National Parks & Wildlife Service

Corliskea/Trien/Cloonfelliv Bog SAC (site code 002110)

Conservation objectives supporting document - raised bog habitats

Version 1

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Contents

1 Introduction

This document presents a summary of the background information that has informed the process of setting the Site-Specific Conservation Objective in relation to the priority Annex I habitat 'active raised bog' (habitat code 7110) (hereafter referred to as Active Raised Bog (ARB)), for which Corliskea/Trien/Cloonfelliv Bog Special Area of Conservation (SAC) has been designated.

Corliskea/Trien/Cloonfelliv Bog SAC is also designated for two other related Annex I habitats, namely; 'degraded raised bogs still capable of natural regeneration' (habitat code 7120) (hereafter referred to as Degraded Raised Bog (DRB)) and 'depressions on peat substrates of the Rhynchosporion' (habitat code 7150). Based on the close ecological relationship between these three habitats types, it is not necessary to set specific Conservation Objectives for all three habitats individually. It is considered that should favourable conservation condition for ARB be achieved on the site, then, as a consequence, favourable conservation condition for the other two habitats would also be achieved.

Corliskea/Trien/Cloonfelliv Bog SAC is also designated for the priority Annex I habitat 'bog woodland' (habitat code 91D0). A separate site-specific conservation objective has been set for bog woodland and therefore is not considered in this supporting document.

1.1 Raised Bogs

Raised bogs are accumulations of deep peat (typically 3-12m) that originated in shallow lake basins or topographic depressions. The name is derived from the elevated surface, or dome, that develops as raised bogs grow upwards through the accumulation of peat; the domed effect is often exaggerated when the margins of a bog are damaged by turf cutting or drainage, and are drying out. Raised bogs are most abundant in the lowlands of central and mid-west Ireland.

Irish raised bogs are classified into two sub-types (Schouten 1984): 1. Western or intermediate raised bogs, and 2. True midland or eastern raised bogs, based on phytosociological and morphological characteristics. In terms of overall morphology, the main difference between these two raised bog types is that while eastern raised bogs tended to stay more confined to the depressions in which they were formed, western raised bogs tended to grow out beyond their original basin, presumably a result of the higher rainfall levels (Cross 1990). In terms of vegetation differences the most obvious difference between the two bog types is the presence of a number of oceanic plant species on western raised bogs which are absent from the true midland raised bogs. The liverwort species *Pleurozia purpurea*[1] and the moss species *Campylopus atrovirens* grow on western raised bogs but not on eastern raised bogs; similarly, *Carex panicea* is generally more common on the high bog surfaces of western raised bogs (Schouten 1984). All of these plant species are widespread in the low-level Atlantic blanket bogs and their presence in western raised bogs is presumed to be due to the higher rainfall levels and greater rain-derived nutrient fluxes.

Exploitation has been extensive and none of the remaining Irish raised bogs are completely intact (Cross 1990). It is estimated that less than 10% of the original raised bog habitat in Ireland is in a near intact state (uncut), with less than 0.5% continuing to support ARB (DAHG 2014). Excavated face banks, whether active or inactive, are a common feature around the

[1] Note on species nomenclature: *In the case of plant species, only scientific names are used throughout the main text while common English names are included in tables. In the case of faunal species, common English names (where known) are used throughout the text together with scientific names.*

margins. Any areas where part of the bog has been removed are termed cutover bog, with the remaining area referred to as high bog or intact bog. In a natural state, raised bogs are circled by a wetland fringe, known as the lagg zone, which is usually characterised by fen communities. In Ireland, most laggs have been lost through drainage and land reclamation (Fossitt 2000).

The surface of a relatively intact raised bog is typically wet, acid, deficient in plant nutrients, and supports specialised plant communities that are low in overall diversity and comprising species adapted to the biologically harsh conditions. The vegetation is open, treeless and bog mosses or *Sphagnum* species dominate the ground layer. Small-scale mosaics of plant communities are characteristic and reflect the complex microtopography of hummocks and hollows on the bog surface (see Section 1.1.1 below). Raised bogs are driest at the margins and wetness generally increases towards the centre of the peat mass where well-developed pool systems are most likely to occur.

Raised bogs may also contain soaks and flushes (wet 'active' or dry 'inactive') due to the increased supply of nutrients over time through concentrated surface flows, or where there are links with regional groundwater or the underlying mineral substratum. Slight mineral enrichment and / or constant through flow of water provide conditions suitable for a range of species that are not typically associated with other areas of raised bog.

When damaged by peat extraction or drainage, the water table in the peat drops and the bog surface becomes relatively dry; pools are rare or absent, cover of bog mosses is greatly reduced and *Calluna vulgaris* increases in abundance. The drop in water table causes the peat to compress under its own weight causing the bog surface to deform. Greater deformation occurs closest to areas where the water table has dropped. This increases the slope of the bog surface causing rain falling on the ground surface to flow off the bog more quickly. The effect is normally greatest around the margins and in a typical situation surface wetness increases towards the centre of the bog. Trees such as *Betula pubescens* and *Pinus sylvestris* frequently invade the drier cut margins, but may also occur in flushed areas.

In Ireland, the Annex I habitat ARB is currently considered to be in unfavourable bad conservation status principally as a result of marginal turf cutting, more recent semi-industrial peat extraction, and associated drainage effects caused by these activities (NPWS 2008; 2013). The lowering of regional groundwater levels are also known to have had an effect on some sites. Fires associated with turf cutting, dumping, or agricultural activities may also adversely affect the condition of the habitat.

1.1.1 Raised Bogs Microtopography

Raised bogs are typically treeless and are characterised by a distinctive vegetation dominated by bog mosses (*Sphagnum*), sedges, and dwarf shrubs, all of which are adapted to waterlogged, acidic and exposed conditions. Bog mosses, which have unique properties, are the principal component of peat, and are largely responsible for the typical surface features of hummocks, hollows, lawns, and pools. The wettest bogs, which have extensive pool systems, have the greatest variety of plant and animal life and support a range of specialist species.

The following terms that describe microtopography are generally accepted in the study of mire ecology (Gore 1983). A schematic diagram showing the typical microtopographical divisions is presented in Figure 1.

Pools

Depressions in the bog surface where the water table remains above the surface level all year around or below surface level for only a very short period of time. They are characterised by the presence of aquatic plant species such as *Sphagnum cuspidatum*, *S. denticulatum*, and *Cladopodiella fluitans*. In more degraded scenarios or where high seasonal water fluctuation occurs, the pools contain open water and/or algae. Tear pools are found on bogs where internal tensions, due to mass movement of peat, has taken place within the high bog and has caused the development of elongated pools. These are frequently found on western bogs and may be natural or anthropogenic in origin.

Hollows

These are shallow depressions (less than 5cm deep) on the bog surface where surface water collects, or where the water table reaches or lies just above ground level, depending on seasonal conditions. They are often filled with *Sphagnum* species such as *S. papillosum* and *S. cuspidatum*. They take many forms but are often eye shaped. Marginal hollows tend to be elongated as they are focused points for surface water run-off. They are often dominated by *Narthecium ossifragum*.

Lawns

These are shallow hollows or flat areas where one species dominates to form a lawn. This is frequently a *Sphagnum* species, such as *Sphagnum magellanicum,* or *S. papillosum* which can completely fill in a hollow to form a small lawn.

Flats

These are more or less flat areas which are intermediate between hollow and hummock communities. They tend to be drier than the above situations.

Hummocks

These are mounds on the bog surface which can range from a few centimetres to more than one metre in height. They are usually composed mainly of *Sphagnum* species, such as *Sphagnum magellanicum, S. capillifolium, S. austinii* and *S. fuscum* but other bryophyte species such as *Hypnum jutlandicum* and *Leucobryum glaucum* are also important, especially as the hummock grows taller and becomes drier. *Calluna vulgaris* is another important element, as it flourishes where the water table is not at surface level (Kelly & Schouten 2002).

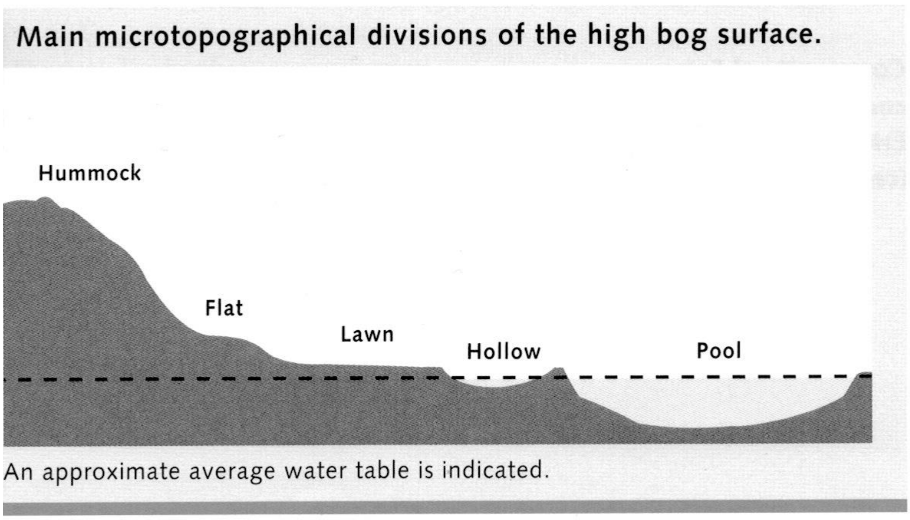

Figure 1 Raised bog microtopographical divisions on the high bog surface (reproduced from Kelly & Schouten 2002).

1.1.2 Typical Flora of Irish Raised Bogs

Raised bogs are characterised by a distinctive vegetation dominated by a variety of mosses (e.g. *Sphagnum spp., Hypnum spp., Racomitrium spp.*), sedges and grass-like species (e.g. *Eriophorum spp., Rhynchospora spp., Narthecium ossifragum, Molinia caerulea* and *Carex spp.*), and dwarf shrubs (e.g. *Calluna vulgaris, Erica tetralix, Vaccinium spp.* and *Empetrum nigrum*). In addition to these groups, a number of other species characterise raised bogs including carnivorous plants (e.g. *Drosera spp., Utricularia spp.*), lichens of both the bog surface and epiphytes on the stems of dwarf shrubs and the occasional trees on bogs (e.g. *Cladonia* spp*., Usnea* spp*.*). Herbaceous plants are not a significant element on raised bogs and include a few commonly occurring species such as *Menyanthes trifoliata, Pedicularis sylvatica*, and *Potentilla erecta* (Cross 1990).

Drier areas and hummocks usually support *Calluna vulgaris*, *Eriophorum vaginatum*, *Trichophorum germanicum*, *Erica tetralix*, lichens (*Cladonia* spp.), bog mosses (*Sphagnum capillifolium*, *S. austinii*, *S. fuscum*, *S. papillosum*) and other mosses (*Dicranum scoparium*, *Leucobryum glaucum*). Wet hollow areas and pools are characterised by *Eriophorum angustifolium*, *Rhynchospora alba*, *Narthecium ossifragum*, *Drosera* spp., *Menyanthes trifoliata*, bladderworts (*Utricularia* spp.) and bog mosses (*Sphagnum cuspidatum, S. denticulatum and S. magellanicum*).

A list of flora species that are regarded as being typical of ARB habitat in Ireland is presented in Table 1. A number of these typical species would have a restricted distribution and do not occur throughout the range of the habitat in Ireland (see above), therefore only a subset of these species would be expected to be present on any individual bog.

Table 1 Flora species typically associated with active raised bog in Ireland (after NPWS 2013). *Species list is based on vegetation communities defined by Kelly (1993) and Kelly & Schouten (2002).*

Common name	Scientific Name
Bog rosemary	Andromeda polifolia
Bog bead moss	*Aulacomnium palustre*
Bristly Swan-neck moss*	*Campylopus atrovirens**
Lichen	*Cladonia ciliata*
Lichen	*Cladonia portentosa*
Long leaved sundew	*Drosera anglica*
Intermediate leaved sundew*	*Drosera intermedia**
Round leaved sundew	*Drosera rotundifolia*
Common cotton grass	*Eriophorum angustifolium*
Hare’s tail cotton grass	*Eriophorum vaginatum*
Large white moss	*Leucobryum glaucum*
Bogbean	*Menyanthes trifoliata*
Bog asphodel	*Narthecium ossifragum*
Purple spoonwort*	*Pleurozia purpurea**
Woolly fringe moss*	*Racomitrium lanuginosum**
White beak-sedge	*Rhynchospora alba*
Austin’s bog moss	*Sphagnum austinii*
Red bog moss	*Sphagnum capillifolium*
Feathery bog moss	*Sphagnum cuspidatum*
Cow-horn bog moss*	*Sphagnum denticulatum**
Rusty bog moss	*Sphagnum fuscum*
Magellanic bog moss	*Sphagnum magellanicum*
Papillose bog moss	*Sphagnum papillosum*
Golden bog moss*	*Sphagnum pulchrum**
Lustrous bog moss	*Sphagnum subnitens*
Bladderwort	*Utricularia minor*
Cranberry	*Vaccinium oxycoccos*

*Notes: * Species more typical of western raised bog sites.*

1.1.3 Typical Fauna of Irish Raised Bogs

Raised bogs are extremely nutrient poor ecosystems. Acidic, waterlogged and exposed conditions make them an unattractive habitat for animal life. As a consequence they are relatively poor both in terms of species diversity and population densities. Many species are opportunists, vagrant or temporary rather than specialists, but nonetheless may have an important impact on the ecosystem through nutrient imports and exports or other interactions (Cross 1990). A list of fauna species that would be typically associated with raised bog habitat in Ireland is presented in Table 2. The species listed are not confined to ARB and most, if not all, will use other areas of the bog and surrounding habitats.

Raised bog is unsuitable habitat for many vertebrates due to the lack of available foraging and suitable breeding places. The Irish hare is the only mammal commonly occurring. The common frog is the most common vertebrate predator.

Although 18 species of birds have been reported breeding on raised bogs (Wilson 1990) many of these species utilise the bog as a nesting habitat only. They are dependent on other neighbouring habitats such as open water bodies, callows and wet grassland particularly for feeding. Just a few species of bird, including meadow pipit (*Anthus pratensis*), skylark (*Alauda arvensis*) and curlew (*Numenius arquata*) complete their full breeding cycle on the bog and the first two species are the commonest species occurring (Bracken *et al.* 2008). Red grouse (*Lagopus lagopus*) must also be included as a typical bog species, occurring year round as a resident. Red grouse and curlew have declined significantly on raised bogs in recent times. BirdWatch Ireland have published an Action Plan for Raised Bog Birds in Ireland which lists 13 species of conservation concern that are associated with Raised Bogs (O'Connell 2011). A recent review of birds of conservation concern in Ireland has since added meadow pipit (*Anthus pratensis*) to the red (most endangered) list of Birds of Conservation Concern in Ireland (BoCCI) (Colhoun & Cummins 2013).

Our knowledge of the invertebrate assemblages associated with Irish raised bogs remains incomplete (particularly micro-invertebrate species) with few studies undertaken (Reynolds 1984a; Reynolds 1984b; Reynolds 1985; De Leeuw 1986; O Connor *et al*. 2001; Crushell *et al.* 2008; Hannigan & Kelly-Quinn 2011; Wisdom & Bolger 2011, Nolan 2013). Van Duinen (2013) highlights the importance of structural diversity at various spatial scales (e.g. micro-scale of hummock hollow topography to macro-scale which would include the landscape setting of the bog, see Schouten (2002)) as a prerequisite for hosting the full species diversity of raised bog landscapes.

A recent study of Lepidoptera associated with raised bogs identified two species that appear to be characteristic of higher quality raised bog habitat, namely bordered grey (*Selidosema brunnearia* (Villers, 1789)) and light knot grass (*Acronicta menyanthidis* (Esper, 1789)) (Flynn 2014).

Recent research on spiders has revealed that a number of species are known to occur in Ireland only on raised bog habitats, all of which are considered local/uncommon or rare across Europe (Myles Nolan pers. comm.). Five of these species that can be considered useful indicators of ARB include: *Glyphesis cottonae* (La Touche 1945), *Walckenaeria alticeps* (Denis 1952), *Satilatlas britteni* (Jackson 1913), *Pirata piscatorius* (Clerck 1757), and *Minicia marginella* (Wider 1834) (Myles Nolan pers. comm.).

The information currently available on other invertebrate groups of peatland systems in Ireland is not sufficient to allow a determination of many species that are typically associated with or may be characteristic of higher quality ARB. A selection of invertebrate species and species groups that are known to be typically associated with raised bogs are presented in Table 2.

Table 2 Fauna species typically associated with raised bog ecosystems in Ireland (after O'Connell 1987; Cross 1990; Renou-Wilson *et al.* 2011; Bracken & Smiddy 2012).

Common name	**Scientific name**
Mammal species	
Irish hare	*Lepus timidus hibernicus*
Otter	*Lutra lutra*
Pygmy shrew	*Sorex minutes*
Fox	*Vulpes vulpes*
Bird species	
Skylark	*Alauda arvensis*
Mallard	*Anas platyrhynchos*
Greenland white-fronted goose	*Anser albifrons flavirostris*
Meadow pipit	*Anthus pratensis*
Hen harrier	*Circus cyaneus*
Cuckoo	*Cuculus canorus*
Merlin	*Falco columbarius*
Kestrel	*Falco tinnunculus*
Snipe	*Gallinago gallinago*
Red grouse	*Lagopus lagopus*
Curlew	*Numenius arquata*
Golden plover	*Pluvialis apricaria*
Lapwing	*Vanellus vanellus*
Reptiles and amphibians	
Common lizard	*Lacerta vivipara*
Common frog	*Rana temporaria*
Typical invertebrates	
Black slug	*Arion ater*
Large heath butterfly	*Coenonympha tullia*
Marsh fritillary butterfly	*Euphydryas aurinia*
Bog-pool spider	*Dolomedes fimbriatus*
Water striders	*Gerris* and *Velia* species
Oak eggar moth	*Lasiocampa quercus*
Four-spotted chaser dragonfly	*Libellua quadrimaculata*
Fox moth	*Macrothylacia rubi*
Ant	*Myrmica ruginodis*
Emperor moth	*Saturnia pavonia*
Great green bog grasshopper	*Stethophyma grossa*
Other species groups that are well represented on raised bogs include:	Araneae (spiders and mites) Ceratopogonidae (biting-midges) Chironomids (non-biting midges) Coleoptera (beetles) Collembola (springtails) Diptera (true flies) Dytiscidae (water beetles) Hemiptera (true bugs) Hymenoptera (bees, wasps, ants and sawflies) Lepidoptera (butterflies and moths) Odonta (dragonflies and damselflies) Orthoptera (grasshoppers) Syrphidae (hoverflies) Tipulidae (craneflies) Tabanidae (horseflies)

1.2 Habitats Directive Raised Bog Habitats in Ireland

Four habitat types listed on Annex I of the EU Habitats Directive are typically associated with raised bogs in Ireland, two of which are priority habitats (*):

- 7110 Active raised bogs (ARB)*
- 7120 Degraded raised bogs still capable of natural regeneration (DRB)
- 7150 Depressions on peat substrates of the *Rhynchosporion*
- 91D0 Bog woodland*

The interpretation manual of EU habitats gives the following description for 'active raised bogs': "*Acid bogs, ombrotrophic, poor in mineral nutrients, sustained mainly by rainwater, with a water level generally higher than the surrounding water table, with perennial vegetation dominated by colourful Sphagna hummocks allowing for the growth of the bog (Erico-Sphagnetalia magellanici, Scheuchzerietalia palustris p., Utricularietalia intermedio-minoris p., Caricetalia fuscae p.). The term "active" must be taken to mean still supporting a significant area of vegetation that is normally peat forming, but bogs where active peat formation is temporarily at a standstill, such as after a fire or during a natural climatic cycle e.g., a period of drought, are also included*." (CEC 2007).

DRB should be, according to the interpretation manual capable of regeneration to 'Active Raised Bog' in 30 years if appropriate measures are put in place (i.e. no major impacting activities are present and any necessary restoration works are implemented).

In Ireland, the identification of ARB is made at ecotope level based on the vegetation classification developed by Kelly (1993) and Kelly & Schouten (2002).

Raised bog vegetation communities are grouped into a series of community complexes and these complexes are then amalgamated into a series of ecotopes characterised by different physical characteristics using the approach outlined by Kelly & Schouten (2002).

The main ecotopes that community complexes are grouped into include:

- Central ecotope
- Sub-central ecotope
- Active flushes and soaks
- Sub-marginal ecotope
- Marginal ecotope
- Inactive flushes
- Face-bank ecotope

Actively accumulating peat conditions occur within the sub-central and central ecotopes, which are the wettest on the bog and an indication of good quality ARB. Active flushes and soaks are also dominated by *Sphagnum* mosses and typically have wet conditions. These features are associated with ARB and contribute to the overall diversity of the habitat.

The adjacent surrounding marginal, sub-marginal, and face-bank bog areas typically have a supporting function for the central and sub-central communities but are not peat accumulating. These drier ecotopes may or may not correspond to the Annex I habitat DRB, as it depends on whether they are capable of regeneration to ARB. Other drier ecotopes recorded on the high bog that do not correspond to ARB include 'inactive flushes' which typically have a low *Sphagnum* cover.

The Annex I habitat Rhynchosporion depressions (7150) typically occurs along pool edges and on flats underlain by deep, wet and quaking peat. Typical plant species include *Rhynchospora alba*, *Drosera anglica*, *Narthecium ossifragum*, *Sphagnum cuspidatum*, *S. denticulatum*, *S. magellanicum*, *S. papillosum*, *Menyanthes trifoliata*, and *Eriophorum angustifolium*.

The priority Annex I habitat bog woodland is also actively peat-forming and overlaps with the ARB habitat. Such woodlands are usually dominated by *Betula pubescens* with a characteristic ground cover dominated by *Sphagnum* moss species, which often form deep carpets, and other mosses including species of *Polytrichum*. A separate conservation objective has been prepared for bog woodland. Woodland areas are occasionally found on raised bogs that have an absence of the characteristic moss layer and are not regarded as peat forming. Such areas do not correspond to the Annex I habitat.

1.2.1 Restoration of Active Raised Bog in Ireland

As already mentioned in the Section 1.1, ARB is currently considered to be in unfavourable bad conservation status in Ireland. In addition, according to its definition, DRB should be capable of regeneration to ARB in a 30-year timescale. Thus, it follows that restoration measures are required in order to halt further losses and increase the area of ARB as well as to improve the condition of existing areas of the Annex I habitat.

Most of the restoration works undertaken so far in Ireland have concentrated on the high bog (e.g. Clara Bog, Mongan Bog, Sharavogue Bog and Raheenmore Bog) to prevent further losses as well as to restore areas to ARB. Nevertheless, some restoration works have also been undertaken on cutover areas such as at Ballykenny and Fisherstown Bogs and Killyconny Bog. Such work aims to do one or more of the following (depending on the bog in question): restore ARB on the high bog; reduce further ARB and DRB loss on the high bog; restore peat forming habitats (such as ARB, bog woodland, poor fen) on the cutover.

Works undertaken by the NPWS have indicated that there are significant differences, both ecological and economic, when comparing the effectiveness of works carried out on the cutover with those carried out on the high bog. Positive and significant results (i.e. expansion or development of ARB) can be achieved over a relatively short timeframe (10 years) on favourable areas of the high bog by blocking high bog drains. In contrast, a longer time period (30 years+) is required to achieve active peat formation on cutover areas, and even then the results are generally confined to smaller areas; i.e. flat areas (≤0.3% surface slope) or enclosed depressions that have sufficient water flow (minimum catchment 0.5ha) to maintain wet conditions throughout the year. A longer time period (minimum 50-100 years) is likely to be required for high quality ARB habitat (vegetation structure and species diversity) to develop on such cutover areas. In addition, costs of restoration measures on cutover areas are typically significantly higher than those on high bog areas.

1.3 Corliskea/Trien/Cloonfelliv Bog SAC

The SAC includes several raised bog domes and surrounding areas which include cutover bog, scrub, river, wet grassland, improved grassland, wet woodland and conifer forestry.

The SAC has been selected for four Annex I habitats as follows:

- [7110] Active raised bogs*
- [7120] Degraded raised bogs still capable of natural regeneration
- [7150] Depressions on peat substrates of the *Rhynchosporion*
- [91D0] Bog woodland*

Corliskea/Trien/Cloonfelliv Bog SAC, located approximately 5km south of Castlerea and straddling the Roscommon/Galway county border, comprises a complex of three raised bogs lying in an inter-drumlin area between the River Suck and the Island River.

The SAC includes relatively large areas of wet raised bog with well-developed pool and hummock systems, large diverse flush systems, subterranean streams with swallow-holes and a lake. The uncut high bog comprises both ARB and non-active raised bog areas, some of which corresponds with DRB. The ARB is largely confined to wetter, central areas. Here there are well-developed pool and hummock systems, in which hummocks are formed by bog mosses. Rhynchosporion vegetation is best developed in the wet areas of the ARB. This is typically dominated by floating rafts of the aquatic bog moss *Sphagnum cuspidatum*

A remarkable feature of these bogs is the presence of well-developed, wooded flushes, some of which conform to the EU Habitats Directive priority habitat bog woodland. Non-wooded flushes also occur on the bogs.

The vegetation of non-active raised bog habitat is also composed of peatland species but is dominated by species indicative of drier conditions. The cover of *Sphagnum* moss is low due to the combined effects of drainage (mostly caused by peripheral peat-cutting) and repeated burning.

This site is of international ecological significance as a largely intact complex of raised bogs, show a good diversity of microhabitats, which are typical of raised bogs

Each of the three individual bogs that make up the complex are described in the following sections.

1.3.1 Corliskea Bog

Corliskea Bog is the largest of the three bogs. The Galway/Roscommon border runs through the bog. The road between Ballymoe and Dunmore runs by the south of the bog while the road from Ballymoe north towards Castlerea runs to the east.

Corliskea Bog is a ridge basin bog and is classified as a western raised bog. The shape is broadly rectangular but it is split in two sections by a till mound, where Doughery woodland lies, and as a result of severe peat cutting.

1.3.1.1 Flora of Corliskea Bog

The ARB at Corliskea Bog includes central and sub-central ecotope, active flush, and bog woodland (Fernandez et al. (2014c).

Central ecotope is found in one location. Only one community complex is recorded which consists of low hummocks, pools and flats. Inter-connecting pools cover 26-33% and *Sphagnum* cover ranges from 36-50%. *Calluna vulgaris* and *Eriophorum vaginatum* are abundant throughout; *Sphagnum capillifolium* is dominant in the hummock layer with occasional *S. fuscum*. Pools are dominated by *Sphagnum cuspidatum* with occasional *S. denticulatum* and lawns are dominated by *S. papillosum*. Additional species that are frequent at low cover throughout include *Carex panicea, Racomitrium lanuginosum* and *Cladonia portentosa.*

Sub-central ecotope is found at 13 locations. Seven community complex types are recorded. The most widely distributed complex is characterised by high *Carex panicea* cover (11-25%) with abundant pools (11-25%) and good overall *Sphagnum cover* (34-50%, lower where burnt). *Calluna vulgaris* and *Eriophorum vaginatum* are abundant with *Sphagnum capillifolium* dominant in the hummock layer. Pools have a low cover of *S. cuspidatum* and grade into lawns dominated by *S. papillosum*. Additional species that are frequent at low cover throughout included *Rhynchospora alba, Aulacomnium palustre* and *Cladonia portentosa.*

The second complex is found in four sub-central areas across the high bog. Here *S. papillosum* lawns dominate this complex, with abundant *Calluna vulgaris, Eriophorum vaginatum* and *Sphagnum capillifolium* in hummocks. Overall *Sphagnum* cover is moderately high (34-50%). *Carex panicea, Rhynchospora alba* and *Narthecium ossifragum* are of low cover and pools were rare.

The third complex is frequent in the central area of the western high bog section. This comprises hummocks, lawns and pools with overall *Sphagnum* cover of 51-75% and interconnecting pool cover of 11-25%. *Calluna vulgaris* and *Eriophorum vaginatum* are abundant with *S. capillifolium* in hummocks. Pools have high *Sphagnum cuspidatum* cover with *S. papillosum* lawns at the edge and quaking vegetation. *Carex panicea* is frequent to abundant in the vegetation. The remaining complexes are found in only one or two locations and descriptions are presented in Fernandez *et al.* (2014c).

There are four active flushes present on Corliskea Bog. These vary slightly and are dominated either by *Molinia caerulea, Calluna vulgaris, Eriophorum vaginatum* or *E. angustifolium.* The *Sphagnum* layer ranges from 34-75% and is generally dominated by *S. papillosum* and *S. capillifolium.*

Non-active raised bog habitat includes sub-marginal, marginal and face bank ecotopes, as well as inactive flushes. Although some of these areas have a relatively well-developed raised bog flora, they are affected by water loss to varying degrees, and are usually devoid of permanent pools.

The sub-marginal ecotope features the most developed microtopography within non-active raised bog habitat.

The wettest community complex occurs in areas of former sub-central ecotope or adjacent to flushes or open water. Here *Sphagnum* cover is 11-25% (locally 26-33%). *Calluna vulgaris* and either *Eriophorum vaginatum* or *E. angustifolium* are dominant, with *Sphagnum capillifolium* in low hummocks, *S. papillosum* in lawns and *S. cuspidatum* in occasional pools.

The most frequent community complex of sub-marginal ecotope is characterised by abundant *Calluna vulgaris, Eriophorum vaginatum* and either *Narthecium ossifragum* or *Carex panicea. Sphagnum* cover is generally 11-25%, but lower where recently burnt.

The high bog also features ten inactive flushes. Most of the flushes are dominated by *Molinia caerulea* with *Calluna vulgaris* and occasional *Erica tetralix, Eriophorum vaginatum*, *E. angustifolium, Myrica gale, Cladonia portentosa, Aulacomnium palustre, Polytrichum strictum, Vaccinium oxycoccos*, *V. myrtillus, Pteridium aquilinum, Juncus effusus, Pleurozium schreberi* and *Hylocomium splendens. Sphagnum* cover is generally less than 4% (locally 5% to 10%) with occasional, *S. papillosum* and *S. capillifolium.* Scrub species such as *Ulex* *europaeus, Salix* species, *Betula pubescens* and *Pinus* species are occasional to frequent.

There is a small oligotrophic lake situated on the southern side of Corliskea Bog. The northern lake shore is surrounded by a fringe of vegetation dominated by *Molinia caerulea*. The shallow water in the west of the lake is dominated by *Menyanthes trifoliata* with occasional *Hydrocotyle vulgaris, Sphagnum fallax,* and *Eriophorum angustifolium.* The remainder of the lake is not vegetated. Around the edges of the lake shore are tall tussocks of *Molinia caerulea*, with *Juncus effusus, Anthoxanthum odoratum*, *Agrostis stolonifera*, *Sphagnum palustre, S. fimbriatum* and *S. fallax,* with young *Salix cinerea* to the north-west side. A line of swallow holes connects with the lake on the north-west side and is associated with this area is a flush. This flush is dominated by *Molinia caerulea, Calluna vulgaris, Erica tetralix, Vaccinium myrtillus, Dryopteris carthusiana* and *D. dilatata*. The ground layer is hummocky, with *Sphagnum capillifolium, S. cuspidatum, S. fallax* and the moss *Leucobryum glaucum.* A large drain to the south of the lake is negatively impacting- on it.

1.3.2 Trien Bog

Trien Bog is separated from Corliskea Bog by a minor road to the North. Trien Bog is a ridge basin bog type that has been classified as an intermediate raised bog indicating that it shares features with blanket bogs (Cross 1990). Trien Bog now comprises two high bog areas separated by a turbary road and associated cutover bog. The larger area of high bog lies to the north-west and has a large flush with a very small bog woodland occurring in its centre. An old turbary track extends in this bog area from the south.

1.3.2.1 Flora of Trien Bog

The ARB at Trien Bog includes sub-central ecotope, active flushes and bog woodland (Fernandez *et al.* 2014d).

Sub-central ecotope is found at five locations. Three sub-central community complex types are recorded. The first and most widespread complex consists of low hummocks, and hollows. Pools cover 11-25%. *Sphagnum* cover is up to 50%, but often less. *Narthecium ossifragum* is a constant but its cover is relatively low (4-10%). *Carex panicea* is occasional. The pools are filled with *Sphagnum cuspidatum* and less *S. denticulatum. Sphagnum papillosum* is often around the pool edges or in low hummocks. *Rhynchospora alba* is associated with the edges of pools or hollows. Other species occurring rarely are *Sphagnum fuscum* and *S. austinii*. *Racomitrium lanuginosum* and *Campylopus atrovirens* are also rare (Fernandez *et al.* 2014d).

A second complex, where *Narthecium ossifragum* is absent is notable in the north-western part. Here the ground is soft. The pools are often interconnecting and long, covering about 25%. *Sphagnum* cover is 30-40% and more or less in places. The main species include *Calluna vulgaris* (11-25%), *Eriophorum vaginatum* (4-10%), *Carex panicea* (4-10%; higher in places), *Narthecium ossifragum* (4-10%), *Trichophorum germanicum* (<4%), *Rhynchospora alba* (<4%; higher in places), *Menyanthes trifoliata* (<4%), *Racomitrium lanuginosum* (<4%), *Cladonia uncialis* (<4%), *Sphagnum* species include; *S. capillifolium* (H[2]; 11-25%), *S. tenellum* (H; <4%), *S. papillosum* (H & P; 4-10%; higher in places), *S. denticulatum* (P; <4%) and *S. cuspidatum* (P; 4-10%).

The third sub-central community complex occurs at a few locations. It is characterised by soft ground with a *Sphagnum* cover around 30% and with few or no pools. *Eriophorum vaginatum* and *Calluna vulgaris* are the main higher plants. *Cladonia* spp. cover is extensive (11-25%) forming white cushions on the vegetation. *Narthecium ossifragum* and *Carex*

[2] The abbreviation ‘H’ is used here to denote ‘Hummock’ while ‘P’ is used to denote ‘Pool’.

panicea are few or absent. The presence of species such as *Molina caerulea, Aulacomnium palustre* and *Vaccinium oxycoccos* are indicative of some flushing.

There are two active peat forming flushes on Trien Bog. The first active flush occupies the central part of the northern lobe. The ground is soft and there are almost no pools. The vegetation is characterised by a high cover of *Calluna vulgaris* and *Cladonia* spp. Beneath this layer, the *Sphagnum* cover within this flush is 11-25% which is low considering it is classed as an active flush. However, the high cover of *Cladonia portentosa* may, at least partially, be the reason for the low *Sphagnum* cover as it dominates large areas of hummocks. *Sphagnum* spp. include small amounts of *S. palustre* and *S. fallax. Molinia caerulea* is present (4-10%) and is higher forming occasional tussocks. *Pleurozium schreberi* and *Hylocomium splendens* form hummocks often associated with *Molinia caerulea*. Other species indicative of flushing include *Vaccinium oxycoccos, Empetrum nigrum, Aulacomnium palustre* and *Polytrichum strictum.* Patches of inactive flush dominated by a higher cover of *Molinia caerulea* are present within the active flush, mainly on the western side of flush. However, these areas form a mosaic with the active flush (Fernandez *et al.* 2014d).

There are six wooded flushes within the main flush described above. These are characterised by the presence of *Betula pubescens* trees. Typically they are 2-6m tall and mostly <10cm diameter at breast height (DBH), although there are a few up to 8m tall and >20cm DBH. Descriptions of these wooded flushes are presented by Fernandez et al. (2014d).

The second active flush is located in the central part of the south-eastern lobe of Trien Bog. It is a lot smaller than the main flush described above but the vegetation is quite similar. The *Sphagnum* cover within this flush is variable with hummocks being quite firm in places and being largely dominated by *Cladonia portentosa*. However, the hollows are very soft and have a high *Sphagnum* cover with the moderate cover of *Sphagnum palustre* being particularly notable. A very small area of *Sphagnum fallax* was noted as well as 1.5-2m tall *Betula pubescens* trees.

Non-active raised bog habitat includes the sub-marginal, marginal and face bank ecotope, as well as inactive flushes. Although some of these areas have a relatively well-developed raised bog flora, they are affected by water loss to varying degrees, and permanent pools are localised.

The sub-marginal ecotope features the most developed microtopography within DRB. There are two main sub-marginal community complexes at Trien Bog. The first community complex is found on the northern lobe of the bog generally close to edge of the sub-central ecotope. Pools are present and mean *Sphagnum* cover is 11-25%. The *Sphagnum* cover in the pools is quite variable, ranging from a good cover (11-25%) of *Sphagnum cuspidatum* and *S. denticulatum* to absent with some algae. The vegetation is characterised by abundant *Calluna vulgaris* and *Cladonia* spp. *Carex panicea* is a constant (4-10%), but *Narthecium ossifragum* is generally low (<4%). Pools are elongated and more or less oriented in a north-west/south-east direction**.**

The second sub-marginal community is widespread throughout the site, especially on the eastern lobe. It has a higher cover of *Narthecium* (11-25%) and lower cover of *Calluna vulgaris.* The *Sphagnum* cover in pools is generally poorer. The sub-marginal complex often grades into the sub-central complex. The sub-marginal complex is found on the northern lobe of the bog. Although it has no pools, the ground is soft and the main species in the vegetation are *Calluna vulgaris*, *Eriophorum vaginatum* and *Sphagnum* spp. *Cladonia* is common also, but there is a notable absence or <4% cover of *Narthecium ossifragum* and *Carex panicea*. A small area of the complex is found south of on the eastern lobe. This is a wet area characterised by high incidence of *Rhynchospora alba* (11-25%) and *Eriophorum angustifolium* (11-25%). The shallow poorly defined 'pools' are mostly open water with little

Sphagnum cover.

Bog woodland is found at one location on the high bog at Trien and it covers a very small area (0.04ha). There are other areas of *Betula pubescens* trees in the flushed parts of the site, but the size of the trees and canopy cover are insufficient to qualify as bog woodland. They are described as wooded flushes by Fernandez *et al.* (2014d). In the bog woodland, the median height of the *Betula pubescens* trees is 5m with some up to 8m and some <4m. There are no other tree species present. Beneath the tree canopy which is just up to 30% cover, the moss cover is 75-80%, but only 10-15% of this is *Sphagnum* spp., which include *S. capillifolium*, and *S. palustre.* The latter species is associated with wet flushes. The most abundant other mosses, which form hummocks, are *Pleurozium schreberi* and *Hylocomium splendens*. Low shrubs include *Calluna vulgaris* (10% cover) and *Vaccinium myrtillus* (<4%). *Molinia caerulea* is also present. A number of other species are present which are good indicators of flushing, they include: *Aulacomnium palustre, Vaccinium oxycoccos* and *Polytrichum strictum*.

1.3.3 Cloonfelliv Bog

Cloonfelliv Bog is located just west of Corliskea Bog on the Galway Roscommon border. Further to the west is Moorfield Bog/Farm Cottage NHA (NPWS Site Code: 000221).

Cloonfelliv Bog has been classified as a small western raised bog (Cross 1990). The bog is also likely to be classed geomorphologically as a ridge basin bog, though it was not surveyed by Kelly *et al.* (1995). It has a regular ovoid shape tapering at the southern end. The bog gradually slopes upwards from north to south. The bog slopes out to the margins on all sides. There are two obvious high areas, one is a *Calluna*-dominated mound in the north and the other is the *Calluna*-dominated ridge at the highest point of the bog in the south (Fernandez *et al.* 2014b).

1.3.3.1 Flora of Cloonfelliv Bog

The ARB at Cloonfelliv Bog includes sub-central ecotope and active flush (Fernandez *et al.* 2014b).

Sub-central ecotope is found at two locations. Only two community complex types are recorded. The first which occurs towards the north of the high bog is essentially a large pool (circa 15m x 7m) full of *Sphagnum cuspidatum* with lawns and low hummocks of other *Sphagna* such as *S. papillosum*, *S. palustre* and *S. capillifolium* growing in, but mostly at the edge of, the pool. The *Sphagnum* cover approaches 100% and *Eriophorum angustifolium* is the most dominant vascular plant. The second complex which occurs towards the centre of the high bog is a much poorer quality area of sub-central ecotope. The *Sphagnum* cover here ranges from 34-50% and is composed mostly of hummocks of *Sphagnum capillifolium* and *S. papillosum* with a patchy cover of *S. cuspidatum* in the pools. *Calluna vulgaris* and *Eriophorum vaginatum* are the most dominant vascular plants while evidence of flushing is also indicated by the presence of *Aulacomnium palustre* and *Polytrichum strictum* (Fernandez *et al.* 2014b).

A small partially active flush is present towards the south of the high bog. Hummocks of *Sphagnum capillifolium* dominate the *Sphagnum* layer although *S. fallax* is also present. Robust *Calluna vulgaris* dominates the vegetation with *Molinia caerulea*, *Phragmites australis*, *Vaccinium oxycoccos*, *Eriophorum angustifolium*, *E. vaginatum*, *Polytrichum strictum*, *Hylocomium splendens*, and *Pleurozium schreberi* also recorded.

Non-active raised bog habitat includes the sub-marginal, marginal and face bank ecotope, as well as inactive flushes. Although some of these areas have a relatively well-developed raised bog flora, they are affected by water loss to varying degrees, and are usually devoid of permanent pools.

The sub-marginal ecotope features the best developed microtopography. Although pools are mostly absent from the high bog, they are found within the wettest sub-marginal ecotope community complex. However, these pools generally feature a low *Sphagnum* cover and are mostly covered with algae. The *Sphagnum* cover in these pools is usually approximately 26-33% composed mostly of hummocks of *Sphagnum capillifolium* and *S. papillosum* with a sometimes patchy cover of *S. cuspidatum* and *S. denticulatum* in the pools. *Calluna vulgaris*, *Eriophorum vaginatum* and *Carex panicea* are the most dominant vascular plants with *Eriophorum angustifolium* also frequent in places. The western indicator species *Racomitrium lanuginosum* and *Campylopus atrovirens* are also present. The cover of *Cladonia portentosa* can be high on hummocks and appears to have displaced the *Sphagnum* in places.

Pools are also present in the slightly poorer quality sub-marginal complex. However, much of the pools in this complex have a very poor cover of *S. cuspidatum* in the pools and there is also a higher cover of *Narthecium ossifragum* and *Carex panicea*. Much of the sub-marginal ecotope in the southern part half of the high bog is devoid of pools and *Calluna vulgaris* and *Eriophorum vaginatum* are the most dominant vascular plants. There is also a very high (sometimes >50%) cover of *Cladonia portentosa*. The poorer quality sub-marginal complex has *Sphagnum* cover of 11-25% composed mostly of hummocks of *Sphagnum capillifolium* and *S. papillosum*. *Calluna vulgaris*, *Narthecium ossifragum*, *Carex panicea* and *Eriophorum vaginatum* are the most dominant vascular plants (Fernandez *et al.* 2014b).

1.3.4 Fauna of Corliskea/Trien/Cloonfelliv Bog SAC

The common frog (*Rana temporaria*) occurs on the bogs. The only mammal species recorded from the high bog is Irish hare (*Lepus timidus hibernicus*) while otter (*Lutra lutra*) has been recorded from marginal areas (and watercourses) surrounding the SAC. Bird species recorded as breeding within the SAC include curlew (*Numenius arquata*), lapwing *(Vanellus vanellus)*, golden plover (*Pluvialis apricaria*), snipe *(Gallinago gallinago)* and red grouse (*Lagopus lagopus*) (DEHLG 2000). Breeding red grouse have been recently re-recorded (Cummins *et al.* 2010)

2 Conservation objectives

A site-specific conservation objective aims to define the favourable conservation condition of a habitat or species at site level. The maintenance of habitats and species within sites at favourable condition will contribute to the maintenance of favourable conservation status of those habitats and species at a national level.

Conservation objectives for habitats are defined using attributes and targets that are based on parameters as set out in the Habitats Directive for defining favourable status, namely area, range, and structure and functions. Attributes and targets may change or become more refined as further information becomes available.

National Conservation Objectives for raised bog SACs have recently been published in the Draft National Raised Bog SAC Management Plan (DAHG 2014). The various attributes and the justification of appropriate targets used to define favourable conservation condition for ARB relevant to Corliskea/Trien/Cloonfelliv Bog SAC are discussed in the following sections.

2.1 Area

NPWS has commissioned a number of raised bog surveys between 1993 and the present- Kelly *et al*. (1995); Derwin & MacGowan (2000); Fernandez *et al*. (2005); Fernandez *et al*. (2006); Fernandez *et al*. (2014a, b, c, d). Mapping from these surveys has been used to derive the area of ARB for each bog as shown in Table 3. More recent surveys have been able to employ more precise and detailed mapping techniques and more standardised ecotope descriptions. NPWS undertook a review of data from earlier surveys in 2014 taking into account these improved techniques with the aim of providing more accurate figures for ARB. This in some cases has resulted in a change in ARB area for these earlier time periods (NPWS, unpublished data).

The national SAC target for the attribute 'habitat area' has been set at 2,590ha (DAHG 2014). This target is based on the estimated area of ARB (1,940ha) and DRB (650ha) present within the SAC network in 1994 (when the Habitats Directive came into effect).

The area of ARB at Corliskea/Trien/Cloonfelliv Bog SAC in 1994 is not known as the high bog at Cloonfelliv was only first surveyed in 2004. Nevertheless, the extent of ARB in Corliskea and Trien Bogs alone in 1994 was 87.5ha (see Table 3). The area of ARB within the entire SAC in 2004 is estimated to have been 73.5ha (see Table 3). Due to the lack of data, it is not possible to use the same approach that has been adopted in setting the national SAC target (sum of ARB and DRB in 1994). However, it can be seen (based on the known trend at both Corliskea and Trien) that a proportion of ARB has been lost from the site during the period 1994 – 2004.

In setting the site-specific target the current hydro-ecological conditions on the bog (including cutover) have been considered in order to ensure that the target being set is based on a realistic appraisal of what is achievable as set out below.

The most recent monitoring survey of the bog estimated the area of ARB to be 69.2ha (Fernandez *et al.* 2014a, b, c, d). This represents a decrease of 4.3ha (5.8%) during the period 2004-2013 (Fernandez *et al*. 2014a, b, c, d).

The current extent of DRB as estimated using a recently developed hydrological modelling technique, based largely on Light Detection and Ranging (LiDAR)[3] data is 54.8ha (see DAHG

[3] LiDAR is a remote sensing technology that measures vertical surface elevation by illuminating a target with a laser and analysing the reflected light. This provides much more detailed topographical maps than can be collected by traditional surveying techniques.

2014 for further details of the technique). This represents the area of the high bog, which does not currently contain ARB but has topographical conditions deemed suitable to support ARB (see Map 1 which shows the total area of current and modelled potential ARB). This area was further refined to 31.8ha by estimating the area that could be restored by blocking drains on the high bog. This refinement was based on applying an efficacy factor (see DAHG 2014).

Based on the current assessment of the bog, it is therefore concluded that the maximum achievable target for ARB on the high bog is 101.0ha. However, it is important to note that this assumes no further decline of ARB due to impacting activities. Similarly, should the bog be significantly dependent on regional groundwater levels then any deepening of drains in the cutover could further impact the potential restoration of ARB on the high bog.

Table 3 Area of ARB and DRB recorded on the high bog at Corliskea/Trien/Cloonfelliv Bog in 1994, 2004, and 2013 (Source: Kelly *et al*. 1995; Fernandez *et al.* 2014a, b, c, d).

	1994		**2004**		**2013**	
	ARB (ha)	DRB (ha)	ARB (ha)	DRB (ha)	ARB (ha)	DRB (ha)
Corliskea Bog	61.5	2.2	48.5	Unknown	44.3	16.4
Cloonfelliv Bog	Unknown	Unknown	0.7	Unknown	0.7	4.0
Trien Bog	26.0	9.9	24.3	Unknown	24.2	11.4
Corliskea/Trien/Cloonfelliv Bog SAC	**Unknown**	**Unknown**	**73.5**	**Unknown**	**69.2**	**31.8**

A recent eco-hydrological assessment of the cutover surrounding the high bog undertaken as part of the restoration planning process estimates that, by implementing appropriate management, an additional 6.5ha of ARB could be restored in this area. The long term achievable target for ARB on Corliskea/Trien/Cloonfelliv Bog is therefore set at 107.5ha.

In conclusion, the site-specific target for the attribute habitat area is: **Restore area of active raised bog to 107.5ha, subject to natural processes.**

2.2 Range

At a national scale, range represents the geographic range that encompasses all significant ecological variations of the ARB habitat. The national SAC target for the attribute 'range' has been set as 'not less than current range subject to natural processes'.

However, range, in the form of habitat distribution, may also be important at the site level, particularly within larger SACs, including those containing a number of individual bogs (i.e. complexes). The attribute therefore under the parameter of range is 'habitat distribution'. At the local level, it is important to conserve the variability and distribution of ARB across a raised bog SAC. This will help to ensure the diversity of the habitat is maintained while lessening the impact of localised damaging activities such as fire.

The conservation of ARB within Corliskea/Trien/Cloonfelliv Bog SAC as set out in Section 2.1 above will contribute to safeguarding the national range of the habitat.

The ARB habitat includes central and sub-central ecotope, as well as active flush and bog woodland. A map showing the most recent distribution of ecotopes throughout Corliskea/Trien/Cloonfelliv Bog SAC is presented in Map 2.

The site-specific target for the attribute habitat distribution is: **Restore the distribution and**

variability of active raised bog across the SAC.

2.3 *Structure and functions*

Structure and functions relates to the physical components of a habitat ("structure") and the ecological processes that drive it ("functions"). For ARB these include attributes such as the hydrological regime, water quality, habitat quality, species occurrence, elements of local distinctiveness, marginal habitats, negative physical indicators, and negative species occurrence. As several of these attributes are inter-connected, they are all included in order to better define habitat quality in a meaningful way. In some cases, attribute targets are not quantified; however, as more detailed information becomes available (for example through further research), more measurable site-specific targets may be developed. Structure and functions attributes are expanded on in the sections below.

2.3.1 High bog area

On individual raised bogs adequate high bog is required to support the development and maintenance of ARB. Raised bog habitat that is classified as neither ARB nor DRB is still important particularly as a supporting habitat for those listed in Annex I of the Habitats Directive. It is an essential part of the hydrological unit which supports the ARB and DRB habitats. High bog is of value in its own right as a refuge for species characteristic of drier bog conditions as well as for providing a transitional zone between the Annex I habitats of the high bog and surrounding areas. Additional values for the maintenance of high bog include the preservation of its record of past environmental conditions and carbon storage. The area of high bog in the entire SAC network in 1994 was 10,740ha. The corresponding area in 2012 is 10,515ha – indicating that there has been a 225ha loss of high bog since 1994.

The national target for the attribute 'high bog' habitat is to ensure no decline in extent of high bog to support the development and maintenance of ARB.

The area of high bog within Corliskea/Trien/Cloonfelliv Bog SAC in 1994 was mapped as 457.8ha, while the corresponding area in 2012 is 452.4ha (based on interpretation of LiDAR and aerial photography flown in 2012), representing a loss of 5.4ha of high bog (DAHG 2014). The extent of high bog within the SAC in 2012 is illustrated on Map 1.

The site-specific target for the attribute high bog is: **No decline in extent of high bog necessary to support the development and maintenance of active raised bog.**

2.3.2 Hydrological regime: water levels

Hydrological processes are key drivers of raised bog ecology. The different raised bog communities, assemblages and species are affected by various hydrological attributes. For ARB, mean water levels need to be near or above the surface of bog lawns for most of the year. Seasonal fluctuations should not exceed 20cm, and water level should be within 10cm of the surface, except for very short periods of time (Kelly & Schouten 2002). Gentle slopes that limit intermittent lateral losses of water (through surface runoff) and encourage sustained waterlogging are the most favourable to achieve these conditions. Such conditions may be maintained on steeper slopes in areas of focused flow (flushes).

The traditional view of water flowing across the bog laterally has been recently refined to also consider that water flows vertically through peat into the underlying substrate. Water loss, by this route, depends on the permeability of the material through which the water must flow and the difference in head (water level elevation) in the bog and underlying mineral substrate; larger differences encountered in higher permeability materials will result in greater losses. Although the proportion of water lost in this manner may be small, the sustained loss during prolonged dry periods may be sufficient to impact bog ecotopes. Drains extending into the mineral substrate in marginal areas surrounding the bog can lead to an increased gradient between the head in the peat and the head in the underlying substrate resulting in increased vertical water losses from the bog.

2.3.2.1 Corliskea Bog

The most recent description of drainage at Corliskea Bog is presented in Fernandez *et al*. (2014c) who reported that 9.0km of drains impact upon the raised bog habitats. Most of these drains are classified as functional (5.8km), with the remaining drains classified as reduced functional (3.2km). In addition, 3.2km of unblocked drains were reported to be in-filled with vegetation; it is not known whether these drains are having any impact upon high bog habitats. Most of the drains occur close to the margins of the high bog. There are also cutover drains associated with peat cutting around the entire perimeter of the bog. These drains continue to drain the high bog and are impacting on high bog habitats.

Much of the knowledge regarding the hydrological requirements of raised bog communities in Ireland stems from the extensive ecological and hydrological work undertaken on Clara Bog since the early 1990s. The only available hydrological study for Corliskea Bog is the work carried out by Kelly *et al*. (1995). The hydrochemistry survey identified electrical conductivity (EC) values between 212-300µS/cm in the drains to the north-west of the high bog. These EC values are much higher than the values typically associated with bog water (<100µS/cm), reflecting the inert properties of the peat. To the south EC values of between 100 and 108µS/cm were reported, indicating very little influence from minerotrophic groundwater. Drains in the south-east had EC values of approximately 230µS/cm.

Upwelling groundwater suggests that drains may intercept the regional groundwater table. This can result in a decline in groundwater head, which can impact on the surface of the bog through subsidence. The risk of subsidence depends on the permeability of the underlying substrate, which will influence the extent of impacts from changes to groundwater head. Geological maps show the area as directly underlain by Visean limestone, which is a regionally important aquifer as it is subject to karstification (conduit). Subsoil mapping indicates that sandstone till is the main mineral substrate in the surrounding areas. However, there is also alluvium to the south and east of the bog. The presence of a productive bedrock unit as well as potentially permeable substrate suggests that a decline in groundwater head may contribute to subsidence on the high bog. Further deepening of marginal drains has the potential to have significant impacts on Corliskea Bog.

2.3.2.2 Trien Bog

The most recent description of drainage at Trien Bog is presented in Fernandez *et al*. (2014d) who reported that 11.1km of unblocked drains impact upon the raised bog habitats. Most of these drains are classified as reduced functional (8.8km) and the remaining classified as functional (2.3km). In addition, 0.2km of unblocked drains were reported to be in-filled with vegetation; it is not known whether these drains are having any impact upon high bog habitats.

Trien bog has been divided into two separate lobes by a road and peat-cutting has taken place at both sides of this road. There are areas of cutover and drains associated with peat cutting present around the entire perimeter of the bog. These continue to drain the high bog and impact on high bog habitats. Fernandez *et al*. (2014d) reported that a review of the 2010 aerial photograph suggests drainage maintenance has taken place to the north of the high bog (associated with agriculture).

As for Corliskea, the only available hydrological study for Trien Bog is the work carried out by Kelly *et al*. (1995). The hydrochemistry survey identified electrical conductivity (EC) values in the central track to be no more than 110µS/cm, indicating very little groundwater influence as the EC values were similar to that of rainwater (generally < 100µS/cm) reflecting the largely inert nature of the peat. In the drains to the east, north and north-east of the bog EC values were less than 100µS/cm. However, in the main stream flowing along the eastern side of the southern lobe, EC values as high as 546µS/cm were reported, indicating significant groundwater discharge. The main channel along the western side of the bog had an EC value of 250µS/cm suggesting some groundwater influence.

Although the hydrochemistry survey indicates limited upwelling in the cutover drains, the presence of upwelling groundwater in the main drains suggests that these drains intercept the regional groundwater table. This can result in a decline in groundwater head, which can impact on the surface of the bog through subsidence. The risk of subsidence depends on the permeability of the underlying substrate, which will influence the extent of impacts from changes to groundwater head. Geological maps show that most of Trien Bog is underlain by Visean limestone, which is a regionally important aquifer as it is subject to karstification (conduit). The bedrock mapping also indicates that a small section to the north-west is underlain by a sandstone, siltstone and black mudstone unit and part underlain by a dark nodular calcarenite and shale bedrock unit. Both are classified as locally important aquifers, as the bedrock is moderately productive only in local zones. Subsoil mapping indicates that sandstone till is the main mineral substrate in the surrounding areas. However, there are also limestone sand and gravel deposits directly north of the bog. The presence of a productive bedrock unit as well as potentially permeable substrate suggests that a decline in groundwater head may contribute to subsidence on the high bog. Further deepening of marginal drains has the potential to have significant impacts on Trien Bog.

2.3.2.3 Cloonfelliv Bog

The most recent description of drainage at Cloonfelliv Bog is presented in Fernandez *et al*. (2014b) who reported that 1.0km of drains were impacting upon the raised bog habitats. Most of these drains were classified as reduced functional (0.7km), with the remaining drains considered functional (0.3km). In addition, 0.9km of unblocked drains were reported to be in-filled with vegetation; it is not known whether these drains are having any impact upon high bog habitats.

Drains associated with peat-cutting are present throughout most of the cutover. These drains continue to drain the high bog and impact on high bog habitats. Maintenance of drains for agricultural purposes has also taken place at a number of locations in recent years. Fernandez *et al*. (2014b) also note that the stream to the west of Cloonfelliv is likely to be regularly dredged and therefore it is likely that there has been a decline in regional groundwater head.

Detailed hydrological studies of Cloonfelliv Bog have not been carried out to date; however, Kelly *et al*. (1995) carried out surveys at the Corliskea Bog and Trien Bog adjacent to Cloonfelliv Bog. As for the other two bogs, surveys identified some groundwater upwelling in the major drains surrounding the bogs, suggesting drainage has had some impacts on groundwater heads. The presence and maintenance of deep marginal drains as well as the dredging of the stream to the west of the bog is likely to have impacted on regional groundwater heads, which may have resulted in subsidence on Cloonfelliv Bog. Geological mapping indicates that most of the bog is underlain by Visean limestone, which is a regionally important aquifer as it is subject to karstification (conduit). Subsoil mapping indicates that sandstone till is the main mineral subsoil in the surrounding area. The presence of a highly productive bedrock unit as well as potentially permeable substrate suggests that a decline in groundwater head may contribute to subsidence on the high bog. Further deepening of marginal drains or dredging of the adjacent stream, has the potential to have significant impacts on Cloonfelliv Bog.

The site-specific target for the attribute hydrological regime – water levels is: **Restore appropriate water levels throughout the site.**

2.3.3 Hydrological regime: flow patterns

As outlined above, ARB depends on water levels being near or above the surface of bog lawns for most of the year. Long and gentle slopes are the most favourable to achieve these conditions. Changes to flow directions due to subsidence of bogs can radically change water regimes and cause drying out of high quality ARB areas and soak systems.

A map illustrating the slopes and drainage patterns on Corliskea/Trien/Corliskea Bog SAC, based on a digital elevation model generated from LiDAR imagery flown in 2012 is presented in Map 3.

2.3.3.1 Corliskea Bog

The slopes and flow patterns on Corliskea illustrate that the bog is likely to have been affected by subsidence. There are large areas of the bog where slopes exceed 1%, which are outside the influence of high bog drains. In addition there are several areas where the flow is focused towards the margins, indicating differential subsidence has taken place. This suggests that a decline in groundwater head may have occurred, resulting in increased vertical losses through the peat leading to subsidence. As this is a western type raised bog steeper slopes and focusing of flow may be expected as would be the case with blanket bog. However, ARB habitat is only present in a few areas suggesting that peat-cutting and marginal drainage has had a significant impact on the surface of the bog. Further changes to flow patterns or slopes arising from subsidence due to the effects of peat exploitation and drainage are likely to have a significant impact on raised bog habitats.

2.3.3.2 Trien Bog

The slopes and flow patterns on Trien illustrate that the bog is likely to have been affected by subsidence. Steep slopes (> 1%) extend into the centre of the high bog to areas where no high bog drainage is present. In addition, there are several areas where the flow is focused towards the margins, indicating differential subsidence has taken place. This is particularly apparent on the northern lobe through the area of focused flow towards the road to the south. These flow patterns coincide with an active and inactive flush. Areas of focused flow are also evident on the southern lobe towards the road to the north-west. Although Trien is a western type raised bog and therefore shares features that are present in blanket bogs, such as steeper slopes and focusing of flow, the focusing of flow towards the road and areas of peat-cutting indicates the impact these activities have had on the topography of the bog. Further changes to flow patterns or slopes arising from subsidence due to the effects of peat exploitation and drainage are likely to have a significant impact on raised bog habitats.

2.3.3.3 Cloonfelliv Bog

The slopes and flow patterns on Cloonfelliv illustrate that the bog is likely to have been affected by subsidence. Steep slopes (> 1%) extend into the centre of the high bog to areas where no high bog drainage is present. In addition, there are several areas where the flow is focused towards the margins, indicating differential subsidence has taken place. This is evident through the focused flow towards the north-western boundary of the bog, which may be related to an infilled drain that follows a similar trend. Although Cloonfelliv is a western type raised bog and therefore shares features that are present in blanket bogs, such as steeper slopes and focusing of flow, the focusing of flow towards areas of turf-cutting indicates the impact these activities have had on the topography of the bog. Further changes to flow patterns or slopes arising from subsidence due to the effects of peat exploitation and drainage are likely to have a significant impact on raised bog habitats.

The site-specific target for the attribute hydrological regime – flow patterns is: **Restore, where possible, appropriate high bog topography, flow directions and slopes.**

2.3.4 Transitional areas between high bog and surrounding mineral soils (includes cutover areas)

Transitional zones between raised bogs and surrounding mineral soils are typically cutover bog and drained lagg zones. The maintenance / restoration of these areas will help to maintain hydrological integrity of ARB and DRB, and support a diversity of other wetland habitats (e.g. wet woodland, swamp and fen) as well as species that they sustain. In some cases, these areas may assist in reducing further losses of ARB / DRB on the high bog and in time could develop into active peat forming habitats (including ARB - see Section 2.1 above). These transitional zones, once restored, can provide ecosystem services through flood attenuation and water purification to downstream areas and potentially increase the carbon storage / sink function of the bog. The estimated extent of such transitional areas within the SAC network is 3,000ha (DAHG 2014). The national target for these transitional areas is to maintain / restore semi-natural habitats with high water levels around as much of the bog margins as necessary.

The transitional areas in Corliskea/Trien/Cloonfelliv Bog SAC include a range of different habitat types (e.g. cutover bog, wet grassland, improved grassland, river, scrub, deciduous woodland and conifer forestry). The total area of cutover bog within the Corliskea/Trien/Cloonfelliv Bog SAC is estimated to be circa 264ha. The development of habitats within cutover areas depends on a number of factors including prevailing land-use, topography, up-welling regional groundwater, and drainage.

Extensive areas of old or abandoned cutover tend to be dominated by *Calluna vulgaris* and *Molinia caerulea*, with mesotrophic species such as *Juncus effusus, Narthecium ossifragum, Carex echinata*, *Anthoxanthum odoratum, Ranunculus flammula, Filipendula ulmaria, Luzula sp.* and *Mentha aquatica*. There is *Typha latifolia* and exposed till in some areas. Elsewhere there are large pools occurring within old cutover areas.

More recent peat-cutting areas are dominated by *Calluna vulgaris* along the turf banks, with some *Eriophorum angustifolium, Molinia caerulea*, *Myrica gale* and *Eriophorum angustifolium* colonising the flats. There are also large areas of exposed peat.

Wet grassland areas are dominated by *Juncus effusus* and *Carex spp.* with some wetland herbs such as *Galium palustre* and *Filipendula ulmaria* present. In the centre of the site, a large area of till supports wet grassland, with the higher ground being colonised by *Ulex europaeus* and *Rubus fruticosus.* The herb layer comprises *Ranunculus repens, Cardamine pratensis* and *Plantago lanceolata*. Grasses, such as *Poa* spp., and *Agrostis stolonifera* also occur.

At Corliskea Bog there are some mixed deciduous woodland areas at the fringe of the bog, with *Alnus glutinosa, Betula pubescens* and *Salix* sp. A band of *Pteridium aquilinum* and *Ulex europaeus* grows between the woodland and the bog at the cutover interface. At the extreme east, southeast of the bog there is mixed woodland dominated by *Betula pubescens* with some occasional *Pinus sylvestris.*

Scrub occurs at a number of locations throughout the cutover areas of the SAC. The scrub is mainly dominated by *Betula pubescens* with *Alnus glutinosa* and occasional some *Salix* cinerea present. In some locations the scrub comprises *Pteridium aquilinum* and *Ulex europaeus*.

There are two rivers within the site, both in proximity to Corliskea Bog. The first river is the larger and flows north, north-west from the lake. The river is in a deep depression and there are erosion channels along both sides. The vegetation along the river is dominated by *Molinia caerulea, Potentilla erecta, Sorbus aucuparia*, some *Lonicera periclymenum, Vaccinium myrtillus, Succisa pratensis, Rubus fruticosus* and small amounts of *Calluna vulgaris.* The river is not continuous, evidence suggests that it may be subterranean in parts.

The second river flows in the west of the bog. Most of the flow appears to be subterranean, but there is some water evident. The river bed is stepped down towards the west and the sides are about 1.24m deep. The vegetation of the river banks is dominated by tall *Calluna vulgaris* with *Molinia caerulea, Pteridium aquilinum, Succisa pratensis, Vaccinium myrtillus, Rumex sp., Cirsium palustre, Rubus fruticosus, Lonicera periclymenum, Salix cinerea, Sorbus aucuparia* and *Hedera helix.*

There is a *Pinus contorta* forestry plantation on the high bog to the north-west of Corliskea Bog, where a series of drains with a flow to the south-west have been excavated. Another *Pinus contorta* plantation with some *Pinus sylvestris* is present at the south-west of Corliskea in a cutover area. A deep drain is present on the bog side of the forestry which is 1m deep by 2m wide. It is colonised by species such as *Lemna* sp.*, Potamogeton polygonifolius, Epilobium palustre,* Soft Rush *Juncus effusus, Salix* spp. and *Carex echinata.* A very small area of *Pinus contorta* has also been planted on the west of the bog.

The site-specific target for the attribute transitional areas is: **Restore adequate transitional areas to support / protect the active raised bog and the services it provides.**

2.3.5 Vegetation quality: central ecotope, active flush, soaks, bog woodland

A diverse good quality microtopography on raised bogs consists of *Sphagnum* dominated pools, hollows, lawns and hummocks, which support the highest diversity of species including hummock indicators: *Sphagnum fuscum* and *S. austinii*; pool indicators: *S. cuspidatum*, *S. denticulatum*, and indicators of lack of burning events e.g. some lichen species (*Cladonia* spp.) (Cross 1990).

The national target for the attribute vegetation quality has been set as "to maintain / restore sufficient high quality bog vegetation (i.e. central ecotope and / or flushes / soaks). At least 50% of ARB habitat should be central ecotope and / or flush / soaks." Bog woodland is also regarded as a desirable variant of ARB as it adds species and structural diversity to the habitat and therefore, where relevant, also contributes to the 50% target at site level.

A summary description of the vegetation of Corliskea/Trien/Cloonfelliv Bog is presented in Section 1.3 above. The vegetation and habitats of the bogs have been described in more detail by Kelly *et al.* (1995) and Fernandez *et al.* (2005; 2014a, b, c, d).

The extent of the different ecotopes that correspond with ARB across all bogs within the SAC based on the most recent surveys is presented in Table 4 and on Map 2. During the most recent surveys the area of ARB comprised central, sub-central ecotopes, active flush, as well as bog woodland. It can be seen from Table 4 that the proportion of the high quality ARB ecotopes has remained relatively stable across all bogs within the site since 2004. The target for this attribute is 53.8ha of high quality ARB (50% of ARB target area (107.5ha)). This requires an increase from the current area of 35.5ha.

Table 4 Extent of ecotopes classified as ARB in 2004 and 2013 (from Fernandez *et al.* 2014a, b, c, d).

Ecotope	**2004**		**2013**	
	ha	**% of total ARB**	**ha**	**% of total ARB**
Corliskea Bog				
Sub-central ecotope	28.36	58.5	24.31	54.9
Central ecotope	0.71	1.5	0.51	1.2
Soaks / active flush	19.18	39.5	19.18	43.3
Bog Woodland	0.25	0.5	0.25	0.6
Cloonfelliv Bog				
Sub-central ecotope	0.52	78.8	0.52	78.8
Soaks / active flush	0.14	21.2	0.14	21.2
Trien Bog				
Sub-central ecotope	8.94	36.7	8.84	36.5
Soaks / active flush	15.36	63.1	15.36	63.4
Bog Woodland	0.04	0.2	0.04	0.2
Total ARB	**73.5**		**69.2**	

The site-specific target for the attribute vegetation quality is: **Restore 53.8ha of central ecotope/active flush/soaks/bog woodland as appropriate.**

2.3.6 Vegetation quality: microtopographical features

The characteristic microtopographical features of raised bogs are described in Section 1.1.1 above.

Hummock, pools and hollow microtopography is well developed on Corliskea/Trien/Cloonfelliv Bog SAC (Kelly *et al.* 1995; Fernandez *et al.* 2005, 2006 & 2014a, b, c, d).

The site-specific target for the attribute microtopographical features is: **Restore adequate cover of high quality microtopographical features.**

2.3.7 Vegetation quality: bog moss (*Sphagnum*) species

Bog mosses, which have unique properties, are the principal component of peat, and are largely responsible for the typical microtopographical features as described in Section 2.3.6 above.

The vegetation of a typical raised bog that is still hydrologically intact is characterised by the dominance of several species of Sphagna and dwarf ericoid shrubs. The most abundant species are *Sphagnum capillifolium, S. austinii* and *S. papillosum* which form hummocks or low ridges. *Sphagnum fuscum* may also form hummocks (Cross 1990). On the flats *Sphagnum magellanicum, S. papillosum, S. tenellum,* and *S. subnitens* are the key species. *Sphagnum pulchrum* may also be dominant in flats on western raised bogs. In permanently waterlogged hollows *Sphagnum cuspidatum* and *S. denticulatum* (western bogs) occur. *Sphagnum fallax* is common where there is slight flushing (Cross 1990). The most commonly occurring *Sphagnum* moss species that occur on raised bogs in Ireland are presented in Table 5 along with a summary of their ecology and typical contribution to peat formation.

Kelly *et al.* (1995) and Fernandez *et al.* (2005 & 2014a, b, c, d) provide information on the occurrence of *Sphagnum* species throughout Corliskea/Trien/Cloonfelliv Bog SAC.

Table 5 *Sphagnum* species typically associated with raised bog ecosystems in Ireland. Ecology as described by Laine *et al.* (2009) with minor modifications.

Species	**Ecology**	**Peat forming capacity**
Sphagnum austinii	Hummock species	High
Sphagnum capillifolium	Forms small hummocks and carpets	Moderate
Sphagnum cuspidatum	Pool and hollow species	Low
Sphagnum denticulatum	Pool and hollow species	Low
Sphagnum fallax	Occurs in lawns and carpets, shade tolerant. Indicative of some nutrient enrichment (soaks and active flushes)	Low
Sphagnum fuscum	Forms dense low and wide, and occasionally high hummocks	High
Sphagnum magellanicum	Lawn species forming carpets and low hummocks	Moderate
Sphagnum palustre	Forms hummocks and dense carpets, often in shaded conditions. Indicative of nutrient enrichment (soaks and active flushes)	Low
Sphagnum papillosum	Lawn , hollow, and low hummock species	Moderate
Sphagnum pulchrum	Grows in lawns and hollows, more typical of western bogs	Moderate
Sphagnum squarrosum	Forms carpets and small mounds. Indicative of nutrient enrichment (soaks and active flushes)	Low
Sphagnum subnitens	Occurs as individual shoots or small cushions and lawns. Tolerant of minerotrophic conditions	Moderate
Sphagnum tenellum	Occurs as single shoots or weak cushions, typically in disturbed patches of the bog surface	Low

The site-specific target for the attribute bog moss (*Sphagnum*) species is: **Restore adequate cover of bog moss (*Sphagnum*) species to ensure peat-forming capacity.**

2.3.8 Typical ARB species: flora

Corliskea/Trien/Cloonfelliv Bog SAC supports the full complement of plant species typically associated with a western raised bog (see Section 1.1.2 above).

The key typical species that are indicative of high quality raised bog include *Sphagnum fuscum* and *S. austinii* which are associated with hummocks and *S. cuspidatum* and *S. denticulatum* which are associated with pools and hollows. All of these species have been reported from Corliskea/Trien/Cloonfelliv Bog (Fernandez *et al.* 2005 & 2014a, b, c, d).

The site-specific target for the attribute typical bog flora is: **Restore, where appropriate, typical active raised bog flora.**

2.3.9 Typical ARB species: fauna

As mentioned in Section 1.1.3, a list of typical fauna specific to ARB has not been developed and the table contains species that use the wider raised bog habitat. This may be refined as more information becomes available.

Corliskea/Trien/Cloonfelliv Bog is likely to support a wide range of fauna species that are typically associated with raised bog habitat (see Section 1.1.3 above).

The site-specific target for the attribute typical bog fauna is: **Restore, where appropriate, typical active raised bog fauna.**

2.3.10 Elements of local distinctiveness

A range of features may be associated with raised bogs which add to the scientific, historical, or conservation value of a bog. These can include geological, topographical, archaeological and hydrological features (e.g. soaks, lakes, flushes) and noteworthy species of flora and fauna (Cross 1990). Notable species of flora and fauna include those listed in the Habitats and Birds Directives, Red-listed species, and other rare or localised species. For this attribute, features that are particularly associated with ARB are relevant.

2.3.10.1 Site features

The active flushes with bog woodland, together with the lake and swallow-hole system are the main features of local distinctiveness on Corliskea/Trien/Cloonfelliv Bogs.

2.3.10.2 Rare flora

On Trien Bog the rare liverwort species *Cephaloziella elachist*a has been recorded in a wooded flush. The rare shrub Alder Buckthorn (*Frangula alnus*), which is listed in the Irish Red Data Book, occurs at a swallow-hole flush on Corliskea Bog (DEHLG 2000).

The relatively scarce plant species *Rhynchospora fusca* has been recorded from some pool areas within the bogs.

2.3.10.3 Rare fauna

As mentioned above, there is limited current documented site-specific data relating to species that are particularly associated with ARB, including rare species. Breeding red grouse (*Lagopus lagopus*) have been recently recorded from the SAC (Cummins *et al.* 2010).

In conclusion, the site-specific target for the attribute elements of local distinctiveness is: **Maintain features of local distinctiveness, subject to natural processes.**

2.3.11 Negative physical indicators

Raised bogs that have been damaged by marginal cutting and drainage, reclamation for agriculture, forestry activities, fire, surface drainage, or the lowering of regional water tables show a range of negative physical indicators (Cross 1990). Such negative physical features of ARB include: bare peat, algae dominated pools and hollows, marginal cracks, tear patterns, subsidence features such as dry peat and / or mineral mounds / ridges emerging or expanding, and burning evidence.

Frequent burning has been reported from the site in the past. Burning is considered to have medium importance/impact on high bog habitats (Fernandez *et al.* 2014a, b, c, d).

The site-specific target for the attribute negative physical indicators is: **Negative physical features absent or insignificant.**

2.3.12 Vegetation composition: native negative indicator species

Indicators of disturbance on a raised bog include species indicative of drying out conditions such as abundant *Narthecium ossifragum* and *Trichophorum germanicum*; *Eriophorum vaginatum* forming tussocks; abundant *Sphagnum magellanicum* in pools previously dominated by species typical of very wet conditions (e.g. *Sphagnum cuspidatum*). Indicators of frequent burning events include abundant *Cladonia floerkeana* and high cover of *Carex panicea* (particularly in the true midlands raised bog type).

The site-specific target for the attribute native negative indicator species is: **Native negative indicator species at insignificant levels.**

2.3.13 Vegetation composition: non-native invasive species

Non-native invasive species that can commonly occur on raised bog habitats include: *Pinus contorta*, *Rhododendron ponticum*, and *Sarracenia purpurea* (Cross 1990).

Non-native species that have been reported from high bog areas within the SAC include *Rhododendron ponticum*, *Pinus* spp., and the moss *Campylopus introflexus* (Fernandez *et al.* 2014a, b, c, d). Indications are that *Pinus* spp. is spreading across the high bog at Trien. Rhododendron occurs very sporadically within the SAC. The *Pinus contorta* plantation on the high bog at Corliskea Bog has impacted on high bog habitats.

The site-specific target for the attribute non-native invasive species: **Non-native invasive species at insignificant levels and not more than 1% cover.**

2.3.14 Air quality: nitrogen deposition

Peatlands are highly sensitive to air pollution, particularly nitrogen deposition. Reactive nitrogen from fossil fuel combustion or intensive agriculture can contaminate rain and snow, causing soil acidification, nutrient enrichment, and a decline in species that are sensitive to these conditions. There is evidence that the combined impact of elevated nitrogen deposition and a warming climate could exceed the sum of the individual stressors and lead to a dramatic decline in the biodiversity of mosses, sensitive vascular plants, and microbes, potentially leading to catastrophic peat loss (PEATBOG project - http://www.sste.mmu.ac.uk).

Air pollution can change both the species composition and the functioning of peatlands. The primary atmospheric pollutant from the Industrial Revolution to the mid 1970s was sulphur deposition, but levels have since greatly declined. Reactive nitrogen (N) deposition (primarily NO3- and NH4+), which can both acidify and eutrophy, became significantly elevated over a widespread area in the early to mid-20th century and is now the major pollutant in atmospheric deposition across most of Europe (Fowler *et al.* 2005).

Nitrogen is commonly a limiting terrestrial nutrient and in un-impacted peatlands it is tightly cycled. With long-term elevated N deposition, vegetation composition typically shifts toward species adapted to higher nutrient levels, with an overall loss of diversity (Malmer & Wallén 2005). In peatlands, field experiments with N additions within the current European range have shown significant declines in bryophyte species-richness and productivity, and shifts in composition toward vascular plants (Bobbink *et al.* 1998; Bubier *et al.* 2007). Community shifts toward more nitrophilous bryophytes in N-enriched regions such as parts of the Netherlands are also well documented (Greven 1992). In the UK, both a general survey of peatlands across the country (Smart *et al.* 2003), and a targeted study of *Calluna* moorland (Caporn *et al.* 2007) showed significant inverse relationships between levels of nitrogen deposition and species richness, with bryophytes particularly impacted. Changes in the vegetation also impact below-ground communities and biogeochemical processes.

Moderate increases in N deposition from a low level may increase *Sphagnum* and vascular plant productivity without an equal increase in decomposition rates, leading to enhanced carbon accumulation (Turunen *et al.* 2004). However, shifts in species composition from bryophytes to vascular plants may increase the production of easily-decomposable plant material, leading to higher rates of decomposition, and reduced carbon accumulation (Lamers *et al.* 2000; Bubier *et al.* 2007).

The particular sensitivity of nutrient-poor ombrotrophic peatlands to nitrogen enrichment is reflected in the low critical load threshold of between 5 and 10kg N/ha/yr for these ecosystems (Bobbink & Hettelingh 2011), a level which is exceeded over a significant portion of their range. An Irish study during the late 1990s undertaken by Aherne & Farrell (2000) concluded that total N deposition shows a strong east-west gradient, with lowest deposition in the west at 2kg N/ha/yr and highest in the east and south-east at 20kg N/ha/yr. Average N deposition over the Republic of Ireland was estimated to be approximately 12kg N/ha/yr. The study also concluded that the Critical Load Threshold for N was exceeded in at least 15% of ecosystems studied. The critical load applied to peatland ecosystems by Aherne & Farrell (2000) was 10kg N/ha/yr. This is in line with the recommendation by Bobbink & Hettelingh (2011) that the critical load should be set at the high end of the range in areas of high precipitation and at the low end of the range in areas of low precipitation assuming that Ireland represents a high precipitation area.

It is recommended in the case of Corliskea/Trien/Cloonfelliv Bog that the level of N deposition should not exceed the low end of the range i.e. 5kg N/ha/yr. This recommendation is based on a precautionary approach, as the evidential basis for setting a higher level is not particularly strong as alluded to by Payne (2014). Total N deposition in the vicinity of Corliskea/Trien/Cloonfelliv Bog as reported by Henry & Aherne (2014) is 10.6kg N/ha/yr.

The site-specific target for the attribute air quality is: **Air quality surrounding bog close to natural reference conditions. The level of N deposition should not exceed 5kg N/ha/yr.**

2.3.15 Water quality

Ombrotrophic peat waters found on the surface of raised bogs are characterised by low pH values (pH < 4.5) (Moore & Bellamy 1974) and also have low values of electrical conductivity. This is due to the fact that the raised bog system derives its mineral supply from precipitation, which is usually acidic and low in nutrients. Raised bog vegetation exchanges cations with protons to further reduce the pH.

Hydrochemistry varies in the areas surrounding a raised bog. Locally, conditions may be similar to the high bog due to a dominance of water originating from the bog. However, elsewhere in the marginal areas, there may be increased mineral and nutrient content of the water due to regional groundwater influences, runoff from surrounding mineral soils, and the release of nutrients through oxidation of peat resulting from reduced water levels.

Kelly *et al.* (1995) presented hydrochemistry data from both Corliskea and Trien Bogs. The surveys identified elevated Electrical Conductivity (EC) in some of the major drains surrounding the bogs, suggesting some mineralised groundwater influence. EC data from elsewhere within the site suggested the prevalence of ombrotrophic water.

The site-specific target for the attribute water quality is: **Water quality on the high bog and in transitional areas close to natural reference conditions.**

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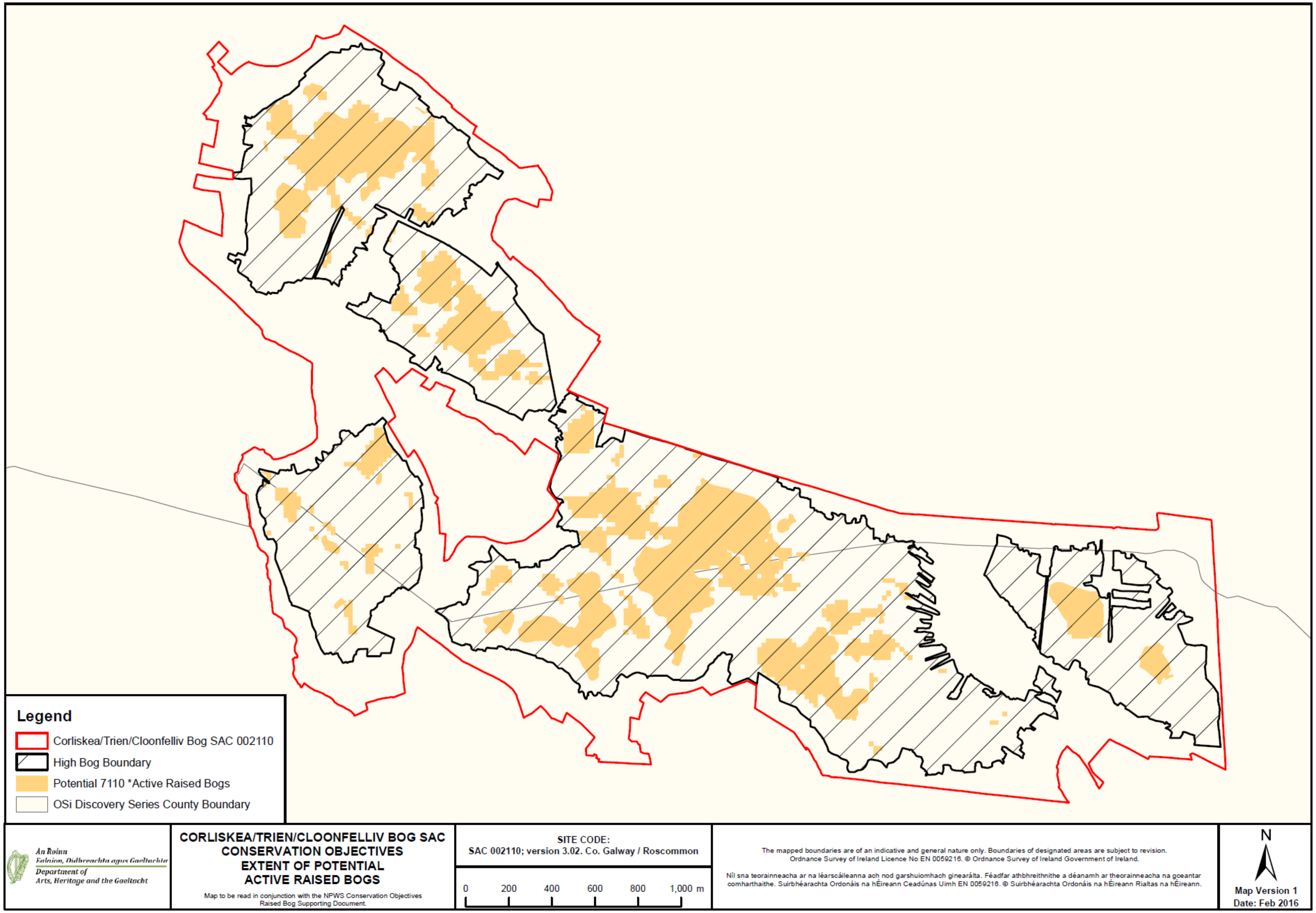
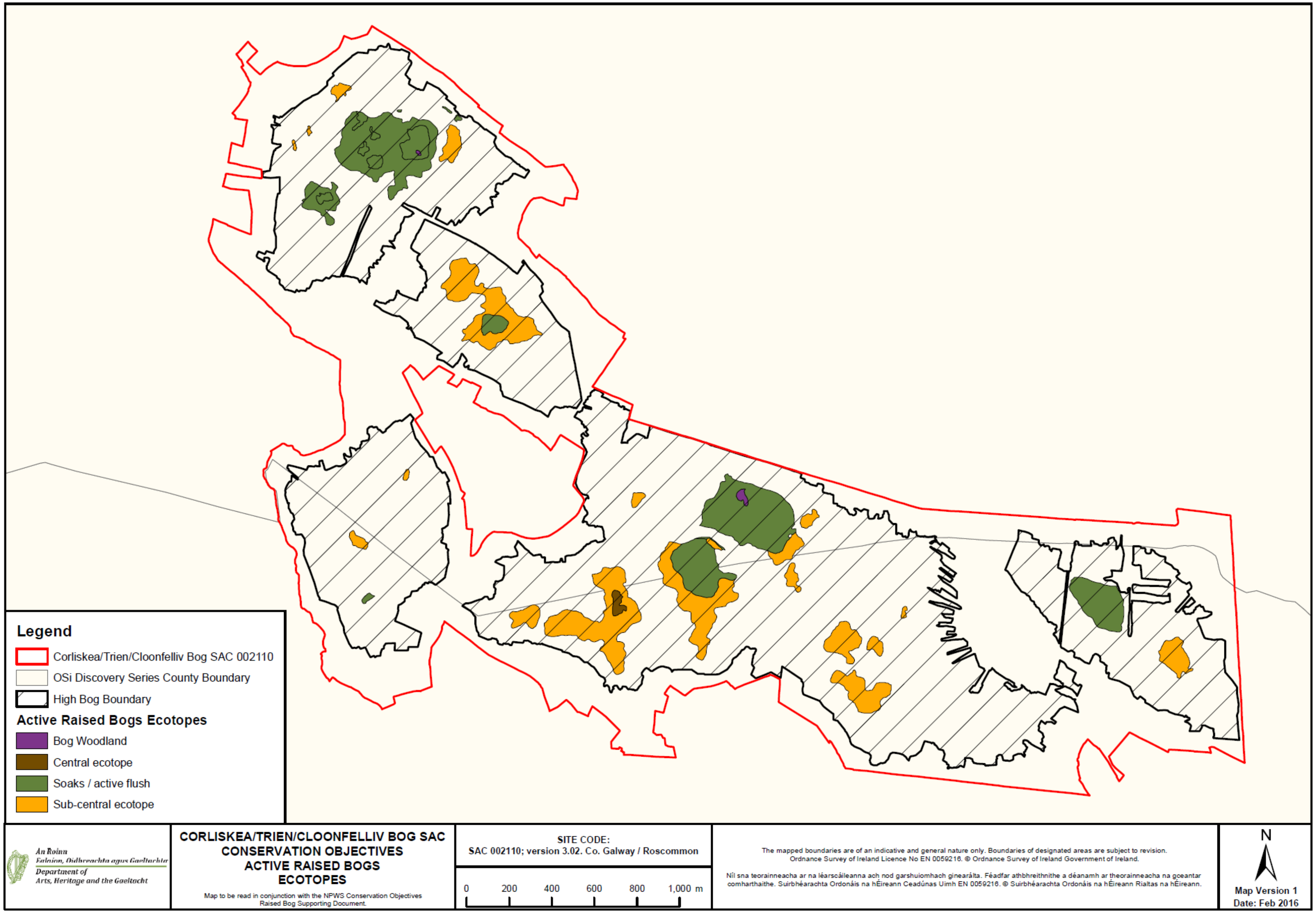
Map 1: Extent of potential active raised bog on Corliskea/Trien/Cloonfelliv Bog.



Map 2: Distribution of raised bog ecotopes on Corliskea/Trien/Cloonfelliv Bog.



Map 3: Digital elevation model and drainage patterns at Corliskea/Trien/Cloonfelliv Bog.