckler-fern (*Dryopteris dilatata*). In contrast, the moss layer is well developed and is dominated by *Sphagnum* species, often also with an abundance of *Polytrichum commune*.

Bog woodland occurs in three distinct habitats:

1) On raised bogs, where it is associated with weakly flushed sites on the high bog. Typical raised bog species, such as hare's tail cotton grass (*Eriophorum vaginatum*) and the dwarf shrubs cranberry (*Vaccinium oxycoccus*) and crowberry (*Empetrum nigrum*), may occur and in places bog myrtle (*Myrica gale*) is abundant.

2) On cutaway bog (locally fen), where it sometimes occurs in association with weak ground-water influence, indicated by the presence of carr species, e.g. ash (*Fraxinus excelsior*), marsh horsetail (*Equisetum palustris*).

3) Within sessile oak (*Quercus petraea*) woodlands, in association with nutrient-poor flushes and with small amounts of characteristic oak woodland species, e.g. hard fern (*Blechnum spicant*).

Epiphytic moss and lichen communities are a characteristic feature of bog woodlands.

For further details see the 2007 Conservation Assessment report (NPWS 2007), Perrin *et al.* (2008) and Fernandez *et al.* (2013).

The dynamics of bog woodlands are not well understood and may vary from site to site. In general there is little regeneration of birch or other tree species even in sites where there appears to be little if any grazing. This suggests that the woodland has developed following a single event (e.g. cessation of cutting, fire) which provided suitable conditions for birch establishment. Once established, the conditions then appear to have become no longer suitable for further regeneration (perhaps due to the high water table, strong *Sphagnum* growth or an unsuitable light climate). As the trees mature and die regeneration may recur or, if the site is too wet and acidic, the area may develop into open bog.

The history of bog woodland sites is not clear, but it would appear that many are recent. None occurring in association with flushed sites on raised bogs appear on the 'historic' 25" maps, which probably date from the early part of the 20th century, although it is possible that they may not have been mapped. These woodlands may be semi-permanent communities persisting as long as the water flow continues. It is debatable whether these stands have developed naturally or whether they are a result of changes of water flow on the high bog following drainage, cutting and subsidence. Those occurring on cutaway can clearly only have developed following the cessation of turf cutting and it is possible that these woodlands are transient communities which arise at a certain stage in the recolonisation of cutaway bog and that will be gradually replaced by open bog vegetation. Those occurring in sessile oak woodlands may be semi-permanent.

Distribution

Bog woodland is a widespread but localised habitat type in Ireland. Geographically, it is found mostly in the midlands, within the drumlin belt of the north midlands and locally elsewhere in upland valleys, e.g. Wicklow, Kerry. (See Fig. 1).

Area

The survey of raised bogs (Cross 1990) identified a number of bog woodlands associated with raised bogs. The National Survey of Native Woodlands (Perrin *et al.* 2008) identified further sites, mostly on cutaway but also within sessile oak woodlands. Bog woodland has been recorded from

33 sites (NPWS 2007) but new sites continue to be found (Perrin *et al.* 2008 and this report), principally on cutaway and it is probable that as peat cutting declines and increasing areas of cutaway are abandoned the number and area will increase.

Bog woodlands are closely linked to precise hydrological conditions which are required both for the initiation and maintenance of the habitat. These conditions are characteristically restricted to small areas and consequently the area of individual bog woodlands is small, with the largest stand only c.14ha and some less than 0.5 ha.

Unlike other woodland habitat, the artificial expansion of new bog woodland is likely to be very difficult, although creation of the right hydrological conditions may tilt existing vegetation in the direction of bog woodland. This has occurred at Annagh Wood, Co. Cavan, for example, where felling of adjacent conifers has resulted in the development of a *Sphagnum* layer and massive regeneration of birch and willow.

Assessment and monitoring of Annex I habitats

Evans and Arvela (2011) present an evaluation matrix for assessing the conservation status of Annex I habitats. A modified version of this matrix is given in Table 1.

In some EU literature, the categories “favourable”, “unfavourable – inadequate” and “unfavourable – bad” are used in place of “green”, “amber” and “red”. This survey assesses just two of the parameters presented in Table 1: structure and functions, and future prospects. Therefore, it is only possible at this time to give a preliminary assessment of the habitat status. The survey methodology follows the approach of the Perrin *et al.* (2009) for upland habitats and Cross and Lynn (2012) for yew woodland, in using monitoring stops to assess the status of structure and functions. Future prospects of sites are assessed on the basis of the occurrence and severity of recorded impacts in the Annex I habitats.

Fig 1. Distribution of Bog Woodland (91D0).

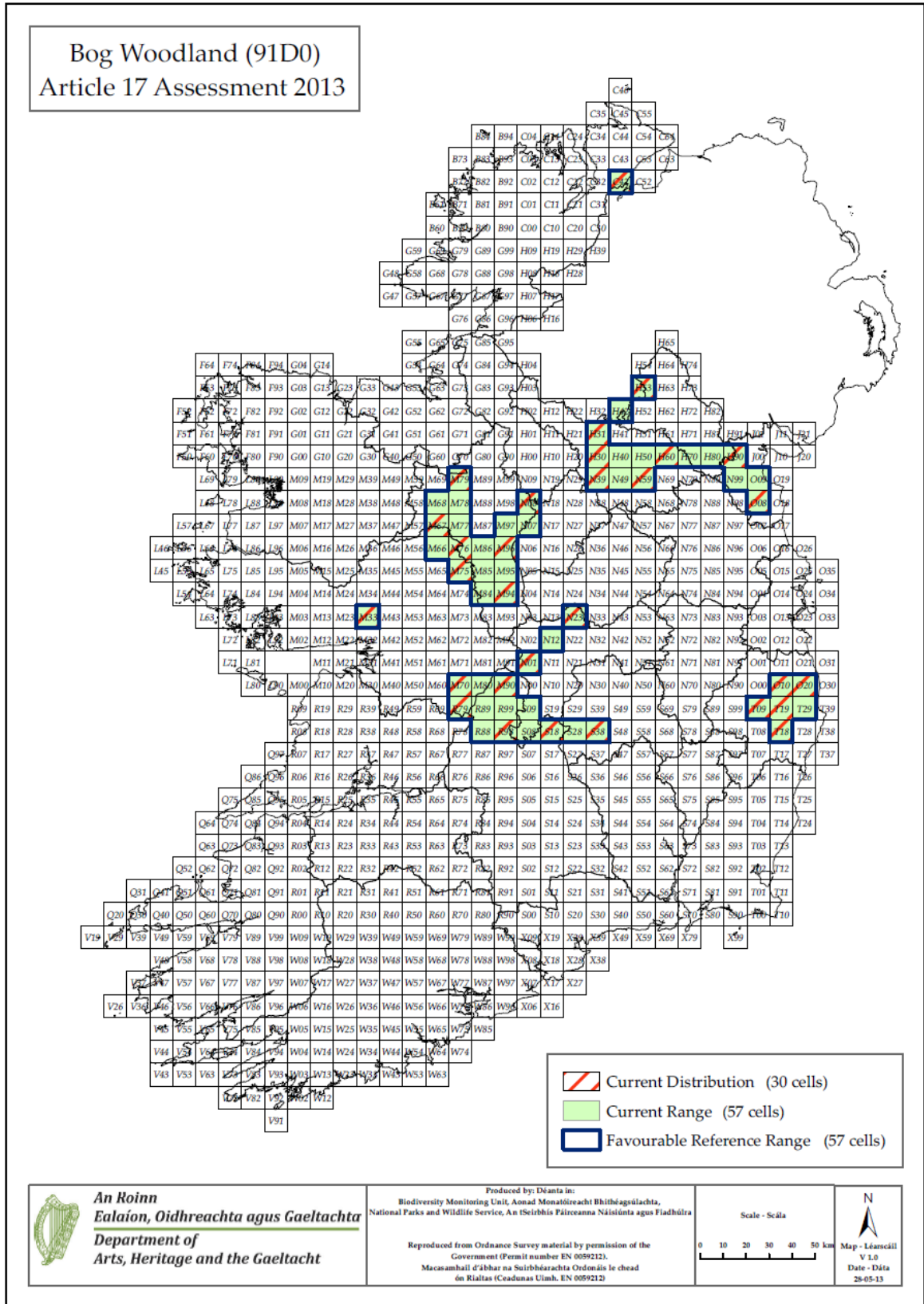


Table 1 Summary matrix of the parameters and conditions required to assess the conservation status of habitats (modified from Evans and Arvela (2011)).

Parameter	Green	Amber	Red
Range	Stable/increasing	>0% - <1% decline/year	≥1% decline in range /year over specified period
Area	Stable/increasing	>0% - <1% decline/year	≥1% decline in area /year over specified period
Structure & Functions	Habitat structure in good condition & functioning normally; typical species present	Any combination other than those described under green or red	>25% of habitat has structure, function or species composition in unfavourable condition
Future Prospects	Excellent, no significant impact from threats expected. Long-term viability assured	Between green and red	Bad, severe impact from threats expected; habitat expected to decline or disappear
Overall assessment of conservation status	All green	One or more amber but no red	One or more red

Scope of the project

A list of known bog woodlands is presented in Appendix III. The remit of the project was to monitor and assess structure and functions and future prospects within a sample of nine Annex I Bog Woodland sites (see Table 2). A general survey was undertaken on two additional sites (Muff and Baltinanima). Additional data was obtained from Fernandez *et al.* (2013) for very small stands on raised bogs.

Table 2. List of bog woodlands monitored.

Site	County	Grid Ref	Area (ha)
Cloonshanville	Galway	752915	2.17
Addergoole	Galway	M 310333	1.22
All Saint's	Offaly	N 013112	14.34
Clara Bog	Offaly	N240302	1.38
Red Bog	Louth	H907041	8.42
Annagh	Cavan	H393131	2.77
Burren	Louth	O 696861	4.33
Castle Kevin	Wicklow	T 162981	5.04
Giant's Cut	Wicklow	T113964	5.85
Muff (General survey only)	Donegal	C453258	15.36
Baltinanima (General survey only)	Wicklow	O164020	10.90

METHODOLOGY

Site selection

Survey work was carried out in October 2011 and between July and October 2012. On arrival at the site an initial assessment of the woodland was made as to whether it conformed to the appropriate Annex I woodland type. For sites which passed this initial assessment, detailed assessments were then carried out at two to four monitoring plots within each site, depending on the size of the woodland. Each plot measured 20 m x 20 m. Plots were selected throughout the site to encompass local variation. Where possible, woodland edges were avoided but this was not possible with small stands. A hand-held GPS (Garmin etrex) was used to record the grid reference of each plot.

Structure and functions

The methodology employed for the monitoring and conservation assessment was modified from Cross and Lynn (2012). Assessments were made at a number of levels: individual-plot, multiple-plot and site levels. The criteria assessed for each woodland stand are shown in Tables 3 and 4

Data recording sheets are given in Appendix I.

Table 3 Assessment criteria at the individual-plot level.

Assessment criterion	91D0 target for pass
Positive indicator species	<i>Betula pubescens</i> and <i>Sphagnum</i> sp. plus at least 5 other positive species
Negative species cover	≤ 10% cover of plot
Median canopy height	≥ 4 m
% total canopy cover	≥ 30% of plot
Proportion of <i>Betula</i> in canopy	≥ 50% of canopy
% native dwarf shrub layer cover	< 50% of plot
% <i>Calluna</i> cover	< 40%
% <i>Sphagnum</i> cover	>25%
% total bryophyte cover	≥ 50%

Individual plot level

A number of positive and negative indicator species was selected based on former surveys of bog woodlands (Perrin *et al.* 2008). The positive species included *Betula pubescens*, the dominant tree species, *Salix* species, the most common associated shrub species, and a number of dwarf shrubs, herbs and mosses, including *Sphagnum* species. Negative species included both native species, e.g. bracken, bramble, and possible alien invasive species. The structural data criteria selected reflected the critical characteristic features of the woodlands, including the height and cover of birch and the cover of *Sphagnum* species.

Multi-stop level

Table 4 Assessment criteria at the 4-plot level.

	91D0 target for pass
Size class distribution	Each size class present
Target species regeneration	At least 1 sapling >1 m in all plots
Old trees & dead wood	Pass = At least 1 old/senescing tree (or dead stem) in >25% of stops and at least 4 standing dead or fallen dead in all stops.

Size class

The dbh of target trees was recorded within three size classes as follows: <10 cm; 11-20 cm; \geq 20 cm. Initially the number in each size category was recorded. However, because of the large number of trees present in many sites this was found to be too time consuming so just the presence/absence of each size category was recorded to give an indication of the size/age structure.

Regeneration of birch.

Regeneration was defined as saplings >1 m in height with a dbh <5 cm.

Dead wood

Dead wood with a diameter of 10 cm or greater was recorded in three categories: old senescent or dead stems (some dead limbs or other signs of damage present); standing dead trees; fallen dead trees/branches. Dead wood was recorded regardless of whether the tree was a target, non-target, native or non-native species.

Structure and functions assessment

Of the nine criteria assessed at the individual-plot level, seven had to reach their target to achieve a pass. Of the three criteria assessed at the multi-plot level, two had to reach their target to achieve a pass. For the overall site level assessment, a green (favourable) assessment result could be achieved only if all plots passed at the individual-plot and multi-plot levels. Thus, in the case of a site with four plots, one failure out of the five assessments (four plots plus the multi-plot) was allowed for a site to receive an amber (unfavourable – inadequate) assessment. More than one failure resulted in a red (unfavourable – bad) assessment (Table 5). However, several sites were so small that only two or three plots could be recorded and here a subjective approach had to be used to assess Structure & Functions

Table 5. Assessment for site with 4 plots

Assessment	Stop level	4-stop level
Green	4 stops pass	3 passes
Amber	4 stops pass	2 passes
Amber	3 stops pass	3 passes
Red	3-4 stops pass	1 pass
Red	<3 stops pass	Any result

Future prospects

The future prospects assessment relates to the likely development and maintenance of the Annex I woodland habitat in favourable condition for the foreseeable future (Ellmauer 2010). The “foreseeable future” is suggested by Ellmauer to be two reporting phases, i.e. 12 years. However,

this time-frame is more applicable to habitats subject to more rapid, short-term changes and turnover of species, such as grassland or dune habitats, than to woodlands, for which a medium to long-term view is more appropriate, i.e. 20-50 years. In order to assess future prospects, pressures, threats and impacts throughout the site were recorded according to the list given by Ssymank (2011). The following details were recorded for each impact: the effect of the impact (positive, negative or neutral), the area of the site affected and the source of the impact (from inside or outside the site).

Future prospects assessment

The assessment of the woodland's future prospects was given according to the following guidelines:

- Green = excellent/good prospects; no significant impact from pressures/threats expected; long-term viability assured.
- Red = bad prospects; severe impact from pressures/threats expected; long-term viability not assured.
- Amber = between these two extremes.

Trends

Current and future trends were assigned using expert judgement and knowledge of the site.

Overall site assessment

Both attributes, i.e. Structure and Function and Future Prospects, had to be green for a site to receive a green assessment. If either structure and functions or future prospects were assessed as red, the overall assessment result for the Site was red. Any other combination resulted in an amber assessment.

RESULTS

Site Results

See Tables 6 and 7 for plot and multiple plot level results respectively. Activities impacting on each site are listed in Table 8.

Addergoole

Site description

This woodland occurs in a small, very exposed site in a flush on the western edge of Addergoole Raised Bog. Overall, the bog woodland is very wet. It consists of pure birch with no *Salix* species or other trees. Trees are typically small, but with a few >20 cm dbh. There are many dead branches on living trees & fallen fine woody debris but coarse woody debris was absent. Nonetheless, the site was considered to be in good condition.

Fernandez *et al.* (2013) note that the central location of the woodland on Addergoole Bog appears to have isolated it to a large extent from the activities that impact on the remainder of the bog habitats. Consequently no deterioration in the habitat is foreseen in the medium term.

Assessment results

All plots passed

Structure and function: Favourable – Green.

Future Prospects: Favourable-Stable - Green.

Cloonshanville

Site description

This bog woodland within a flush consists of two separate stands, a large stand in the centre of the bog and a small stand to the north adjacent to a former conifer plantation. Both stands are very wet with birch and willow species in a range of size classes and including large, mature birch trees. Parts of the wood are rather open with a birch cover <30% and this criterion failed at one stop. However, the woodland was very narrow at this point and had a smaller plot size been used, this attribute would have passed. Regeneration is abundant. No activities are recorded that would impact negatively on the bog woodland in the near future.

Assessment results

All plots passed.

Structure and functions: Favourable- Green

Future Prospects: Favourable-Stable - Green.

All Saint's Bog

Site description

This is the largest stand of bog woodland in the country and the only extensive stand on a raised bog. It consists of 4 main stands connected by birch woodland on a drier substrate and woodland <4m tall. It has a very well developed, if sometimes rather open, structure with birch trees of all size classes. There is a thin shrub layer of birch and willows, well developed dwarf shrub and herb layers and a deep carpet of *Sphagnum* species and other bryophytes and lichens, particularly *Polytrichum commune*. Typical raised bog species, such as crowberry and cranberry, are present. Dead wood, both standing and fallen, of all size classes is present with an abundance of epiphytic lichens. In 2 plots bracken (*Pteridium aquilinum*) cover exceeded the 10% limit. There is also a considerable amount of Scots pine, especially on the margins of the birch stand, possibly as a result of fires on the high bog. Together with the local abundance of bracken this suggests that the bog is drying out, especially as cover was recorded as being lower in the past (Cross 1987).

Drying out is a result of turf cutting and associated drainage. In particular, there is an extensive area on the northeast corner of the bog, immediately adjacent to the bog woodland, which has been cut away mechanically. In addition hydrological changes may be arising from quarrying of the

esker ridge to the south. Fire has also damaged the margins of the wood. Restoration of this site is likely to be extremely difficult.

Assessment results

All plots passed.

Structure and functions: Favourable- Green

Future Prospects: Inadequate – Unfavourable amber – decreasing.

Clara Bog

Site description

Bog woodland on Clara Bog occurs in several small stands associated with flushes on the western side of the bog, the largest of which lies to the west of Shanley's Lough. Several of the sites are very wet and dominated by bog myrtle (*Myrica gale*) and/or purple moor-grass (*Molinia caerulea*). Structurally, there is a range of size classes overall and while regeneration is absent in two of the plots it is abundant in one. Dead wood is abundant although often < 10 cm dbh.

Clara Bog has been seriously damaged by cutting and associated drainage and also in the past by fire. The bog is subsiding and the drainage patterns changing so that less water is flowing out past Shanley's Lough. The impact of these changes is unclear. It is believed that this may actually encourage the expansion of bog woodland in some places – there is evidence of expansion in the vicinity of Shanley's Lough - or lead to some of the stands drying out. Nonetheless, these changes are likely to be slow.

Assessment results

All plots passed.

Structure and function: Favourable - Green

Future Prospects: Favourable - Green.

Annagh Lough

Site description

This bog woodland occurs within a larger area of woodland and would appear to have developed within an alder carr on a former fen or cutaway. It differs from the raised bog woodlands in the presence of carr and fen elements, such as ash and marsh horsetail. Willow species are frequent and *Sphagnum* cover is rather patchy while raised bog elements, e.g. cranberry, crowberry, are absent or less abundant than on raised bog sites. A coniferous plantation on the western side was felled a few years ago and *Sphagnum* quickly became established (Coillte 2009).

This site has been the subject of much research as a new road is being built to the west, including a bridge which will span the deepest part of the peat deposit. This includes a feeder spring which is believed to support a rain-water mound that provides the oligotrophic conditions for the bog woodland (Minerex Environmental Ltd. 2000). The new road involved drilling into subsoil to provide foundations for a bridge over very deep peat. As the engineering works have only been in

progress for a year or so it is too soon to say whether there will be a negative impact, but changes made to the design as a result of pressure from NPWS may ensure that there is no negative impact.

Surveys conducted over the past 12 years suggest that this bog woodland is expanding at the expense of carr woodland. Further, the felling of the conifers on the western edge has improved the light climate in the adjacent bog woodland and has encouraged the expansion of the *Sphagnum* and birch and willow in the former plantation.

Assessment results

All plots passed.

Structure and function: Favourable – Green

Future Prospects: Favourable Green

Red Bog

Site description

Red Bog consists of a large area of cutaway with a mosaic of dried out bog, regenerating bog, birch and carr woodland. Both dry and wet birch woodland occurs, with the latter falling into the category of bog woodland. At least 3 distinct stands occur - in the northern, south-eastern and south-western parts of the site. *Sphagnum* cover is very high with some very large hummocks.

At the 3-plot level the absence of dead wood in 2 plots means that this criterion fails. There is also an absence of trees >20 cm dbh. However, this situation is probably a reflection of the young age of the stands and/or the very wet conditions inhibiting trees from growing to a large size. As in all other respects the woodland is in excellent condition it is assessed as Favourable.

This area of abandoned cutaway appears to be safe from any serious disturbance. It lies in a hollow and would therefore be difficult to drain, although local drainage can never be ruled out. Difficult access, combined with the very wet conditions also make it unattractive for timber extraction

Assessment results

Structure and Function: Favourable -Green

Future Prospects: Favourable - Green.

Burren

Site description

The bog woodland here is associated with a small fen in a hollow. It is extremely wet and the bog woodland is developing around the margins of the site, being most extensive on the north-eastern edge. Some elements of fen vegetation persist, e.g. bog bean (*Menyanthes trifoliata*), marsh horsetail, and the rare species round-leaved wintergreen (*Pyrola rotundifolia*) is also present. The size of the site allowed only two plots to be assessed.

Like Red Bog, this site consisted mostly of young trees and there was little dead wood within the plots. However, there are scattered bigger trees within the site (including in one of the plots) that

may be the 'mother' trees, and dead wood occurred outside the plots. Consequently a more flexible approach to the assessment has been given and the site is considered to be in Favourable condition.

This small site is extremely wet and bog woodland is developing from fen and fen carr. The site appears to be contained within a rock basin and drainage would therefore appear to be difficult and likely to pose little threat. No other threat is foreseen.

Assessment results

Structure and function: Favourable - Green

Future Prospects: Favourable – Green

Giant's Cut

Site description

This is a relatively large stand of birch adjacent to the Lower Lake in Glendalough. This may have been former cutaway but the site was planted with conifers which were felled c. 30 years ago and birch subsequently regenerated vigorously. The site is characterised by large hummocks of *Sphagnum* and *Polytrichum commune*, locally with *Molinia*.

All plots pass, although in one plot the number of positive indicator species failed. At the multi-plot level there is a good size structure and dead wood of all sizes is present. However, there is one failure because of lack of regeneration in three plots. While this may be partly due to the age structure, heavy grazing pressure by deer is probably also responsible. Deer occur in the adjacent oak woods and on the nearby uplands and tracks and dung provide evidence of their presence. Heavy grazing pressure is inhibiting regeneration of the birch and full development of the herb and dwarf shrub layers. A major reduction in grazing pressure would be required to reverse this situation but it is likely that the site would recover relatively quickly.

Assessment results

Structure and function: Favourable - Green

Future Prospects: Unfavourable – Inadequate – Amber

Castlekevin

Site description

Fragmented stands of birch woodland within a sessile oak woodland occur on the floor of the Avonmore River valley where water accumulates from flushes running down the valley sides. Some of these conform to bog woodland. The trees are considerably taller than on raised bog and cutaway sites. Sessile oak woodland elements are present, e.g. hard fern, as well as flush species, e.g. marsh violet (*Viola palustris*) but the herb layer is dominated by *Molinia caerulea* and soft rush (*Juncus effusus*). All plots passed, although *Sphagnum* cover is low in one plot. There is a wide range in size classes of living trees as well as dead wood in all plots. Regeneration of birch (and other tree species) occurs in small amounts. These stands are an integral part of a more extensive forested area. As there is little timber of any value within the bog woodland it is unlikely that there is a

serious threat to the site and felling of adjacent woodland would be unlikely to impact negatively on the site. The hydrology is dictated by the topography and is not under any apparent threat.

Assessment results

Structure and function: Favourable – Green

Future Prospects: Favourable - Green

Additional Sites

Fernandez *et al.* (2013) examined flushed areas contained a scattering of birch trees and small stands of birch on several raised bogs. While they were associated with abundant *Sphagnum* and other bog woodland species, they were considered too small to be classified as bog woodland. However, they may be precursors of bog woodland. A general survey was undertaken of two larger sites, Muff, Co. Donegal and Baltinanima, Co. Wicklow. A brief description of these sites is given below:

Muff

Birch woodland, 8-12m high, with scattered rowan and large pines is located in a shallow depression within a larger stand of deciduous and mixed woodland. The area is probably a former cutaway bog. The dwarf shrub layer is patchy and consists of bilberry and scattered ling heather and gorse. The forest floor is a mosaic of bilberry, bramble, grasses (mostly *Agrostis* species) and mosses. The terrain is uneven and hummocky with ridges/knolls and depressions. *Sphagnum* cover varies from 0 to 100% increasing to the south-west, which is lower lying and wetter. The *Sphagnum* hummocks appear to be active and give the impression of expanding. There are scattered beech seedlings, originating from mature trees to the north, but they are unthrifty. No birch regeneration was recorded at this site but this is probably the result of an unsuitable light climate. Despite this, the site was considered to pass for Structure and Function. Future prospects also appear favourable with no obvious threats to the woodland survival.

Baltinanima

This large area of birch bog woodland occurs within an extensive sessile oak wood. Parts of this conform to bog woodland in association with flushing. Purple moor-grass, forming large tussocks, dominates the herb layer with frequent soft rush and a patchy *Sphagnum* cover. There is a range of tree sizes and standing dead and coarse woody debris is common. Although regeneration is more or less absent, even within clearings, probably a result of heavy deer grazing, the site was considered to pass for Structure and Function. However, the area is heavily grazed by deer and for this reason the Future Prospects are assessed as Unfavourable-Inadequate.

Table 6. Plot level assessment results

Site Name	Site Code	Quadrat Name/No.	Positive indicator species	Negative indicator species	Median canopy height	Total canopy cover %	Betula cover %	Dwarf shrub cover %	Calluna cover %	Sphagnum cover %	Bryophyte cover%	Plot level
Cloonshanville	0614	1	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Cloonshanville	0614	2	Pass	Pass	Pass	Fail	Pass	Pass	Pass	Pass	Pass	Pass
Addergoole	0297	1	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Addergoole	0297	2	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
All Saints	0566	1	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
All Saints	0566	2	Pass	Fail	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
All Saints	0566	3	Pass	Fail	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
All Saints	0566	4	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Clara Bog	0572	1	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Clara Bog	0572	2	Pass	Pass	Pass	Pass	Pass	Fail	Pass	Pass	Pass	Pass
Clara Bog	0572	3	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Clara Bog	0572	4	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Red Bog	-	1	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Red Bog	-	2	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Red Bog	-	3	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Annagh	0007	1	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Annagh	0007	2	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Annagh	0007	3	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Burren	-	1	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Burren	-	2	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Castle Kevin	-	1	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Fail	Pass	Pass
Castle Kevin	-	2	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Castle Kevin	-	3	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Giant's Cut	2122	1	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Giant's Cut	2122	2	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Giant's Cut	2122	3	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Giant's Cut	2122	4	Fail	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass

Table 7. Assessment at the multi-plot level

Site Name	Site Code	dbh	Old and dead wood	Birch regeneration	Multi-stop level
Cloonshanville	614	Pass	Pass	Pass	Pass
Addergoole	297	Pass	Pass	Pass	Pass
All Saints	566	Pass	Pass	Pass	Pass
Clara Bog	572	Pass	Pass	Pass	Pass
Red Bog		Pass	Fail	Pass	Pass
Annagh	7	Pass	Pass	Pass	Pass
Burren		Pass	Pass	Pass	Pass
Castle Kevin		Pass	Pass	Pass	Pass
Giant's Cut	2122	Pass	Pass	Fail	Pass

Overall condition assessment

Two sites (All Saint's and Giant's Cut) were assessed as Unfavourable – Inadequate or Amber, one of which shows a declining trend. The rest were assessed as Favourable - Green.

Table 8. Assessment overview of sites surveyed.

Site Name	County	Structure and Function	Future Prospects	Overall Assessment
Addergoole	Galway	Pass	Pass	Pass
Cloonshanville	Galway	Pass	Pass	Pass
All Saint's	Offaly	Pass	Unfavourable -inadequate	Unfavourable -inadequate
Clara	Offaly	Pass	Pass	Pass
Annagh Lough	Cavan	Pass	Pass	Pass
Red Bog	Louth	Pass	Pass	Pass
Burren	Louth	Pass	Pass	Pass
Castle Kevin	Wicklow	Pass	Pass	Pass
Giant's Cut	Wicklow	Pass	Unfavourable -inadequate	Unfavourable -inadequate
Muff (General survey)	Donegal	Pass	Pass	Pass
Baltinanima	Wicklow	Pass	Unfavourable -inadequate	Pass

Plot level

Target tree species and positive indicator species

While birch was constant and dominant *Salix* species were less constant, although one or two individuals were usually present within the stands. There was typically a range of positive indicator species present, the composition reflecting the habitat type. The most abundant *Sphagnum* species were *S. palustre* and *S. fallax*, with the occasional less common species, such as *S. fibriatum* and *S. squarrosum*. All but one plot passed this criterion.

Negative indicator species

Unlike many other woodland types, invasive non-native species were rarely recorded and even where non-native species were present, e.g. Giant's Cut, there was no indication that they posed a potential problem. This is probably a reflection of the extreme physical conditions characteristic of this habitat. Negative native species in excess of 10% were recorded only on All Saint's Bog (bracken), probably indicating that this site is drying out.

Structural data

All sites passed the structural data criterion, typically for all criteria. In one site, Cloonshanville, the birch cover was <30% but the well developed bog woodland was narrow at this point and graded into more open woodland and scrub. Dwarf shrub cover was generally low, the exception being on Clara Bog where there were tall stands of bog myrtle, which approached or exceeded 50% in two plots. Ling heather (*Calluna vulgaris*) cover, an indicator of drier conditions, was low in all sites, while total bryophyte cover was high, typically exceeding 80%. In general *Sphagnum* cover was very high, often exceeding 80%. Only in Castlekevin did bryophyte cover fall below 50% in one plot and this was also the only plot where *Sphagnum* cover was below the target. Nonetheless, the overall cover of bryophytes and *Sphagnum* within the woodland justified the site passing.

Multi-plot level

dbh

It was not uncommon to find that at least one dbh size class was missing, usually trees >20cm. This may be a reflection of 2 factors. Firstly, some of the stands are relatively young and older and larger trees may be absent or present only in very small numbers. It was not uncommon to find one or two large, mature trees within a stand which probably acted as 'mother' trees, surrounded by a dense growth of younger trees. Secondly, in the very wet substrate many trees fail to reach a large size before becoming moribund. The absence of trees >20cm therefore is not necessarily an indication of young age.

Dead wood.

Size class is reflected in the size and quantity of dead wood, particularly in the absence of dead wood >20cm. Dead wood >10cm is also often absent or present only in small quantities. In contrast,

dead standing timber, dead fallen timber and senescing trees <10cm are more common. Fallen dead wood tends to rot quickly and become engulfed in *Sphagnum* and may not be readily visible.

Regeneration

The size class profile is also reflected in the quantity of regeneration. In many sites the amount of regeneration is poor or absent. This may be a reflection of the general age class or, more probably, the light climate under a relatively closed birch canopy. It was noticeable that those stands with most regeneration tended to be older and more open, such as All Saint's Bog, where a complete range of size classes was present. The only site which failed for regeneration was Giant's Cut where there is evidence of strong grazing pressure.

DISCUSSION

Overall, bog woodlands have been assessed as being in Favourable Conservation Condition (Green) with only two sites falling into the Unfavourable – Inadequate category: this is due to drying out of one raised bog site (All Saint's Bog) and overgrazing in the other site (Giant's Cut). The assessment is considerably better than in the previous reporting period (NPWS 2007). This may give the impression that their condition has improved but the assessment is a result of a combination of better knowledge and a better understanding of the processes at work, especially on raised bogs, and the earlier assessment may have been unduly pessimistic.

The habitat of bog woodland on raised bogs is determined by the overall bog hydrology. The idea that drainage and turf cutting will lead to drying out of bog woodland, postulated in the 2007 report, may be only partly true. Evidence from Clara Bog indicates that overall drying out of the bog resulting in subsidence leads to changes in surface hydrology causing both localised wetting and drying out. Both results may be beneficial to bog woodland: drying out of soak/pool areas may encourage the establishment/expansion of birch while wetting and slight nutrient enrichment resulting from changes in surface flow may facilitate colonisation by birch. Thus, for most of the raised bog sites the future prospects for the woodlands is considered to be favourable rather than poor as reported in the last assessment. The exception is All Saint's Bog, which does appear to be drying out. This is a serious situation given the extent and importance of this site.

The National Survey of Native Woodlands (NSNW) and surveys by NPWS Regional Management staff located additional bog woodlands on former cutaway and within sessile oak woodland that were not assessed in the last reporting period, e.g. Red Bog, Muff. This has expanded both the range and area of the habitat. In the majority of these sites the Structure and Function and Future Prospects have been assessed as Favourable and in one site, Annagh, restoration work by Coillte (2009) has led to the bog woodland beginning to expand. Taken together, therefore, the overall assessment is Favourable.

As mentioned earlier, however, the long-term dynamics of bog woodlands is not understood. Those associated with flushes on raised bogs and within sessile oak woods may be more or less permanent, provided the bog hydrology does not change radically. However, those on cutaway may be relatively transient communities that gradually revert to raised bog communities or dry out

to become dry birch wood or some other woodland type. Irrespective of their location, however, an in-built inertia may result in the woodlands persisting for decades, well after hydrological changes have rendered conditions unsuitable for their long-term survival.

RECOMMENDATIONS

Indicator species

The list of indicator species was found to be appropriate. However, Scots pine might be added to the list of negative indicator species. A few trees are not necessarily a negative indicator but it can regenerate strongly after fire and while it does not always thrive large amounts are probably indicative of a site drying out.

Tree girth/dead wood

The dbh limit may have been set too high as in the very wet conditions characteristic of bog woodlands birch trees do not grow very large. In numerous plots the trees were < 10 cm dbh and consequently much dead wood was also < 10 cm. In future monitoring surveys consideration should be given to a site passing on the basis of 2 size classes rather than all three being present. The dead wood criterion should accordingly be based on the dbh of living trees.

Regeneration

Poor regeneration may be due to the age structure of the woodlands, low light climate or to the very wet conditions but the precise requirement for birch regeneration in these sites is not well understood. If, as suggested above, these bog woodlands are transient communities, then regeneration may not occur or be only at a very low level within the existing woodland. However, it may occur in adjacent areas. This criterion needs to be re-examined for future monitoring surveys.

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APPENDIX I: DATA SHEETS

91DO Bog Woodland: Monitoring sheet

20x20m plots

Site name		Recorders		Photo no.s	
Stop Number		Date		Grid ref	
Positive indicator species		✓	Negative indicator species		% Cover
Trees and woody species <i>Betula pubescens</i> <i>Salix aurita</i> <i>Salix atrocinerea</i> Dwarf shrubs, herbs & ferns <i>Dryopteris dilatata</i> <i>D. carthusiana.</i> <i>Carex rostrata</i> <i>Juncus effusus</i> <i>Molinia caerulea</i> <i>Vaccinium oxycoccus</i> <i>Empetrum nigrum</i> <i>Vaccinium myrtillus</i> <i>Epilobium palustre</i> <i>Calluna vulgaris</i> <i>Potentilla erecta</i> Mosses <i>Polytrichum commune</i> <i>Sphagnum fimbriatum</i> <i>Sphagnum fallax</i> <i>Sphagnum palustre</i> <i>Hylocomium splendens</i> <i>Aulacomnium palustre</i>			<i>Pteridium aquilinum</i> <i>Rubus</i> agg. <i>Rhododendron ponticum</i> Non-native conifer species List: Others List:		
Pass = <i>Betula pubescens</i> , <i>Sphagnum</i> species plus ≥5 of the other species			Pass = Negative indicator species <10%		

Structural data	Result	Stop level	Passes
Median canopy height >4m Total canopy cover >30% of plot <i>Betula pubescens</i> >50% of canopy Dwarf shrub layer cover <50% <i>Calluna</i> cover <40% % <i>Sphagnum</i> cover (pass = $\geq 25\%$) % Bryophyte cover (pass = $\geq 50\%$)		≥ 7 passes = pass < 7 passes = fail Result	

Target tree species dbh	✓	Old trees & dead wood (any species)	Result
<i>Betula pubescens</i> 5-10 cm 10-20 cm >20 cm		No. of old/senescing trees or dead stems >10cm No. of standing dead trees >10cm No. of fallen dead trees/branches >10cm	
Pass = Over all stops each size class represented		Pass = 1+ old/senescing trees (or dead stems) in >25% of stops and 4+ standing dead or fallen dead in total number of stops	
<i>Betula pubescens</i> regeneration			
Pass = At least 1 sapling >1m in all plots			

APPENDIX II: LIST OF ACTIVITIES IMPACTING ON SITES

Addergoole

Code	Description	Influence	Intensity	Area impacted	Comment
C01.03.02	Peat extraction	Negative	L	Margins of bog	No direct impact on bog woodland

Cloonshanville

Code	Description	Influence	Intensity	Area impacted	Comment
C01.03.02	Peat extraction	Negative	L	Margins of bog	No direct impact on bog woodland

All Saint's Bog

Code	Description	Influence	Intensity	Area impacted	Comment
C01.03.02	Peat extraction (mechanical)	Negative.	H	Whole bog	Cutting now stopped but the impact will affect site for many years unless remedial action is taken.
I02	Problematic native species	Negative	M	Locally within woodland	Bracken and Scots pine spread may be indicative of drying out.
J01	Fire	Negative	M	Margins	Less likely now than in past but a constant danger from accidental or deliberate burning.
J02	Changes in hydraulic condition	Negative	H	Whole bog	Drainage associated with peat cutting is causing the bog to dry out and probably subside. This will very probably intensify in the future.

Annagh Bog

Code	Description	Influence	Intensity	Area impacted	Comment
B02.02	Forestry clearance (c.5 years ago)	Positive	M	Western edge	Increased light to adjacent bog woodland. Bog woodland shows signs of expanding into former plantation.
D01.02	Roads and motorways	Possibly negative	Unknown	Indirect but could affect entire woodland	New road being built on SW corner which involved drilling into subsoil to provide foundations for bridge over very deep peat. It could damage the hydrology of the site.
J02	Changes in hydraulic condition	Negative	Unknown	Whole site	May intercept feeder spring to peat deposit which is believed to support a rain-water mound.

Burren

There are no obvious impacting activities on this site, which lies in an isolated and inaccessible location

Clara Bog

Code	Description	Influence	Intensity	Area impacted	Comment
C01.03.02	Peat extraction (mechanical)	Neutral	H	Whole bog	Cutting now stopped but impact will affect site for many years.
J01	Fire	Negative	L	Margins	Less likely now than in past but a constant danger from accidental or deliberate burning.
J02	Changes in hydraulic condition	Neutral	H	Whole bog	Drains opened up for peat cutting partly blocked. However, the bog is subsiding and altering the drainage pattern. The impact is unclear: it may encourage the expansion of bog woodland or lead to some of the stands drying out.

Castlekevin

There are no obvious impacting activities on this site, which lies in an isolated and inaccessible location

Red Bog

Code	Description	Influence	Intensity	Area impacted	Comment
E 03.01	Disposal of household waste	Negative	L	Margins near road	This may occur around site entrance and near houses but elsewhere along roadside access is too difficult.

Giant's Cut

Code	Description	Influence	Intensity	Area impacted	Comment
B 06	Grazing in forests/wood lands	Negative	M	Whole site	Deer grazing is currently preventing regeneration of trees and damaging the herb layer

APPENDIX III: LIST OF KNOWN BOG WOODLANDS

Site Name	Site Code	Designation	County	NSNW Releve	X	Y	Data Source	Authors / Year	Conservation Status Assessment	Habitat Area (ha)	Comment
Addergoole	0297	SAC	Galway	1649/01	130980	233387	RBMP	Fernandez <i>et al.</i> (2013)	Favourable	1.22	Habitat 91D0 confirmed
All Saints	0566	SAC	Offaly	605/01	201309	211207	RBMP	Fernandez <i>et al.</i> (2013)/ Cross and Lynn (2013)	Favourable	14.34	Habitat 91D0 confirmed
Annagh (Lough Oughter)	0007	SAC	Cavan	465/01	239346	313170	NSNW / Coillte/Cross and Lynn	Cross and Lynn (2013)	Favourable	2.77	Habitat 91D0 confirmed
Ballinanty	-	-	Wicklow	802/01	314360	186294	NSNW	Perrin <i>et al.</i> (2008)	N/A	2.08	Habitat 91D0 confirmed
Ballynamona Bog	2339	SAC	Roscommon	N/A	194167	242919	RBRP	Derwin & MacGowan (2000)	N/A	7.82	Habitat 91D0 confirmed
Baltinanima	2122	SAC	Wicklow	746/03	16386	02218	NSNW	Perrin <i>et al.</i> (2008)/ Cross and Lynn (2013)	Favourable	10.90	Habitat 91D0 confirmed
Brownstown East	-	-	Offaly	326/01	197558	183098	NSNW	Perrin <i>et al.</i> (2008)	N/A	NA	Potential Habitat 91D0

Burren	-	-	Louth		06899	86044	Cross and Lynn 2013	Cross and Lynn (2013)	Favourable	4.33	Habitat 91D0 confirmed
Carricknavedda	-	-	Cavan	650/01	251417	298020	NSNW	Perrin <i>et al.</i> (2008)	N/A	4.98	Potential Habitat 91D0
Carrigan	-	-	Cavan	698/01	238608	293956	NSNW	Perrin <i>et al.</i> (2008)	N/A	2.62	Potential Habitat 91D0
Castlekevin	-	-	Wicklow	785/02	316208	197608	NSNW	Perrin <i>et al.</i> (2008)	Favourable	5.04	Potential Habitat 91D0
Clara	0572	SAC	Offaly	606/01	224098	230055	RBMP	Cross and Lynn (2013)	Favourable	1.38	Habitat 91D0 confirmed
Clonfinane	0641	SAC	Tipperary	N/A	198807	203702	RBMP	Fernandez <i>et al.</i> / (2005)	Favourable	0.51	Habitat 91D0 confirmed
Clonkeen	N/A	N/A	Wicklow	892/01	307375	193418	NSNW	Perrin <i>et al.</i> (2008)	N/A	3.37	Potential Habitat 91D0
Clooncoe Wood and Lough	0424	NHA	Leitrim	330/02	210834	292279	NPWS	Perrin <i>et al.</i> (2008)	N/A	NA	Potential Habitat 91D0
Clooncraft- Cloonlarge	2310	SAC	Roscommon/Gal way	N/A	195024	262997	Turf cutting impact assessment	Fernandez <i>et al.</i> (2006)	N/A	2.12	Habitat 91D0 confirmed
Clooneen	2348	SAC	Longford	N/A	206658	284328	RBRP	Derwin & MacGowan (2000)	N/A	3.38	Habitat 91D0 confirmed

Cloonmoylan	0248	SAC	Galway	N/A	177562	199671	Raised Bog Monitoring Project (RBMP)	Fernandez <i>et al.</i> (2005)	N/A	0.97	Not surveyed since 2008
Cloonshanville	0614	SAC	Tipperary	N/A	175247	291534	RBMP	Fernandez <i>et al.</i> (2013)	Favourable	2.17	Habitat 91D0 confirmed
Cordonaghy Bog	0978	NHA	Cavan	614/01	230948	294446	NSNW	Perrin <i>et al.</i> (2008)	N/A	9.24	Habitat 91D0 confirmed
Corduff East	N/A	N/A	Cavan	1251/01	237275	296223	NSNW	Perrin <i>et al.</i> (2008)	N/A	NA	Habitat 91D0 confirmed
Corliskea	2110	SAC	Roscommon, Galway	N/A	169150	273593	RBMP	Fernandez <i>et al.</i> (2013)	Favourable	0.25	Habitat 91D0 confirmed
Drummod Great Wood	-	-	Cavan	459/01	234866	301552	NSNW	Perrin <i>et al.</i> (2008)	N/A	1.81	Potential Habitat 91D0
Giant's Cut	2122	SAC	Wicklow	786/01	311361	196440	NSNW	Perrin <i>et al.</i> (2008)/Cross and Lynn (2013)	Unfavourable - Inadequate	5.85	Habitat 91D0 confirmed
Killeaney	-	-	Laois	297/02	236000	187800	NSNW	Perrin <i>et al.</i> 2008	N/A	6.29	Potential Habitat 91D0
Kilmore	0283	NHA	Galway	N/A	174260	254882	Turf Cutting Impact Assessment	Fernandez <i>et al.</i> (2006)	N/A	3.11	Habitat 91D0 confirmed
Kilmore West	-	-	Monaghan	854/01	255519	337504	NSNW	Perrin <i>et al.</i> (2008)	N/A	6.05	Habitat 91D0 confirmed

Knightstown	-	-	Meath	726/01	285806	278583	NSNW	Perrin <i>et al.</i> (2008)	N/A	3.63	Habitat 91D0 confirmed
Muff	-	-	Donegal	1438/01	245208	425688	NWNS; Cross 2012	Perrin <i>et al.</i> (2008); Cross and Lynn (2013)	Favourable	15.36	Habitat 91D0 confirmed
Nore Valley - Timoney	1853	NHA	Tipperary	N/A	216567	184589	Raised Bog Restoration Project (RBRP)	Derwin & MacGowan (2000)	N/A	4.38	Bog drained in 2003 but now being restored.
Red Bog	-	-	Louth	640/01	290943	303687	NSNW Cross and Lynn 2013	Perrin <i>et al.</i> (2008)/Cross and Lynn (2013)	N/A	8.42	Habitat 91D0 confirmed
Skeagh	-	-	Cavan	621/02	265488	301768	NSNW	Perrin <i>et al.</i> (2008)	N/A	7.24	Habitat 91D0 confirmed
Sruveel	-	-	Monaghan	1221/01	255705	337226	NSNW	Perrin <i>et al.</i> (2008)	N/A	4.32	Habitat 91D0 confirmed
Tithwer	-	-	Wicklow	999/01	22632	205645	NSNW	Perrin <i>et al.</i> (2008)	N/A	3.0	Habitat 91D0 confirmed
Trien	2110	SAC	Roscommon	N/A	165466	275955	RBMP	Fernandez <i>et al.</i> (2013)	Favourable	0.04	Habitat c
Ussey	-	-	Galway	N/A	172046	268333.00	Conservation Status Assessment Project	Fernandez (2007)	N/A	3.00	Potential Habitat 91D0