NATIONAL RAISED BOG SPECIAL AREAS OF CONSERVATION MANAGEMENT PLAN 2017-2022

An Roinn
Cultúir, Oidhreachta agus Gaeltachta

Department of
Culture, Heritage and the Gaeltacht

Main Cover Photograph: Derrinea Bog SAC, Co. Roscommon.

Images courtesy of the National Parks and Wildlife Service and the National Monuments Service of the Department of Culture, Heritage and the Gaeltacht, Coillte, RPS, Tina Claffey Photography, Irish Peatland Conservation Council, Theresa Kelly, George Smith (Blackthorne Ecology) and Bord na Móna.

All web links in this publication are curent at time of going to print in January 2018.

Designed by 2b:creative
info@2b-creative.com

Table Of Contents

FOREWORD BY THE MINISTER

Ireland's raised bogs are special and unique. They are places that play an important role in contributing to our biodiversity, economy, well-being and our natural and cultural heritage. A home for wildlife, acting as a carbon store and providing natural areas for recreation – these are just some of the benefits associated with one of Ireland's oldest and most vital ecosystems. With further rehabilitation our raised bogs will continue to give for future generations.

Irish raised bogs have been managed throughout the centuries for various industrial, commercial, agricultural and domestic uses to meet the needs of each generation. Ireland recognised in the 1990s that this important raised bog resource was in serious decline and took steps to designate 53 raised bog sites as Special Areas of Conservation (SACs) and later a further number of sites as Natural Heritage Areas. These raised bog sites are unique in that they host substantial areas of rare habitat, and with the right conditions they can continue to form peat and allow their distinctive flora and fauna to thrive.

The reality now, however, is that our raised bogs have suffered serious damage through the years for various reasons. Over 37% of our active raised bogs (where the conditions are right for peat to form) in the SACs network have been lost in the last 20 years and we need now to work together to reverse this decline. This has left us with a challenging issue – to manage and conserve Ireland's designated raised bogs whilst addressing the concerns of turf-cutters, land users and landowners within the raised bog SACs network. Approximately 9% of the original resource of raised bog habitat is considered to be suitable for conservation in protected sites and is within the terms of this national plan.

Ireland's peatlands evoke varying memories and experiences for different people. They epitomise community spirit and a place where people come to work together. Our bogs are also a place of serenity and a wonderful exhibition of what nature can offer. As set out in the Programme for a Partnership Government (May, 2016), the Government recognises that domestic turf-cutters have a traditional right to cut turf and that this right is balanced with the conservation objectives and legal obligations on the State. The role and rights of stakeholders in maintaining this unique ecosystem is recognised in this management plan. Many land users, landowners and turf-cutters have worked with my Department in complying with obligations arising from the EU Habitats Directive and I thank them for this.

This national plan for the raised bog SACs network sets out for the first time a roadmap for the long-term management, restoration and conservation of protected raised bogs. The provisions within it, along with the Review of the Raised Bog Natural Heritage Area Network and the National Peatlands Strategy, will provide a coherent approach to the conservation of designated raised bogs in Ireland. It will also explore measures to allow a co-existence on certain SACs. This is not the final resolution, as the journey for our raised bogs will continue. Instead, it is a path to achieving complementary rather than competing land use.

Stakeholders, through public consultation and meetings, through the Peatlands Council and the Raised Bog Conservation Study Steering Group, were given an opportunity to input into the preparation of this plan. I would like to thank those parties that have worked with my Department and with the Peatlands Council to finalise its contents. Members of the Peatlands Council representing turf-cutters, landowners and environmental interests have advocated strongly for those that they represent and have helped guide me towards the proposed approaches. The Scientific and Policy Advisory Group to the Peatlands Council has provided invaluable advice and

guidance during this process. Commissioner Vella and his officials within the European Commission have also proven themselves to be constructive partners in tackling this difficult issue.

I recognise that there are raised bogs both inside and outside the raised bog SACs network where State-owned companies such as Bord na Móna and Coillte are also demonstrating great responsibility in contributing to the State's conservation effort through management of the lands that they hold in trust for the Irish people. Environmental non-governmental organisations and local community groups are also putting in great efforts to restore and protect these unique wetland habitats.

It is my hope that Ireland's designated raised bogs can transition from being considered a commodity to become places of wild natural beauty and biodiversity that can provide a place for communities to come together again with new purpose. This plan will provide opportunities for those who have a stake in the network of raised bogs to come forward and get involved in its conservation so that future generations can visit and enjoy them.

The National Raised Bog Special Areas of Conservation Management Plan is the framework for our actions in the years ahead as we continue to protect the environment, live up to our EU obligations, and work with landowners and turf-cutters, on whose lives these obligations can have a significant impact.

Heather Humphreys T.D.

Minister for Culture, Heritage and the Gaeltacht

Executive Summary

Purpose of the Plan

This is the first national management plan for Ireland's raised bog Special Areas of Conservation (SACs) network. This plan, together with the National Peatlands Strategy (NPWS, 2015) and the Review of Raised Bog Natural Heritage Area Network (NPWS, 2014), is part of the Government's coherent approach to the management of Ireland's peatlands. It also addresses European Commission concerns on the declining conservation status of the protected raised bog network.

This plan was prepared on foot of a recommendation of the Peatlands Forum, convened in 2012, and a resolution from Dáil Éireann. Since 2012 significant resources have been put in place to manage the issues surrounding turf-cutting on designated sites. The establishment of the Peatlands Council and the introduction of a comprehensive financial compensation and relocation scheme for turf-cutters have greatly assisted with trying to bring about a resolution to this issue.

The aim of the National Raised Bog Special Areas of Conservation Management Plan 2017–2022, as set out in Chapter 1, is to provide clarity to all parties regarding how Ireland's network of raised bog SACs will be managed, conserved and restored into the future. This will be done in co-operation with landowners, turf-cutters and local communities and in keeping with legal obligations and commitments such as under the European Union (EU) Habitats Directive (Directive on the Conservation of Habitats, Flora and Fauna 92/43/EEC). The plan sets national restoration targets for raised bog habitats that require the restoration of the national network of raised bog SACs and Natural Heritage Areas (NHAs).

The plan also sets out how the concerns of those who use Irish raised bogs will be addressed. This includes the provision of a financial compensation and relocation scheme for turf-cutters, and in a small number of cases, where no feasible alternatives exist, investigating the potential for continued turf-cutting within SAC sites in line with the requirements of the EU Habitats Directive. The plan outlines the many benefits of the raised bog designated SACs network and explores how local communities can become involved in the management and conservation of raised bogs.

The plan comprises five core objectives, underpinned by a programme of conservation measures and by the setting of national conservation objectives for raised bog habitats. These core objectives are:

1. To understand and describe the conservation status and the ecological and hydrological conditions of our raised bogs;
2. To put in place a raised bog national designated network that will be sustainable into the future;
3. To develop mechanisms to restore and rehabilitate protected habitats within the network of designated raised bogs;
4. To manage protected raised bogs in a manner compatible with their uses and the concerns of stakeholders whilst maintaining their biodiversity and natural function; and
5. To raise awareness and understanding of the benefits and values of raised bogs and encourage community involvement to inform future decisions.

This plan is informed by principles laid down in relevant national policies, in particular the National Peatlands Strategy (NPWS, 2015) and the National Biodiversity Plan 2017–2021 (NPWS, 2017), as well as international conventions such as the Convention on Biological Diversity, the Ramsar Convention and the requirements to protect the raised bog SACs for future generations.

The key outcomes of this plan are:

- The establishment of a comprehensive programme of conservation measures for the designated raised bog network;
- Extensive restoration and rehabilitation works to be undertaken within the designated raised bog network to reverse the decline in protected habitats;
- Designation of two new SACs to compensate for permanent loss of active raised bog (the living, actively growing upper layer of a raised bog);
- Recognition of the traditional rights of turf-cutters;
- Exploring the opportunities for recreational amenities within the raised bog SAC network;
- Working with other bodies to deliver actions in the National Peatlands Strategy;
- Implementation of key actions of the Review of Raised Bog Natural Heritage Area Network (2014);
- Promoting education and awareness of the value of ecosystem services (range of benefits that arise and are derived from a natural system) and biodiversity within the network;

- Continuing to pursue solutions to address the needs of stakeholders without impacting on the integrity of the raised bog SAC network;
- Supporting communities involvement in the decision making process; and
- Pursuing research opportunities to improve the management and restoration practices of the designated raised bog network into the future.

The sustainable management approach to the designated raised bog network advocated in this plan will require a joint understanding between many individuals and organisations, including land users and owners, turf-cutters, the scientific and environmental community, and Government. It will require funding, resources, support and time over the lifetime of the plan to bring it into a reality. The Department of Culture, Heritage and the Gaeltacht will undertake the necessary policy development to implement this plan and will lead the work in partnership with relevant State bodies and with the input of stakeholders.

Status of Irish Raised Bogs

Peatlands have formed in the Irish landscape since the last Ice Age and, together with remnants of primeval forests, they form some of our oldest surviving ecosystems (natural systems). Irish peatlands are some of the country's last and largest areas of wilderness, hovering between land and water, providing unusual habitats with their unique and specialist flora and fauna. They once covered a large area of the land surface, occurring as raised bogs, blanket bogs or fens and form distinctive landscapes in many parts of the country.

In terms of environment and biological diversity, Ireland's raised bogs are of importance not only nationally, but also at a European and indeed global level. The current designated raised bog network consists of 53 raised bog SACs and 75 raised bog NHAs covering an area of 17,995 ha. It is considered necessary to protect SACs under the EU Habitats Directive as they contain habitats and species that are rare and threatened on a European scale. SACs are also referred to as Natura 2000 sites or European sites in legislative terms. Natura 2000 is a network of sites across the European Community selected for the purposes of conserving natural habitats and species of plants and animals which are rare, endangered or vulnerable. SACs (together with Special Protection Areas (SPAs)) form the Natura 2000 Network. NHAs are areas designated under the Wildife Acts and are considered important for the habitats present or for the species of plants and animals they hold whose habitat needs protection.

A comprehensive review of the raised bog NHAs and undesignated raised bogs of conservation value was undertaken in 2014. The review concluded that Ireland could more effectively achieve conservation of threatened raised bog habitat through focused protection and restoration of a reconfigured network. As a result 46 raised bog NHAs (including parts of seven NHAs) are scheduled for de-designation. To compensate for the loss of habitat within sites where it is proposed that turf-cutting can continue, 25 undesignated raised bogs, which are largely in public ownership or where there is reduced turf-cutting pressure, are scheduled to be designated as NHAs.

This plan outlines the current condition of our raised bogs nominated for designation in accordance with the Habitats Directive and designated under the Wildlife Acts, and explains why we need to conserve and manage them appropriately. Chapter 2 describes the condition of Ireland's raised bog network.

National Raised Bog Resource

The original area of raised bogs in the State was approximately 310,000 ha (Hammond, 1981) while it has been estimated that **approximately 9% of the original raised bog resource (high bog in a relatively intact state along with surrounding cutover)** is now suitable for conservation purposes.

The most recent Conservation Status Assessment Report (Fernandez *et al.*, 2014) indicates that only 50,000 ha of "intact" high bog remain in the country out of the original figure estimated by Hammond. There is an estimated 17,995 ha of high bog and a minimum of 9,100 ha of cutover bog within the designated (SAC and NHA) raised bog network, of which only 1,639 ha can be classified as active raised bog. Both SACs and NHAs also contain cutover areas, which would have been part of the 310,000 ha of raised bog originally reported by Hammond. This means that in total there is a minimum of 27,100 ha of high bog and cutover bog in protected sites.

The remainder of the national raised bog resource has been drained or exploited to various extents, such as for industrial peat harvesting. Much of Ireland's peatlands are in private ownership although considerable areas are also owned by the State or by State-owned companies such as Coillte and Bord na Móna.

The national conservation status of active raised bog habitat, a priority (Annex 1) habitat under the Habitats Directive, has been assessed as 'Unfavourable Bad-Declining' in Ireland's six-yearly article 17 report to the European Commission, the worst rating possible.

It is estimated (Fernandez *et al.*, 2014) that there was a 25–36.7% decline in area of active raised bog for 48 Irish raised bogs assessed in the 1994/95 to 2004/05 reporting period. There were further declines, estimated at 1.61%, of active raised bog between the 2004/05 and 2011/13 reporting period within the 44 raised bogs assessed.

Raised Bog Area

The area of **active raised bog** within Ireland's 53 SACs estimated from ecological surveys was 1,940 ha in 1994 (the year in which the Habitats Directive came into effect). This decreased to 1,210 ha in 2012/13, which is a loss of 730 ha. This represents an approximate loss of 37% of the SAC active raised bog habitat over the period 1994 to 2012/13. In addition, it is estimated that the area of active raised bog within the original network of 75 NHAs was 490 ha in 1994, decreasing to 284 ha in 2012/13, a loss of 206 ha. This represents an approximate loss of 42% of the NHA active raised bog habitat over that period.

Furthermore, it is estimated that the area of active raised bog within non-designated bogs of potential conservation value was 200 ha in 1994, decreasing to 145 ha in 2012/13, which is a loss of 55 ha.

The current area of **degraded raised bog** (DRB) (raised bog which can be restored to active raised bog) (also an Annex 1 habitat under the Habitats Directive) within Ireland's raised bog SAC network is 1,114 ha with 440 ha in the original network of NHAs. It is estimated that there were 650 ha of DRB within the 53 raised bog SACs and 520 ha within the original network of 75 NHAs in 1994.

There is a loss of approximately 2% of the high bog area in raised bog SACs during the period 1994 to 2012/13, decreasing from 10,740 ha in 1994 to 10,515 ha in 2012/13. The high bog area of the NHA raised bog habitat has seen a loss of approximately 4% during this same period.

Table E1: Summary of raised bog area in Ireland

Bog Habitat	Resource	1994[1] (ha)	2012/13[2] (ha)	Change (ha)
Active Raised Bog	Current SACs network	1,940	1,210	-730
	Current NHAs network	490	284	-206
	Non-designated sites	200	145	-55
	National Network	**2,630**	**1,639**	**-991**
Degraded Raised Bog	Current SACs network	650	1,114	+464
	Current NHAs network	520	440	-80
	Non-designated sites	625	570	-55
	National Network	**1,795**	**2,124**	**+329**
High Bog	Current SACs network	10,740	10,515	-225
	Current NHAs network	7,790	7,480	-310

As can be seen in Table E1 there has been an overall decline in active raised bog and high bog area within the raised bog network in Ireland, with significantly greater losses in areas of active raised bog occurring relative to losses in high bog.

For active raised bog to survive, mean water levels need to be near or above the bog surface for most of the year. The main threats to Irish raised bogs conservation arise from actions that drain water and cause them to dry out. These threats include drainage, peat harvesting or turf-cutting, planting of commercial forestry, burning and other activities such as water abstraction, which can lower the regional groundwater level. Chapter 2 outlines in detail how drainage and other activities can affect raised bogs' hydrological regime and correspondingly lead to degradation of the raised bog ecosystem.

1. Year by which EU Member States had to comply with the provisions of the Habitats Directive
2. Period of most recent monitoring and modelling assessments

Setting Conservation Objectives for Raised Bog Habitats

One of the main aims of the Habitats Directive is to ensure that the habitats and species listed in the Directive achieve "favourable conservation status". This means that these habitats and species are being maintained in satisfactory condition and that this situation is likely to continue for the foreseeable future.

The conservation status of bog habitats listed in the Habitats Directive has deteriorated in Ireland and continues to do so. As a first step in planning the restoration of active raised bog, conservation objectives at different scales need to be set. Chapter 3 identifies the conservation objectives required to achieve an ecologically coherent national raised bog network. Conservation objectives, set by a scientific process on a national and site-specific level, aim to define how much, where and what conditions are necessary to maintain or restore the raised bog network to favourable conservation status. **The target for the area of active raised bog in the national raised bog network is: area increasing and not less than 3,600 ha.**

The site-specific conservation objectives which define favourable conservation conditions for a particular habitat or species at site level are now set for raised bog SACs. For further information, see published documents for relevant SACs at http://www.npws.ie/protected-sites.

Scientific Analysis and Conservation Measures

In 2012 the State committed to undertake the scientific analysis required to underpin the National Raised Bog Special Areas of Conservation Management Plan. The analysis team includes experts in the scientific disciplines required to inform policy on conservation, restoration and hydrological management of these bogs. This scientific analysis has included a review of the current condition and restoration potential of a large number of raised bogs including those designated as SACs, NHAs and numerous non-designated bogs of potential conservation interest. Through this process a network of raised bog SACs and NHAs has been identified that will enable the national conservation objectives to be met and will more than double the current area of active raised bog habitat present in the country once restoration works are implemented.

Raised Bog SACs Network Targets

Ireland's commitment under the Habitats Directive is to have a robust ecological network of raised bogs that is sustainable into the future. This includes the raised bog SACs, which are the best remaining examples of the habitat. This commitment includes replacing and restoring the area of active raised bog within the SACs network that has been lost since 1994 when the Habitats Directive came into force.

Nationally there has been a significant loss (circa 1,000 ha) of active raised bog habitat which was 2,630 ha in 1994 and 1,639 ha in 2012 (see Table E1). As stated above, the national target for active raised bog habitat in the raised bog national network is set at 3,600 ha. This is derived by summing the areas of active and degraded raised bog habitat in the current SACs and NHAs networks when the Habitats Directive came into force in 1994.

There is currently a total of circa 1,500 ha of active raised bog habitat in the SACs and proposed *new* NHAs networks plus 1,616 ha of degraded raised bog habitat which can be restored to active using the measures outlined in this plan. In addition, 183 ha of active and degraded raised bog habitat will be provided by the designation of two additional SACs as compensatory habitat into the SACs network. However, this still leaves a shortfall in achieving the national target. To meet the active raised bog national conservation objective it will therefore be necessary to restore active raised bog on high bog areas as well as creating peat-forming conditions on cutover areas.

Table E2: Summary of area of active raised bog and degraded raised bog within the designated network of raised bog

Bog Habitat	SACs network (including two new SACs) (ha)	New NHA network (ha)	Total (ha)
Active Raised Bog	1,244	290	1,534
Degraded Raised Bog	1,263	502	1,765
Potential bog peat-forming habitats	298	150*	448*
Total	**2,805**	**942**	**3,747**

**Estimate based on percentage of cutover within SACs network expected to become peat-forming habitats*

Table E2 shows that a total of 3,747 ha of active raised bog can be achieved within the designated raised bog network in the long term, with restoration implemented in the short to medium term. This figure is above the national active raised bog target of 3,600 ha. However, it does not take into account any ongoing losses due to damaging activities.

Restoration

Chapter 4 outlines that, up to 2011, restoration works were undertaken on 47 raised bogs sites covering some 2,500 ha of land. The site-specific conservation objectives now set for the raised bog SACs will form the basis for restoration planning at each site by providing a set of targets against which the success of the restoration plan for each site can be measured.

Draft site-specific restoration plans have been developed and will be implemented for all raised bog SACs on a phased basis. Each plan defines the measures required to achieve targets set within the site-specific conservation objectives and ultimately contribute to national targets. These plans are considered long-term and generally connected to the management of the sites. The plans comprise three key elements:

- Details of physical restoration measures proposed;
- Proposals for drainage management to be integrated into restoration plans;
- Information on how community benefits of the restoration plans will be optimised.

The plans will be developed further in conjunction with local communities, including landowners, users and turbary right holders, to ensure concerns are adequately addressed, and, where necessary, plans amended prior to restoration works taking place.

The Irish LIFE Raised Bog Restoration Project 'The Living Bog' (LIFE14/NAT/IE/000032) funded under the EU LIFE 2014–2020 Programme, commenced in 2016, is the largest single peatlands restoration project undertaken by the State. This project will concentrate on restoring active raised bog on 12 SAC sites and will be the first project to utilise these draft restoration plans as a basis for consultation. A sample draft plan for one of the sites, Ardagullion Bog SAC in Co. Longford, is contained in Appendix 6. The remaining raised bog SACs draft restoration plans will be made available during further proposed consultation processes. A scheme to compensate those who may be impacted by restoration works is being developed and will be implemented by the State on a phased basis.

A similar scientific process will be carried out for raised bog NHAs to define site-specific targets and develop restoration plans that will enable these targets to be met.

Generally, to achieve the objectives of the restoration process, active intervention will be necessary to prevent further losses of habitat. Intervention measures include preventative measures (control of certain activities, e.g. burning, drainage, peat harvesting) and active intervention including drain blocking on the high bog, removal of forestry plantations, marginal bunds and high bog and cutover bog excavation/re-profiling. These measures are explained further in Chapter 4. These active intervention measures aim to raise the water table in peat, in order to establish suitable hydrological conditions for peat to form. This will typically involve raising the water table to at, or slightly above, the ground surface only. It is not the aim to create deep pools (>50cm), as this inhibits the growth of *Sphagnum* (bog moss species), the desired species for peat rejuvenation. Restoration measures are focused on high bog and cutover areas. Only in very rare occasions, where it is absolutely essential, will these measures be focused on areas including agricultural land. Restoration measures will only be implemented in agreement with landowners.

A guidance document that outlines current best practice in the restoration of Irish raised bogs will be published in conjunction with this plan.

Restoration Measures and Flooding Concerns

Whether raised bog restoration measures could result in increased flooding in the surrounding area is a cause of concern to some stakeholders. In many instances, restoration works have the opposite effect by returning natural hydrological conditions whereby flow is attenuated and reaches the surrounding watercourses more slowly than when drains were present. The site-specific restoration plans for each of the raised bog SACs will include an integrated drainage management plan prepared in conjunction with local stakeholders. This will ensure that the main periphery drains surrounding a bog can be maintained in a way that will not have an adverse impact on the bog (see 'Addressing flooding concerns' in Chapter 4).

Addressing the Needs of Stakeholders

A major element of this management plan is exploring options to address the concerns of affected landowners, turf-cutters and other stakeholders (local and national).

Irish people have been closely connected to peatlands by a long history of cultural and economic development. The extraction of peat for fuel grew in importance as our native forests were lost, with the consequence that generations of Irish families have relied on turf as their only source of heat. Peatlands have developed over millennia, creating an important economic raw material on which the livelihoods of some rural populations depended.

Turf-cutting by citizens for their own domestic fuel needs is a valued traditional activity across many peatlands. While the Government has no intention of ending the traditional right to cut turf for a person's own domestic use, it is necessary to deal with the management challenges that have arisen in recent times for protected peatlands. In many areas such activity can continue into the future, as approximately only 9% of the original raised bog resource is considered to be of national conservation value. However, where turf-cutting conflicts with conservation objectives and obligations on the State, it needs to be curtailed. The aim of Government policy is to ensure that where this is necessary, in the interests of the common good, the rights of turf-cutters are fully addressed through monetary compensation to all affected or through facilitating turf-cutters on alternative non-designated bogs, if possible.

Up to December 2016, over €17.7m has been paid to turf-cutters under the Cessation of Turf Cutting Compensation Scheme since its introduction in 2011. In addition, over €3.2m has been spent on assessing alternative sites for turf-cutting and the State has spent approximately €29m purchasing land or rights in designated areas since 1999.

Thanks in large part to the efforts of turf-cutter representatives, non-governmental organisations, the Peatlands Council, and State-owned bodies such as Bord na Móna and Coillte working with the Department of Culture, Heritage and the Gaeltacht, considerable progress has been made in finding solutions to meet Ireland's obligations under the Habitats Directive.

Article 6(3) and Article 6(4) of the Habitats Directive

Relocation has proven to be a lengthy process due to the complexities involved. The Department, together with Bord na Móna and national and local turf-cutting interests, has invested considerable time, effort and resources into seeking to identify and facilitate cutting on nearby alternative bogs in respect of SACs bogs. In some cases, however, there are no feasible relocation sites available or not enough plots in a relocation site to accommodate those who wish to continue turf-cutting. In this scenario, the State in this plan explores the options of utilising the provisions of Article 6(3) and Article 6(4) of the Habitats Directive to provide for consent to cut turf within defined areas of a small number of SACs.

Article 6(3) of the Directive provides that consent by the relevant public authority for certain plans or projects can be given only where it can be demonstrated that they will not adversely affect the integrity of a European site. An Appropriate Assessment, if screened in, must be undertaken of the impacts of the proposal on any European (Natura 2000) site. This assessment, based on the best scientific information available, must focus on the qualifying interests of the site, as well as its conservation objectives and conservation condition. The effects of such proposals must be assessed alone and in combination with other plans or projects.

Following consultation with turf-cutting representatives, scientific investigations have been carried out for a limited number of proposals for continued cutting within parts of certain raised bog SACs. It has been possible to demonstrate in some cases that some turf-cutting may take place in accordance with the provisions of Article 6(3) of the Habitats Directive. Chapter 5 outlines in detail these assessments for a number of SACs. Further scientific investigation is ongoing for other sites. Until these proposals have received the necessary consents from the relevant public authorities, no turf-cutting can take place on these sites.

Where it has been determined that a plan or project cannot proceed under Article 6(3), it may be possible for it to be authorised under Article 6(4). Article 6(4) allows for a plan or project that has been subject to a negative assessment but for which there are no alternative solutions to proceed when it must be carried out for 'imperative reasons of overriding public interest'. This measure can be explored, if necessary, in a limited number of cases and as part of an overall solution to the management of the raised bog SACs network. If this provision is brought into effect for turf-cutting, compensatory measures, which include designation of new sites, must be taken to ensure the overall ecological coherence of the Natura 2000 Network and the achievement of national conservation objectives.

Raised Bogs and Other Land Uses

It is recognised that the management and use of peatlands takes place in a complex regulatory environment with overlapping policies, licence and consent requirements. For raised bogs, land uses other than peat extraction can generally take place on the surrounding cutover areas of the raised bog SACs network once it is compatible with the conservation objectives of the site and subject to the necessary assessments for impacts on a European site (SAC or Special Protection Area (SPA)). Chapter 5 provides information on the consent system for SACs and gives examples of other land uses such as agricultural and recreational. The management approach to water, waste, heritage and fire for raised bog SACs, based on the policies of the National Peatlands Strategy, is also outlined in this chapter.

Benefits and Value of Raised Bog Conservation

Irish raised bogs are part of Ireland's oldest surviving ecosystem and are an important part of the country's 'natural capital' (the elements of nature that produce value – directly or indirectly – to people (DEFRA, 2013)). Raised bogs can provide many valued ecosystem services or nature-generated benefits such as:

- Carbon storage and sequestration;
- Support for habitats and species biodiversity;
- Water purification and flood attenuation;
- Cultural heritage preservation;
- Landscape and recreation; and
- Peat as a resource (source of energy, horticulture, cultural tradition and recreation).

Associated benefits will bring clean water, climate regulation, biodiversity and support for health and well-being. The ability of intact bogs to accumulate carbon, and their large carbon storage capacity, means that they can have an important contribution to Ireland's commitments to international climate change agreements. The benefits and the value that raised bogs can provide to society and humans are discussed in Chapter 6 of this plan.

The cultural heritage of turf-cutting on raised bogs is still preserved on non-designated sites (just over 91% of the national raised bog resource); whereas almost all the other benefits that raised bogs bring to society can be recovered and enjoyed by all on the remaining 9% of the estimated resource that is located in the protected sites. It is recognised that there are opportunities for the enhancement of the raised bogs network as tourism and recreational amenities and to provide a community dividend.

The Way Forward

A conservation programme for the first cycle of this plan (2017–2022) has been developed in order to achieve the protection and conservation of Ireland's designated raised bog network and to support the plan's wider objectives. The programme, set out in detail in Chapter 7 and summarised in Table E3, includes restoration, preventative, monitoring, review, research, surveying, community engagement, education and awareness measures derived in part from existing legislation and conservation initiatives.

Implementing the Plan

The successful implementation of this plan will require continued dialogue with turf-cutters and turf-cutting representatives, other stakeholders, local communities, relevant Government departments, State agencies, semi-State bodies, non-governmental organisations and the Peatlands Council, with everyone working together within the legislative requirements.

Full implementation of the programme of conservation measures set out in this plan will result in a more sustainable ecological network of protected raised bogs, which will also bring a wide range of beneficial ecosystem service opportunities without compromising on cultural and traditional beliefs. The involvement and engagement of local communities is an essential element for the conservation and management of Irish raised bogs.

The plan will be implemented in a six-year cycle from 2017 to 2022, with a further two six-year cycles to follow after this period. The plan will be reviewed after three years to ensure progress on delivery and will be guided by ongoing research and monitoring. The Department of Culture, Heritage and the Gaeltacht will oversee implementation of the plan, will update the Peatlands Council regularly on the measures being undertaken, and will provide a report to Government on the outcome of the three-year review as well as at the end of the six-year cycle.

Table E3: Summary of Designated Raised Bog Network Conservation Programme (First Cycle 2017–2022)

Measure	Where	When	Who	Estimated Cost (2017–2022)
1. Notification and designation of two new SACs	Primarily Bord na Móna owned land	2017	Department of Culture, Heritage and the Gaeltacht	€0.005m (excludes cost of compensation/ relocation for affected turf-cutters)
2. Restoration through implementation of best practice restoration techniques of the raised bog designated network entailing: (refer to Chapter 4 for further details)	53 Raised Bog SACs (and 2 SACs to be designated) and sites from new NHA network			
• Implementation of EU LIFE Project – "Restoring Active Raised Bog in Ireland's SAC Network 2016–2020"	12 Raised Bog SACs	2016–2020	Department of Culture, Heritage and the Gaeltacht (National Parks and Wildlife Service (NPWS))/LIFE Project Team/European Commission	€5.4m (75% EU funded)
• Restoration measures on SACs and NHAs to support national conservation objectives for the raised bog network, development of restoration plans and restoration incentive measures. Development of site-specific conservation objectives for raised bog NHAs. Supporting guidance documents and code of practice.	Selection of sites in SACs network and sites from new raised bog NHA network	2017–2022	Department of Culture, Heritage and the Gaeltacht (NPWS) Other bodies: Coillte/ Bord na Móna/ Community Groups/ other stakeholders	€12m

Measure	Where	When	Who	Estimated Cost (2017–2022)
3. Preventative measures (cessation of damaging activities including drainage and turf-cutting, planting of commercial forestry, spread of fires, and other human activities) Other measures:	53 current raised bog SACs (and two sites to be designated) and sites from new NHA network	2017–2022	Department of Culture, Heritage and the Gaeltacht (NPWS) and other stakeholders Relevant statutory bodies and consent authorities	Cessation of Turf-Cutting Compensation Scheme (financial compensation, turf deliveries and relocation) €26.1m (Note: fire management/waste management/invasive species management/other human activities costed as part of restoration measures
Pursue applying provisions of Article 6(3) through scientific analysis to identify areas in SACs suitable for turf-cutting which will not impact on the integrity of the sites (See Chapter 5)	Small number of selected sites after consultation and agreement with local turf-cutting communities	2017–2018	Department of Culture, Heritage and the Gaeltacht (NPWS)/Stakeholders	€0.1m per site (cost can vary per site and depending on level of scientific investigations required)
Explore applying provisions of Article 6(4) for certain SACs, if necessary		2017–2018	Department of Culture, Heritage and the Gaeltacht (NPWS)/Stakeholders	€0.1m per site (cost can vary per site and depending on level of scientific investigations required)
Continue with enforcement measures and aerial monitoring of SACs	All raised bog SACs	Ongoing	Department of Culture, Heritage and the Gaeltacht (NPWS)/Garda Siochána/Defence Forces	Not costed within this plan – ongoing activities
Development of Drainage Management plans	Raised bog SACs	2017–2022	Department of Culture, Heritage and the Gaeltacht (NPWS)/OPW/ local authorities/ landowner)	€0.300m
4. Implementation of Review of Raised Bog NHA Network	Current and new NHA Networks	2017–2018	Department of Culture, Heritage and the Gaeltacht (NPWS)	Not costed in this plan – ongoing activities (cost of restoration of a number of raised bog NHAs is included under measure 2)
5. Support to other organisations/ individuals for conservation measures in raised bog SACs network	Selected Sites	2017–2022	Department of Culture, Heritage and the Gaeltacht (NPWS) and other stakeholders	€0.5m

Measure	Where	When	Who	Estimated Cost (2017–2022)
6. Mid-cycle Review of the National Raised Bogs Special Areas of Conservation Management Plan	National	2020	Department of Culture, Heritage and the Gaeltacht (NPWS)	€0.2m
7. Preparation of Second National Raised Bogs Special Areas of Conservation Management Plan	National	2022–2023	Department of Culture, Heritage and the Gaeltacht (NPWS)	€1.0m
8. Raised Bogs Community Engagement, Education and Awareness Programme	National	2017–2022	Department of Culture, Heritage and the Gaeltacht (NPWS), public authorities and other stakeholders	€0.5m
9. Raised Bogs Ecotope Surveying and Monitoring Programme	National	2017–2022	Department of Culture, Heritage and the Gaeltacht (NPWS)	€1.0m
10. European Communities (Birds and Natural Habitat) Regulations 2011–2015, Environmental Impact Assessment Regulations and Environmental Liabilities Regulations implementation to prevent damaging activities, where relevant and appropriate	National	Ongoing	Department of Culture, Heritage and the Gaeltacht (NPWS) and other relevant authorities	Not costed in this plan – ongoing activities
11. Raised Bogs Research Programme	Raised Bog Network	Ongoing	Department of Culture, Heritage and the Gaeltacht (NPWS) and other relevant bodies/agencies	€0.2m
12. Ensure legislative and policy linkage to other plans and programmes including River Basin Management Plans and Catchment Flood Risk Management Plans	National	Ongoing	Department of Culture, Heritage and the Gaeltacht (NPWS)	No cost applicable to this plan

Chapter 1
THE NEED FOR A MANAGEMENT PLAN

Chapter 1
THE NEED FOR A MANAGEMENT PLAN

Introduction

This National Raised Bog Special Areas of Conservation Management Plan (2017–2022) sets out a roadmap for the effective preservation of Ireland's designated raised bogs. This represents approximately 9% of the original raised bog resource (both high bog and cutover bog within the designated raised bog network (see Chapter 2)). The plan outlines the national conservation objectives for raised bog habitats within the network of protected sites to ensure the long-term viability of these habitats. It also provides for a programme of measures to achieve the objective and the restoration of the national network of designated raised bogs. The aim of the plan is that the rights, hopes and needs of those affected by it are addressed in a manner that supports the overall ecological coherence of the raised bog Special Areas of Conservation (SACs) network and ensures that Ireland meets its legal obligations for nature conservation.

Protected Raised Bogs in Ireland

Raised bogs are extremely rare in global and European terms. Ireland holds approximately 50% *(*Foss *et al., 2001)* of all raised bogs remaining in the Atlantic region of north-west Europe and so Ireland and the European Union have a special responsibility for their conservation at an international level.

Natura 2000 is the centrepiece of EU nature and biodiversity policy. It is an EU-wide network of nature protection areas, SACs established under the 1992 EU Habitats Directive (Directive on the Conservation of Habitats, Flora and Fauna 92/43/EEC), and Special Protection Areas (SPAs) established under the 1979 EU Birds Directive (Directive on the Conservation of Wild Birds 2009/147/EC). The aim of the network is to assure the long-term survival of Europe's most valuable and threatened species and habitats.

SACs are selected to protect habitats and species that are rare and threatened at a European scale. The EU Habitats Directive lists certain habitats (listed in Annex I) and species (listed in Annex II) that must be conserved by designating and appropriately managing SACs, including restoring them where necessary. There are 59 habitats listed in Annex I in Ireland, including raised bogs, blanket bogs, turloughs, sand dunes, limestone pavement, heaths, orchid-rich grassland, estuaries and reefs. Annex II species found in Ireland include salmon, otter, freshwater pearl mussel, Killarney fern and bottlenose dolphin. Habitats and species on these lists that are considered to be particularly endangered are called "priority" habitats and species. Each SAC is designated for one or more Annex I habitats and/or Annex II species; 439 SACs have been nominated for designation throughout the State, 153 of these sites have been formally designated by Statutory Instrument.

Annex I of the Habitats Directive contains four habitat types that are commonly associated with raised bogs:

- Active raised bogs (ARB);
- Degraded raised bogs (DRB) still capable of natural regeneration;
- Bog woodland; and
- Depressions on peat substrates of the *Rhynchosporion*.

In this context, "active" means that the conditions are right for continued peat formation (which, for example, may no longer be the case where bogs are drained). DRB still capable of natural regeneration are bogs where peat formation could be expected to recommence provided steps were taken to repair damage and manage the bogs, for example, by managing drainage. Raised bogs where active peat-forming conditions occur, are considered to be priority habitat types, which are in particular danger of disappearance within the European Union. Bog woodland is also a priority habitat type.

Raised bog SACs

Between 1997 and 2002, Ireland nominated a total of 53 raised bog sites for designation as SACs. The raised bog SACs contain most of the functioning remnants of the extensive raised bog complexes that once covered much of the midlands. What makes them so rare is that they still have substantial areas of active raised bog where the conditions are right for peat to continue to form and where the typical species of plants and animals can thrive.

Raised bog Natural Heritage Areas

Between 2003 and 2007, 75 raised bog Natural Heritage Areas (NHAs) were formally designated by Ireland under the Wildlife Acts. These sites were designated in part response to the infringement action brought against Ireland by the EU Commission relating to the application of the Environmental Impact Assessment Directive to the extraction of peat. The Wildlife Acts provide protection to NHAs through a requirement for certain potentially damaging activities to require Ministerial consent before being undertaken. Turf-cutting, drainage works and afforestation are typically listed as activities that require such consent.

The Need for a National Raised Bog Special Areas of Conservation Management Plan

The management of Ireland's designated raised bogs presents competing demands between certain land uses, particularly turf-cutting, and the legal obligation to conserve a habitat that is in danger of disappearance. Irish people are closely connected with raised bogs by a long history of cultural and economic development. Many of these raised bogs are in private ownership, although the State or State-owned companies such as Coillte and Bord na Móna own considerable areas.

This National Raised Bog Special Areas of Conservation Management Plan is part of the Government's strategic approach to the management of Ireland's peatlands. It also addresses concerns raised by the European Commission regarding the conservation and management of Ireland's designated raised bog network. Given the European and global significance of Ireland's raised bogs, and their current declining conservation status, it is necessary to ensure that the remaining best examples survive, if Ireland is to honour global environmental commitments it has entered into.

The European Commission is charged with responsibility for ensuring that Member States meet their agreed legal obligations. It has previously taken a close interest in Ireland's performance in managing raised bogs, and in the 1990s took action against Ireland for failure to prevent ongoing large-scale industrial exploitation of peatlands without being assessed under the Environmental Impact Assessment (EIA) Directive. This case was closed after Ireland designated areas as NHAs and altered relevant planning laws. The State also took steps to end commercial extraction on designated raised bogs. In 1999, a derogation for domestic turf-cutters was introduced, together with a voluntary bog purchase scheme. However, it was evident in the following years that domestic cutting was continuing at a level that was seriously impacting on the conservation status of Irish raised bogs.

In 2011, the Commission commenced infringement action against Ireland for alleged failures to adhere to the Habitats Directive (relating to the regulation of turf-extraction from its SACs) and the EIA Directive. Ireland formally replied to this Reasoned Opinion in 2011 and outlined the various measures taken to implement the Directives in Ireland, including the phasing out of turf-cutting on 53 raised bog SACs and the introduction of a compensation system for eligible turf-cutters.

Since 2011, significant efforts have been made by the State to resolve the issue of the protection of Ireland's raised bog SACs within the framework of the EU Habitats Directive. This has included intense and ongoing engagement with turf-cutting interests, the farming community, non-governmental organisations and with the European Commission. Decisions taken have included:

- Notwithstanding the severe economic circumstances in which Ireland found itself, the Government established a long-term financial compensation scheme for all turf-cutters within raised bog SACs who were obliged to cease cutting turf as well as a scheme to facilitate, where possible, the relocation of turf-cutting activity to non-SAC/NHA sites;
- Direct communication was made with all individuals known to have an interest in raised bog SAC sites, along with media notices, outlining that all turf-cutting had to cease on these sites;
- A system of surveillance, monitoring and enforcement for raised bog SACs was established to identify any unauthorised turf-cutting and to take enforcement action including prosecutions; and
- New regulations were put in place in September 2011 to allow for more effective sanctions against those engaged in unauthorised damage to SACs as part of a comprehensive updating of the regulations implementing the Birds and Habitats Directives in Ireland.

Other Government actions have included the establishment of the Peatlands Council and the publication of the National Peatlands Strategy.

Peatlands Council – In April 2011, the Government established an independently chaired Peatlands Council to ensure that stakeholders had an opportunity to engage with each other and with the relevant State authorities, including the then Department of Arts, Heritage and the Gaeltacht so that all parties could reach a shared understanding of the challenges involved and work together to address this complex issue. While the Turf Cutters and Contractors Association (TCCA) decided to withdraw from engagement with the Peatlands Council in September 2011, the Council has been central in finding acceptable and workable approaches to challenging issues and its members have been effective in representing their members' interests. The interests of turf-cutters and landowners have been represented by the Irish Farmers Association and Irish Rural Link, while environmental concerns have been represented by the Irish Environmental Network. Expertise on bog management and restoration has been provided by Bord na Móna, Coillte and the Irish Peatland Conservation Council. This expertise has been supplemented through the work of the Provision of Scientific Basis for Raised Bog Conservation in Ireland Steering Group[3].

Peatlands Strategy – In establishing the Peatlands Council, the Government asked if it could assist in drafting a National Peatlands Strategy. This National Raised Bog Special Areas of Conservation Management Plan is being produced as one element of the implementation of the Peatlands Strategy, which aims to provide a long-term framework within which all peatlands within the State can be managed responsibly in order to optimise their social, environmental and economic contribution to the well-being of this and future generations. The strategy dispels fears that the Government wishes to end turf-cutting in Ireland, while making clear that Ireland's peatlands need to be managed in a balanced way. The National Peatlands Strategy 2015 is available on the National Parks and Wildlife Service (NPWS) website http://www.npws.ie.

2012 Peatlands Forum In February 2012, at the instigation of the Chair of the Peatlands Council, a Peatlands Forum was convened, chaired by a High Court Judge, Mr Justice John Quirke. The forum heard proposals from turf-cutting communities on each of the raised bog SACs to find solutions for their particular circumstances. Most proposed relocation to alternative bogs. Some proposed co-existence, where limited cutting would continue within the SAC sites. A small number proposed complete habitat replacement, where cutting would continue and compensatory habitat would be provided.

In his report following the 2012 Peatlands Forum (Quirke, 2012), Justice Quirke recommended that a national plan for raised bog SACs habitats be drawn up to ensure a holistic approach to the management of Ireland's raised bog SACs network. The Government accepted this recommendation at its meeting on 6 March 2012 and the draft (for consultation) National Raised Bog Special Areas of Conservation Management Plan was published in January 2014. This National Raised Bog Special Areas of Conservation Management Plan 2017–2022 is the final step in the process, starting with Justice Quirke's recommendation and a resolution from Dáil Éireann.

Raised bog NHAs review

Subsequently, in 2014, a comprehensive review of raised bog NHAs and undesignated raised bogs of conservation value has informed a radical reconfiguration of our network of NHAs. This new NHA network will provide for significantly improved conservation outcomes while avoiding areas that are subject to significant turf-cutting. It will markedly reduce costs for the taxpayer in terms of the provision of compensation arising from the cessation of turf-cutting. A number of State-owned bogs will be included in the NHA network. Other sites of conservation value where there is little or no turf-cutting pressure will also be included. It is anticipated that 46 sites (39 in full and 7 partially) that are current raised bog NHAs will be de-designated. The Wildlife (Amendment) Bill 2016 to give effect to the de-designation has been initiated in Dáil Éireann and published. Once these sites are de-designated, it will provide scope for additional relocation sites. The proposed new network will consist of 61 NHA sites. Site-specific management plans, which will primarily relate to the restoration of each site, will also be developed for each NHA site being retained in the reconfigured NHA network.

Aims of this Plan

The plan has two broad aims:

1. The conservation and management of a designated network of raised bogs

The plan aims to provide clarity to all parties regarding how Ireland's network of raised bog SACs will be managed, conserved and restored into the future, in co-operation with landowners, turf-cutters and local communities, and in keeping with legal obligations under the EU Habitats Directive. The plan sets national restoration targets for raised bog habitats that require the restoration of the national network of raised bog SACs and NHAs.

3. The Steering Group was comprised of representatives of the then Department of Arts, Heritage and the Gaeltacht, the Irish Farmers Association, An Taisce, Irish Peatland Conservation Council, the Peatlands Council, Bord na Móna, Trinity College Dublin, University College Dublin and RPS.

2. Addressing the needs of turf-cutters, landowners and land users

The plan also sets out how the concerns of those who use these raised bogs, including turf-cutters and landowners, will be addressed. This includes the provision of a compensation and relocation scheme for turf-cutters, and in a small number of cases, where no alternatives exist, investigating potential for continued turf-cutting within SAC sites in line with the requirements of the EU Habitats Directive. The plan outlines the many benefits of the raised bog designated network and explores how local communities can become involved in the management and conservation of raised bogs.

The Core Objectives of the National Raised Bog Special Areas of Conservation Management Plan are:

1. To understand and describe the conservation status and the ecological and hydrological conditions of our raised bogs;
2. To put in place a raised bog national designated network that will be sustainable into the future;
3. To develop mechanisms to restore and rehabilitate protected habitats within the network of designated raised bogs;
4. To manage protected raised bogs in a manner compatible with their uses and the concerns of stakeholders whilst maintaining their biodiversity and natural function; and
5. To raise awareness and understanding of the benefits and values of raised bogs and encourage community involvement to inform future decisions.

Guiding Principles for this Plan

This plan is informed by the principles laid down in relevant national policies, in particular the National Peatlands Strategy (NPWS, 2015) and the National Biodiversity Plan 2017–2021(NPWS, 2017), international conventions such as the Convention on Biological Diversity, the Ramsar Convention, the requirements to protect the raised bog SACs for future generations and in keeping with legal obligations and commitments.

The plan will be reviewed and updated in three six-year cycles; this will ensure that any necessary amendments are made as matters progress. This plan concerns the first cycle from 2017 until 2022 and utilises the best available scientific knowledge at the time of publication. It will be subject to a mid-term review that will include an update on information available from peer-reviewed publications.

Relevant European Policies and International Conventions

EU BIODIVERSITY POLICY

In March 2010, EU leaders recognised that the 2010 biodiversity target would not be met despite some major successes, such as establishing Natura 2000, the world's largest network of protected areas. They therefore endorsed the long-term vision and ambitious headline target proposed by the Commission in its Communication "Options for an EU vision and target for biodiversity beyond 2010" (EC, 2010).

2050 EU VISION

The EU long-term vision is that *"by 2050, European Union biodiversity and the ecosystem services it provides – its natural capital – are protected, valued and appropriately restored for biodiversity's intrinsic value and for their essential contribution to human well-being and economic prosperity, and so that catastrophic changes caused by the loss of biodiversity are avoided"* (EC, 2011).

2020 HEADLINE TARGET

The EU published its headline target for progress by 2020 as *"to halt the loss of biodiversity and the degradation of ecosystem services in the EU by 2020, restore them in so far as feasible, while stepping up the EU contribution to averting global biodiversity loss"* (EC, 2011).

UN CONVENTION ON BIOLOGICAL DIVERSITY

The tenth Conference of the Parties to the Convention on Biological Diversity, held in Nagoya in 2010, led to the adoption of a global strategic plan for biodiversity 2011–2020, and a strategy to mobilise resources for global biodiversity. The EU 2020 biodiversity strategy responds to both mandates, setting the EU on the right track to meet its own biodiversity objectives and its global commitments. As a contracting party to the Convention, Ireland is committed to measures to conserve its biodiversity including conservation of ecosystems, habitats and species in their natural surroundings. Ireland sets out how this is to be achieved in Ireland's National Biodiversity Plan 2017–2021 (NPWS, 2017).

GREEN INFRASTRUCTURE ENHANCING EUROPE'S NATURAL CAPITAL

Green Infrastructure is based on the principle that protecting and enhancing nature and natural processes, and the many benefits human society gets from nature, are consciously integrated into spatial planning and territorial development. The European Commission has identified that Green Infrastructure can contribute significantly to achieving many of the EU's key policy objectives.

RAMSAR CONVENTION

The Convention on Wetlands of International Importance (Ramsar Convention) is the intergovernmental treaty that provides the framework for the conservation and wise use of wetlands and their resources. The Convention was adopted in the Iranian city of Ramsar in 1971 and came into force in 1975. Since then, almost 90% of UN Member States, from all the world's geographic regions, have acceded to become "Contracting Parties"[4].

UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE

In 1992, countries joined an international treaty, the United Nations Framework Convention on Climate Change, as a framework for international co-operation to combat climate change. The Kyoto Protocol (1997) legally binds developed country Parties to emission reduction targets. The Protocol's first commitment period started in 2008 and ended in 2012. The second commitment period began on 1 January 2013 and will end in 2020[5].

In December 2015, all 196 Parties to the United Nations Framework Convention on Climate Change agreed a new legally binding, global agreement on climate change. Ireland's Climate Action and Low Carbon Development Act 2015 puts in place the necessary National Frameworks to ensure Ireland can plan for, and take the necessary action on both adaptation and mitigation within the context of the global efforts now underway towards achieving a shared goal.

Public consultation

In 2013, the then Department of Arts, Heritage and the Gaeltacht engaged a team of external scientific contractors, led by RPS[6], to undertake the scientific analysis required to underpin the aims of the National Raised Bog Special Areas of Conservation Management Plan.

A draft plan was published in January 2014 alongside the draft National Peatlands Strategy and the Review of Raised Bog Natural Heritage Area Network. This was followed by a period of public consultation from January 2014 to April 2014, during which over 1,500 responses were received. Most of the responses to the consultation process can be separated into two distinct groups. A large number of responses were from individuals and groups of turf-cutters who wish to continue domestic turf-cutting within designated raised bogs as well as private landowners with concerns that restoration of raised bogs would have adverse impacts on their land. In contrast, a substantial number of submissions were from individuals and groups with concerns over the damage that has occurred to raised bog habitat and who were seeking greater effort to protect the relatively small remaining area of raised bog habitat. Numerous meetings and discussions have also taken place with stakeholders since the consultation period ended.

This plan has been developed to take account of these various viewpoints and it offers a way forward by outlining how a representative network of raised bogs will be conserved and managed.

Strategic Environmental Assessment and Appropriate Assessment of this plan

Strategic Environmental Assessment (SEA) and Appropriate Assessment (AA) are processes by which environmental considerations are integrated into the preparation of plans and programmes prior to their completion. The objectives of the processes are to provide for a high level of protection of the environment and to promote sustainable development by contributing to the integration of environmental considerations into the preparation and adoption of specified plans and programmes, as well as to inform or form the basis of decisions as whether to proceed with a plan, in light of its implications for the environment. In recognition of the potential for actions within the National Raised Bog Special Areas of Conservation Management Plan to impact on raised bogs and other habitats and species, which may also be protected under the Habitats Directive, an AA of the National Raised Bog Special Areas of Conservation Management Plan was carried out in parallel to the SEA process. This AA and the SEA Statement will be available on the website of the NPWS of the Department of Culture, Heritage and the Gaeltacht at: https://www.npws.ie.

4. www.ramsar.org
5. http://unfccc.int/
6. A planning, design, engineering, environmental, and communications services company

Chapter 2

The Status of Ireland's Raised Bog Network

Chapter 2
The Status of Ireland's Raised Bog Network

What is a Raised Bog?

Raised bogs are wetland ecosystems formed by accumulations of deep peat that originated in shallow lake basins or topographic depressions at the end of the last glaciation, 10,000 years ago. The waterlogging that occurs in these areas provides suitable conditions for peat formation. Peat is an accumulation of partially decayed vegetation that forms in wetland conditions, where waterlogging obstructs contact with oxygen from the atmosphere, slowing rates of plant decomposition. Peat soils are mainly formed of water, organic matter (plants) and small amounts of mineral material. On undamaged Irish peat bogs, bog mosses (*Sphagnum* species) dominate the vegetation and are the most important contributors to peat formation.

According to Schouten (2002) the volume of water in undisturbed peat varies in the range of 88% to 97%. As organic material survives in the anaerobic conditions of peat bogs, material such as wood, textile, fruit and seeds, even human skin, tissue and hair survives in pristine condition in its waterlogged context. The name raised bog is derived from the elevated surface that develops as raised bogs grow upwards creating a slight dome-shaped surface above that of its surrounding, illustrated in Plate 2.1. This *high* bog is primarily rainwater fed and is generally considered to be isolated from the local groundwater table.

The surface of a relatively intact raised bog is typically wet, acidic and deficient in plant nutrients (as bogs receive most nutrients through rainfall), and supports specialised plant communities that are not generally found in other ecosystems. As mentioned above, one of the most abundant plant components is *Sphagnum* moss, although many other species can contribute. Grasses and sedges are abundant in damp places while small shrubs in the heather family grow in drier areas. More detailed descriptions of raised bog vegetation are given further on in this chapter.

ARB, as illustrated in Plates 2.2 and 2.3, is characterised by the presence of a top (10–30cm) vegetation layer or acrotelm, which is defined as the living, actively growing (growth rate of approximately 1–3cm per year) upper layer of a raised bog, the surface of which is composed mainly of living bog mosses (*Sphagnum* species). The presence of the acrotelm is vital to a raised bog as this is the peat-forming layer and it strongly influences the rate of water run-off from the bog. Below the living acrotelm lies the catotelm which comprises layer after layer of dead vegetation in waterlogged conditions which over a very long period of time forms brown peat. The catotelm can grow at a rate of 1mm per year and can be over 10m deep in Irish bogs. As successive increments of dead vegetation build up, the peat layers at the bottom turn black.

Intact raised bogs are surrounded by other wetland habitats such as swamps, fens and wet woodlands. These peripheral habitats form a transition between the peat and adjacent mineral soils and are known as lagg zones. Such zones are now very rare in Ireland.

Plate 2.1: Sheheree Raised Bog SAC, Co. Kerry

Ireland's raised bogs occur principally on land below an altitude of 130m. They are classified into two different sub-types depending on the amount of rainfall (Hammond, 1984). The geographic boundary between the two is taken as the approximate position of the 1,000mm isohyet (a line on a map connecting areas of equal rainfall). To the east of this line there are the 'True Midland raised bogs' and to the west of it the 'Western' or 'Intermediate raised bogs' prevail. The latter were considered by Hammond to be transitional between the Midland raised bogs and blanket bogs which generally occur above the 1,250mm rainfall limit, and which are widespread in the western seaboard.

Raised bogs were part of extensive wetland complexes that developed over much of the central lowlands of Ireland, most notably the Shannon River Basin, where the limestone plain is covered by a variable thickness of undulating glacial drift. This provided suitable basins for the development of lakes and/or fens (precursor to bogs). Today, the surviving bogs are found mainly in the lowlands of central and mid-west Ireland (see Figure 2.2).

Plates 2.2 and 2.3: Examples of Irish active raised bog – highest quality vegetation

National raised bog resource

According to the most recent Conservation Status Assessment Report (Fernandez *et al*., 2014) only 50,000 ha of "intact" high bog remain in the country out of an original figure of 310,000 ha estimated by Hammond (1981) (see Figure 2.1). There are an estimated 17,995 ha of high bog and a minimum of 9,100 ha of cutover bog within the designated (SACs and NHAs) raised bog network of which only 1,639 ha can be classified as ARB. Both SACs and NHAs also contain cutover areas, which would have been part of the 310,000 ha of raised bog originally reported by Hammond (1981). This means that in total there is a minimum of 27,100 ha of high bog and cutover bog in protected sites, which represents approximately 9% of the original raised bog resource.

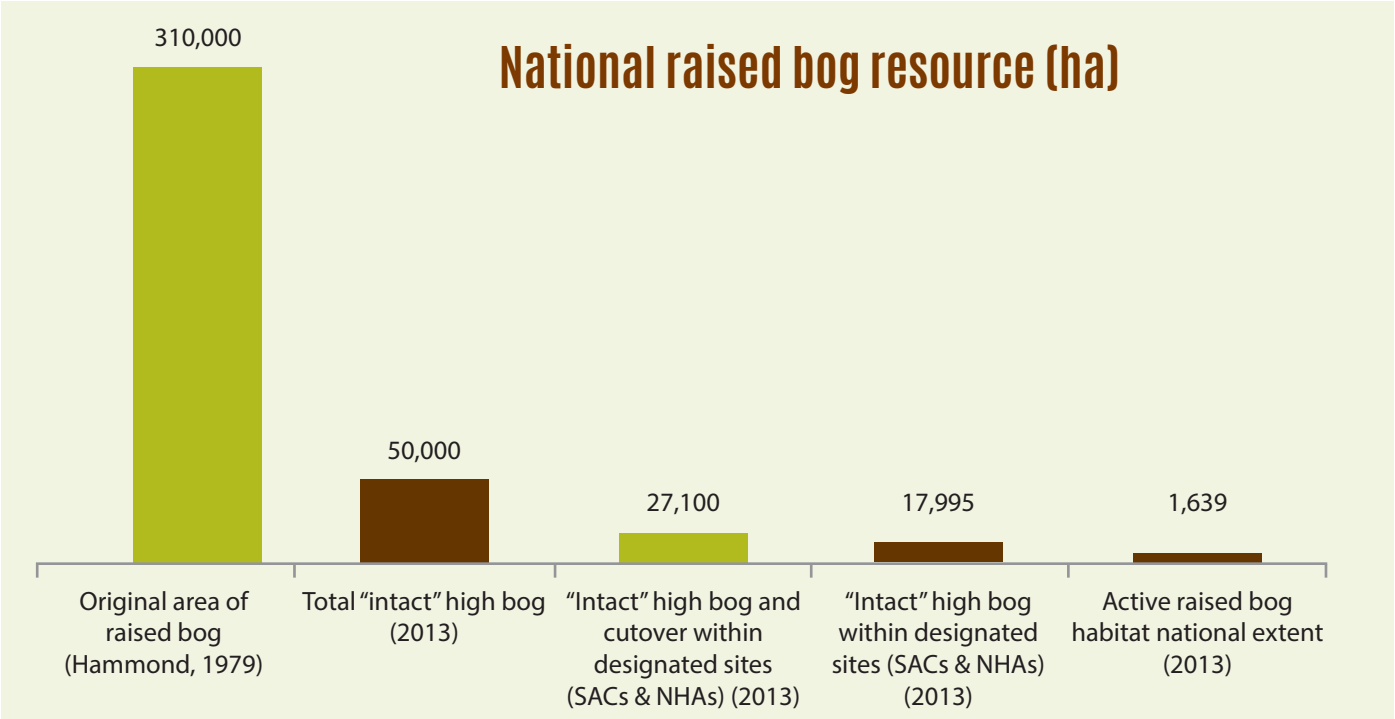


Figure 2.1: National raised bog resource

Industrial peat harvesting resulted in very rapid losses of high bog since the middle of the 20th century. Bord na Móna owns approximately 80,000 ha of peatlands and a large proportion of these have been utilised for industrial peat harvesting. However, significant peatland areas were not fully drained and developed for peat harvesting and in recent years, Bord na Móna has invested in a Raised Bog Restoration Programme on many of these bogs. Several other companies have also harvested peat commercially on raised bogs in Ireland, although on a much smaller scale than Bord na Móna. In total, it is estimated that approximately 100,000 ha of raised bog in Ireland has been subject to industrial harvesting. Therefore, since only 50,000 ha of the original 310,000 ha resource remain, this means that approximately 160,000 ha of raised bog have been extracted, predominantly through hand cutting, over the past number of centuries.

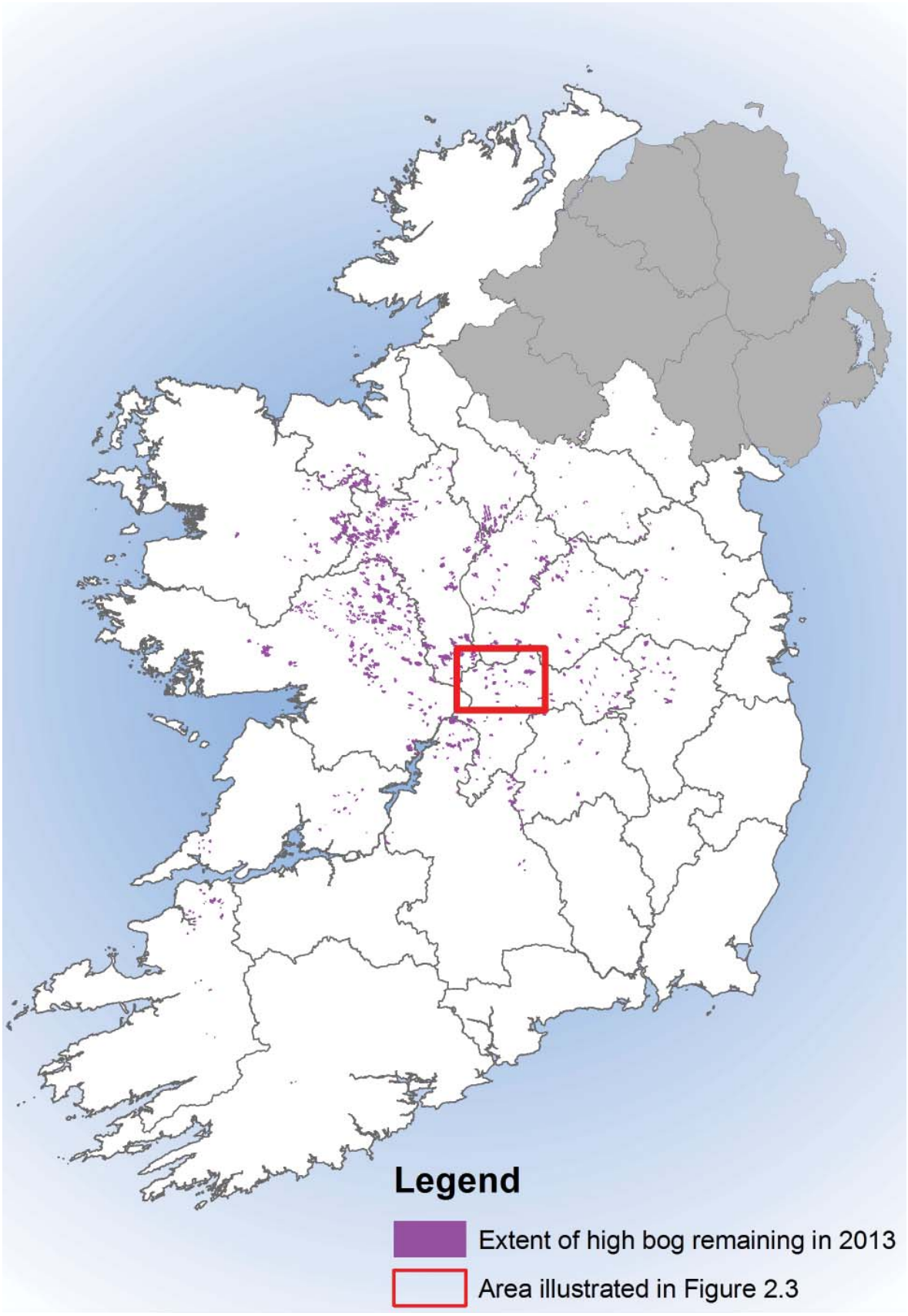


Figure 2.2: Map outlining the extent of uncut raised bog remaining in the Republic of Ireland

Large bog complexes extending over thousands of hectares were once common in the Irish midlands. Many of these former bogs have largely been (or are currently being) industrially harvested or cut away for domestic use. Figure 2.3 illustrates the extent and distribution of designated sites (blue and green areas) in part of the midlands compared to the extent and distribution of raised bog, which is now largely cutaway and devoid of vegetation (red areas). Clara Bog SAC, Co. Offaly in the middle is the largest intact area of raised bog remaining in the midlands with 440 ha of high bog. Its original extent was around 990 ha.

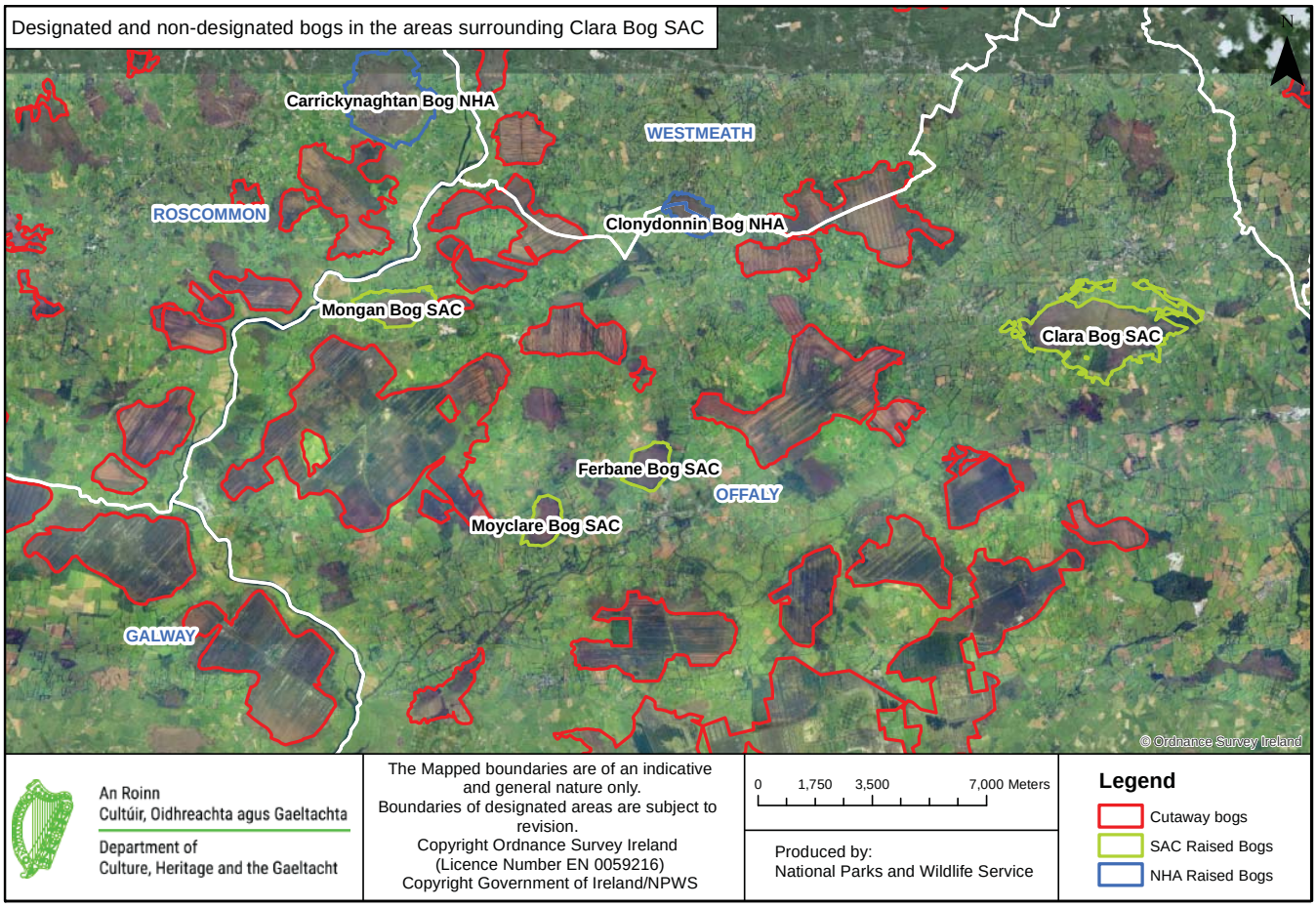


Figure 2.3: Designated and non-designated bogs in the areas surrounding Clara Bog SAC, Co. Offaly

Describing raised bog habitat in more detail

A system for mapping and describing high bog vegetation communities is now well established in Ireland. "Ecotope classification" involves grouping plant community complexes into ecotopes, which are distinguished by different physical characteristics. See Fernandez *et al.* (2014) for further details.

The main ecotopes are:

- Central ecotope
- Sub-central ecotope
- Active flushes and soaks
- Sub-marginal ecotope
- Marginal ecotope
- Inactive flushes
- Facebank ecotope.

Actively accumulating peat conditions (forming ARB) occur within the sub-central and central ecotopes. Central ecotope areas are typically the wettest on the bog and an indication of good quality active raised bog. 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. As mentioned in Chapter 1, ARB is a priority habitat listed in Annex I of the Habitats Directive.

The adjacent surrounding marginal, sub-marginal, and facebank bog areas typically have a vital supporting function for the central and sub-central communities, but are not peat-accumulating. Some of these areas will have the potential to be restored 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.

Repeat ecotope mapping over time allows even small changes in habitat quality to be measured. The details of monitoring surveys undertaken of protected sites are outlined in the next section.

Unlike ARB, which can be accurately mapped using the ecotope survey methodologies described above, bog that is currently not peat-forming but has the potential to be restored (known as degraded raised bog or DRB) is more difficult to map as, by definition, it includes only those areas that can be restored within a period of 30 years following implementation of restoration measures. (Note, as stated in Chapter 1, this habitat is listed in Annex I of the Habitats Directive.) In order to quantify such areas of DRB, a methodology has been developed to identify areas on a raised bog where suitable hydrological conditions exist for ARB to be restored.

This methodology makes use of detailed topographic data for each raised bog obtained from LiDAR (Light Detection and Ranging) surveys to assess the potential for the bog surface to support ARB. LiDAR is a remote sensing technology that measures vertical surface elevation by illuminating a target with a laser and analysing the reflected light. The data are collected in the field using a low-flying aeroplane. This gives much more detailed and accurate raised bog topographical maps than can be collected by traditional surveying techniques.

The use of the LiDAR data has supported a programme of scientific research which has greatly improved the knowledge of the eco-hydrological (interaction between water and ecosystems) behaviour of raised bogs in Ireland. By using the detailed topographic survey data, it is now possible to model eco-hydrological conditions (based on the raised bog's slope, drainage patterns and rainfall) and relate these conditions to recent ecological surveys. In this way, it is possible to determine the area of each bog that has suitable conditions for the development or occurrence of ARB. This eco-hydrological modelling process can therefore quantify each raised bog's restoration potential and these areas can be considered DRB. A detailed description of the eco-hydrological modelling techniques is presented in Appendix 2.

As the model utilises topographic data as a means for assessing hydrological conditions, it can in some cases over-predict the potential for ARB restoration where vertical losses of water are elevated. In order to address this issue and ensure that realistic conservation objective targets are set, the efficacy of restoration measures has been assessed for each raised bog. For example, where there is an obvious reason for the absence of ARB in an area where the model predicts it should occur, such as the presence of functional drains, it is assumed that restoration by drain blocking will be highly effective in restoring ARB (high efficacy). In contrast, where such obvious reasons for the absence of ARB are not apparent, it is assumed that restoration will be relatively ineffective and the restoration potential predicted by the model is reduced (low efficacy) hence this area is not considered as Annex 1 habitat DRB.

Assessing the Conservation Condition of Individual Raised Bogs

The first series of ecotope surveys in Ireland was carried out between 1992 and 1995 (Kelly (1993) and Kelly *et al.* (1995)). This series of surveys included complete or partial surveys of 45 raised bogs within 40 SACs. In 1999 and 2000 a further series of ecotope surveys was carried out, which included complete or partial surveys of 14 raised bogs within 11 SACs (Derwin and MacGowan, 2000). Subsequent ecotope surveys were carried out between 2003 and 2005 (reported in Fernandez *et al.* (2005) and Fernandez *et al.* (2006)), including repeat surveys of many of the bogs surveyed between 1992 and 1995. One raised bog SAC (Clara Bog, Co. Offaly) had an ecotope survey completed in 2009. The latest series of ecotope surveys was carried out between 2011 and 2013 (Fernandez *et al.*, 2014) comprising surveys of 44 bogs within 37 SACs and one NHA.

Since the ecotope mapping process was first developed, there have been some amendments and improvements to increase accuracy and ensure consistency between surveys. Current methodologies make use of highly accurate GPS devices with sub-metre accuracy. Therefore, it is known that there are some minor discrepancies between surveys carried out at different periods. However, to ensure an accurate comparison, the reporting process includes a comprehensive review of vegetation descriptions and survey records from previous surveys to determine whether a real change in habitat extent and/or quality has occurred or if changes are due to more accurate mapping.

By carrying out a comprehensive review of past survey data, a more accurate estimate of the area and condition of raised bog, since the Habitats Directive came into effect, has been possible.

Conservation Status of Annex I Raised Bog Habitats

Every six years, Member States of the European Union are required to report on the conservation status of all habitats and species listed in the annexes of the Habitats Directive. In June 2013, Ireland submitted the second assessment of conservation status for 58 habitats and 61 species (NPWS, 2013). This included an assessment of the conservation status of the Annex I habitats ARB and DRB (both within and outside the designated network). The results of monitoring surveys described above were used to undertake the assessment. The report details that both ARB and DRB are considered to be in "unfavourable bad" conservation status in Ireland. The main pressures were identified as peat extraction, drainage, lowering of groundwater levels, artificial planting of non-native trees and fires.

The **national conservation status of active raised bog habitat** has been assessed, by the then Department of Arts, Heritage and the Gaeltacht in its six-yearly Article 17 reporting to the European Commission under the Habitats Directive, as ***"Unfavourable Bad-Declining",*** which is the worst possible rating under the reporting system. Fernandez *et al.* (2005) estimated a 25–36.7% decrease in the area of active raised bog for 48 Irish raised bog assessed in the 1994/95–2004/05 reporting period. The most recent raised bog monitoring report (Fernandez *et al.*, 2014) outlined that despite ongoing restoration efforts over the last two decades, approximately 13 ha (1.61%) of ARB has been lost between the 2004/05 and 2011/13 reporting period within the 44 raised bogs assessed.

Loss of Raised Bog Area

Area is a key metric when assessing the status of Ireland's raised bog network. The changes in area of ARB and DRB, and the total area of high bog within Ireland's network, are assessed to determine the trends in the network's status.

Active raised bog area

The area of ARB habitat within Ireland's 53 SACs, estimated from ecological surveys, was 1,940 ha in 1994 (the year in which the Habitats Directive came into effect). This decreased to 1,210 ha in 2012/13, which is a loss of 730 ha. **This represents an approximate loss of 37% of the SACs ARB habitat from 1994 to 2012/13.**

In addition, the area of ARB within the original network of 75 NHAs, estimated from available ecological surveys and extrapolated to establish the national picture, was 490 ha in 1994, decreasing to 284 ha in 2012/13, a loss of 206 ha. This represents an approximate loss of 42% of the NHA ARB habitat over that period.

Furthermore, the area of ARB within non-designated bogs of potential conservation value, again estimated from available ecological surveys and extrapolated to establish the national picture, was 200 ha in 1994, decreasing to 145 ha in 2012/13, which is a loss of 55 ha. This represents an approximate loss of 28% over that period.

Nationally this demonstrates a significant loss (circa 1,000 ha) of active raised bog habitat which was 2,630 ha in 1994 and 1,639 ha in 2012/13.

Degraded raised bog area

In the absence of reliable survey information, the current area of DRB was determined by using the previously described eco-hydrological model to identify areas with potential for restoration of ARB. The current area of DRB within Ireland's 53 SACs is 1,114 ha, with 440 ha in the original network of 75 NHAs. In order to hind-cast the area of DRB that would have been present in 1994, ortho-rectified aerial photographs from a range of time periods were used to identify high bog boundaries; a marginal buffer was applied to delineate outer boundaries of DRB; and finally, the known historical area of ARB was deducted to calculate the area of DRB. Using this approach, it has been estimated that there was 650 ha of DRB within Ireland's 53 SACs and 520 ha of DRB within the original network of 75 NHAs in 1994.

Whilst the statistics demonstrate a gain in DRB area within the SACs (Table 2.1), it must be noted that this represents significant deterioration in status as it occurred at the expense of ARB. The aim, at the time of selecting bogs for SAC designation, was to restore DRB areas to ARB, thus the target for the former was a reduction as opposed to the net gain now observed.

Total area of high bog in designated raised bog network

The changes to the area of high bog since the mid-1990s were calculated using ortho-rectified aerial photographs for a range of time periods. In addition, Digital Terrain Models derived from high resolution LiDAR data collected in 2012 were used to improve the accuracy of high bog boundaries. This data enabled them to be accurately digitised and entered into a GIS (geographical information system) from which differences in area could be evaluated.

The area of high bog within Ireland's 53 SACs, was 10,740 ha in 1994, decreasing to 10,515 ha in 2012/13, a loss of 225 ha. This represents an approximate loss of 2% of the SACs high bog area over that period.

In addition, the area of high bog within Ireland's 75 NHAs, was 7,790 ha in 1994, decreasing to 7,480 ha in 2012/13, which is a loss of 310 ha. This represents an approximate loss of 4% of the NHA high bog habitat from the period 1994 to 2012/13. This is almost twice the rate of loss within the SACs bogs over the same period.

Summary of Raised Bog Area Trends

There has been an overall decline in ARB and high bog area within the raised bog network in Ireland. A significantly greater loss in the area of ARB has occurred relative to losses in high bog. The following sections outline the main threats to raised bog habitats.

Table 2.1: Summary of raised bog area in Ireland

Bog Habitat	Resource	1994[7] (ha)	2012/13[8] (ha)	Change (ha)
Active Raised Bog	Current SACs network	1,940	1,210	-730
	Current NHAs network	490	284	-206
	Non-designated sites	200	145	-55
	National Network	**2,630**	**1,639**	**-991**
Degraded Raised Bog	Current SACs network	650	1,114	+464
	Current NHAs network	520	440	-80
	Non-designated sites	625	570	-55
	National Network	**1,795**	**2,124**	**+329**
High Bog	Current SACs network	10,740	10,515	-225
	Current NHAs network	7,790	7,480	-310

What are the Main Threats to Irish Raised Bogs?

Article 2 of the Convention on Biological Diversity[9] defines ecosystems as "a dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit". It is important, therefore, to understand that threats to the survival of an ecosystem are related not only to impacts on the living organisms but also to impacts on the non-living environment that supports them. As raised bogs are wetland ecosystems, the main threats to their conservation arise from any actions that drain water and cause them to dry out. In the case of ARB, mean water levels need to be near or above the bog surface for most of the year in order for it to survive. The main threats to Ireland's raised bogs include:

- Drainage of raised bog habitat or surrounding wetland habitats (e.g. for reclamation of cutover bog for agriculture);
- Peat harvesting and turf-cutting;
- Planting of commercial forestry;
- Burning; and
- Other activities such as water abstraction from groundwater, which can have a significant impact on raised bogs by lowering the regional groundwater level.

The above activities can compromise the hydrological integrity of a raised bog, leading to the lowering of the water table, which in turn can cause cracking, deformation, collapse or bursts. Such actions can result in peat being exposed to air as water levels drop and dead plants in the peat start to decompose, thus releasing carbon dioxide and other gases into the atmosphere. These changes to the raised bog structure also result in the loss of the unique raised bog ecology.

Understanding how drainage affects raised bogs

Tackling raised bog ecosystem degradation requires an understanding of the root causes of changes in a bog's hydrological regime. Introducing drains on the high bog not only results in water being rapidly transported off the bog surface, but also can result in increased topographic gradients as the peat compresses due to a lowering of the water table. In areas where topographic gradients are increased, water flows away much more rapidly, resulting in unsuitable hydrological conditions for ARB to be maintained. Research has demonstrated that continued turf-cutting at the periphery of the high bog will, in almost all cases, have a disproportionate impact on the remaining ARB and DRB, as illustrated in Figure 2.4.

Drains at the bog margins can also have significant impacts. Raised bogs develop by infilling waterlogged basins, leading to a hydrological equilibrium with surrounding inorganic deposits (Figure 2.5A). High water levels (heads) in the peat, and lower levels in the inorganic deposits underlying the bog (substrate), result in natural downward seepage of bog water. Vertical seepage is proportional to the difference in water level between both units and is influenced by the permeability of the substrate. Small differences in water level and/or a low permeability substrate usually mean that this loss is small.

7. Year by which EU Member States had to comply with the provisions of the Habitats Directive
8. Period of most recent monitoring and modelling assessments
9. www.cbd.int/convention/articles/default.shtml?a=cbd-02

Cutting and draining peat around bog margins disturbs the natural hydrological equilibrium. The degree of disturbance depends both on the permeability (K) of substrate materials and how deep marginal drains have been cut. Marginal drains that do not cut close to the peat base have limited impact on water levels in the deposits underlying the bog but do result in a decline in the water levels within the peat itself (Figure 2.5B). This results in peat subsidence that can extend into the bog for several hundred metres. Impacts to the bog ecosystem decrease with distance from the marginal drains and the distance that impacts will extend depends on peat properties and drainage depth.

By contrast, where drains cut close to, or through the peat substrate, water levels in the inorganic deposits underlying the peat can decline substantially, depending on the properties of the underlying inorganic substrate, resulting in significant increases in vertical water loss through the peat to underlying inorganic deposits (Figure 2.5C). This can cause ecological impacts over a wide area, even at significant distances from the drains. Substrate permeability (K) determines the degree of water loss and the extent of ecological damage, with impacts being greater with more permeable materials (for example, if the low permeability substrate layer in Figure 2.5C was missing then the rate of vertical seepage through the more permeable substrate material will be higher and a greater reduction in ARB is likely to result). In situations where substrate conditions are irregular (for example, an impermeable substrate layer is not continuous below the peat mass), restricted intense seepage may occur and subsidence can result. Hollows that form in response to such subsidence can give rise to localised patches of ARB in the lower lying hollows that intersect the water table. All the above scenarios are seen in raised bogs throughout Ireland.

An overview of the impact of subsidence caused by drainage is outlined by van der Schaaf (2002a), who demonstrated that turf-cutting can have an impact extending far into the bog. As the drains lower the water table in the peat, which, when undisturbed, is typically 95% water, it compresses under its own weight causing the bog surface to deform. Greater deformation occurs closest to areas where the water table has dropped. This then increases the slope of the bog's surface, causing rain falling on it to flow off more rapidly. The effect is normally greatest around the margins and in a typical situation, surface wetness increases towards the centre of the bog.

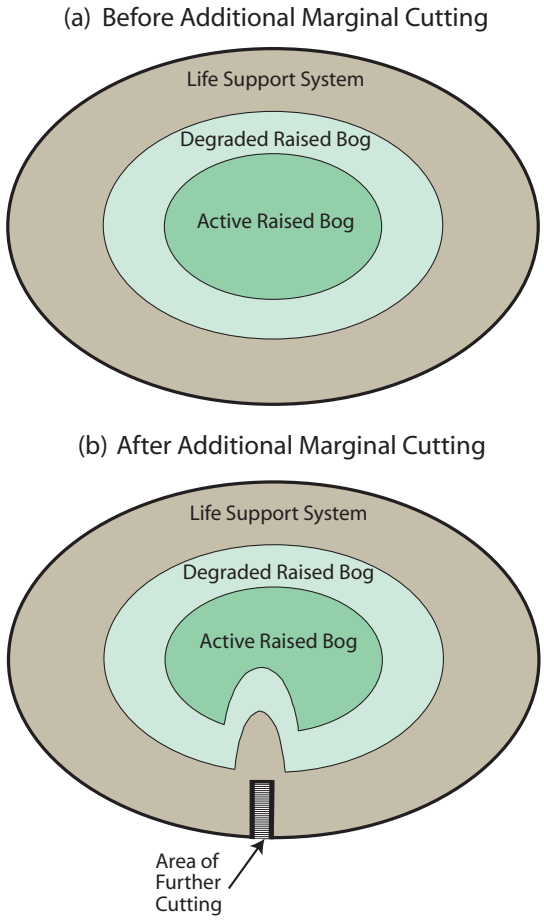


Figure 2.4: Schematic illustrating the disproportionate impact cutting of the "life support" system can have on active and degraded raised bog habitat

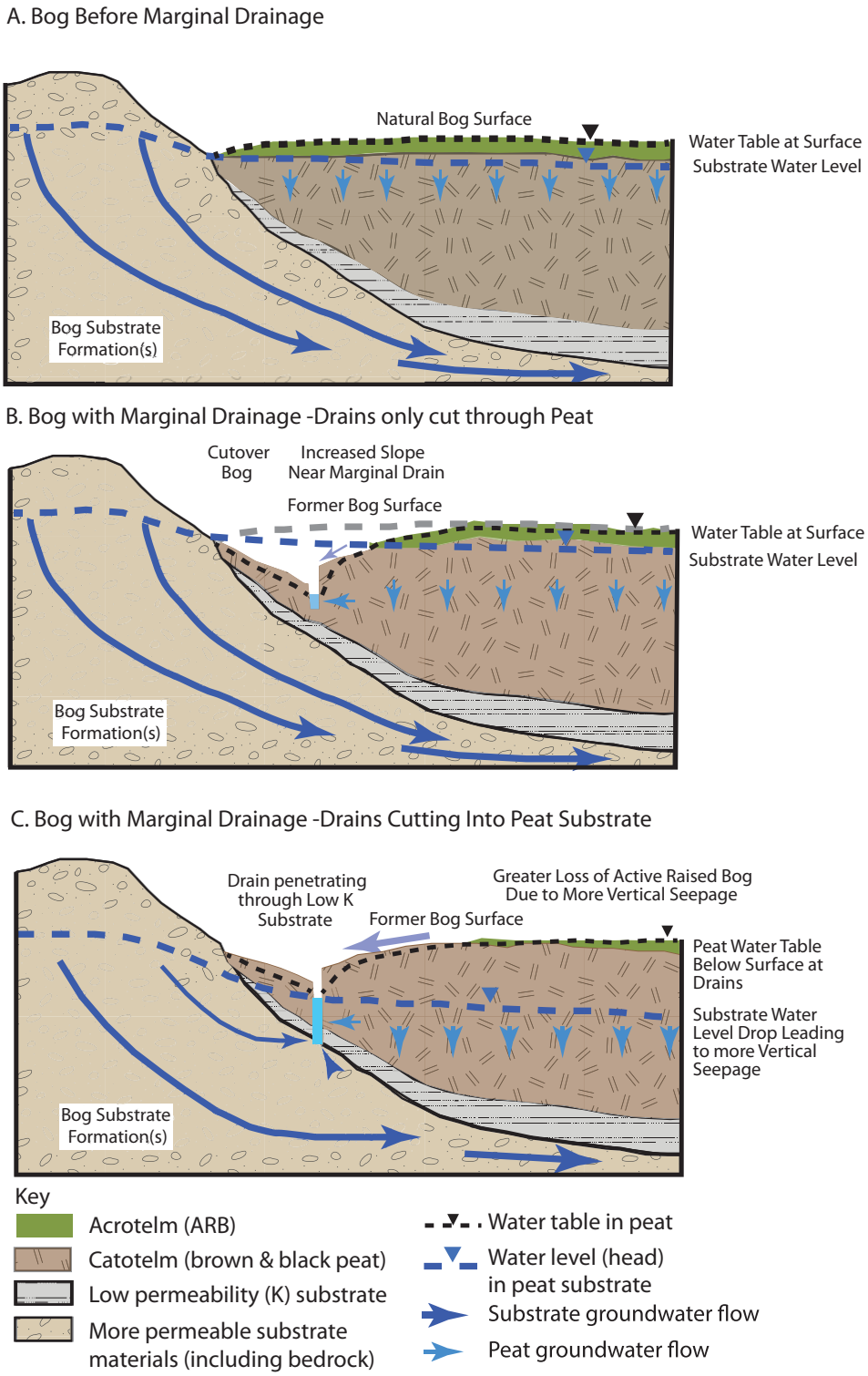


Figure 2.5: Schematic illustration of the impact of marginal drainage on raised bog eco-hydrology for a raised bog with a low permeability substrate, e.g. Lacustrine Clay

Figure 2.5 shows: (A) Intact raised bog where the bog's water table remains within 10cm of the surface throughout the year. A slightly lower water level in the substrate material(s) leads to limited vertical seepage. (B) Shallow marginal drainage leads to a decline in the bog's water table approaching the margins and die back of active raised bog extending into the bog. The low permeability substrate prevents significant changes to the water level in underlying more permeable deposits. (C) Deep marginal drainage cuts through the fine grained substrate into more permeable materials allowing upwelling of regional groundwater. Downward seepage below the bog increases leading to greater die back of active raised bog but vertical losses are limited by the low permeability substrate.

Forestry

Planting of forestry on a raised bog can significantly lower the water table in the peat through increased rates of evapotranspiration and interception. In addition, significant drainage is typically carried out prior to the planting of many forests in order to ensure dry enough conditions for trees to become established. In many cases, fertilisers are applied when establishing forestry, which can have further impacts on ecological conditions not only within the area that has been planted but in downstream areas that may receive additional nutrient inputs. Very often water levels are so low that the upper layers of peat are permanently exposed to air leading to ongoing decomposition and releases of carbon.

Invasive species

Non-native invasive species can lower the water table in a manner similar to forestry. Similarly, other associated impacting activities allow these species to gain a foothold in the drier habitat conditions.

Burning

The burning of raised bogs can have a significant detrimental impact through direct loss of vegetation cover, including on many of the extremely sensitive species associated with active raised bog. Loss of vegetation cover leads to more rapid losses of water through overland flow, causing more significant fluctuations in water levels within the peat and the release of carbon into aquatic systems. In some cases, burning may lead to temporary loss of active raised bog that will recover through time. However, depending on the frequency and intensity of burning, permanent losses of active raised bog can occur.

Abstraction

Other activities such as water abstraction from groundwater can have a significant impact on raised bogs by lowering the regional groundwater level. This includes quarrying, where de-watering is carried out to facilitate rock extraction or abstraction of groundwater, for example as a water source. These activities can have an impact on the regional groundwater level over a very wide area. This can lead to increased rates of vertical infiltration through the peat to depth. The extent of impact depends on the extent of water level decline and properties of the peat and substrate underlying the bog.

Is Climate Change Influencing the Loss of Active Raised Bog Habitat?

Changes in climatic conditions have a demonstrated impact on peat accumulation/disintegration on peat bogs (Bellamy, 1986). This raises the issue of whether changes in climatic conditions may have contributed to the loss of active raised bog habitat observed in Ireland. More specifically a reduction in either rainfall or rainfall frequency could be expected to give rise to less favourable conditions supporting active raised bog, and thus a potential loss of habitat. The following is a summary of the findings of an investigation into this issue.

A comparison of climatic (30-year average) rainfall and evapotranspiration data at the 12 Met Éireann synoptic weather stations enabled the following questions to be addressed:

- Has total rainfall declined during the period over which active raised bog degradation has occurred?
- Has effective rainfall declined over the same period?
- Has rainfall frequency declined over this period?
- Have there been significant shifts in regional rainfall patterns that have given rise to localised climate change and corresponding changes leading to active raised bog habitat loss?

Answering these questions involved comparing climatic

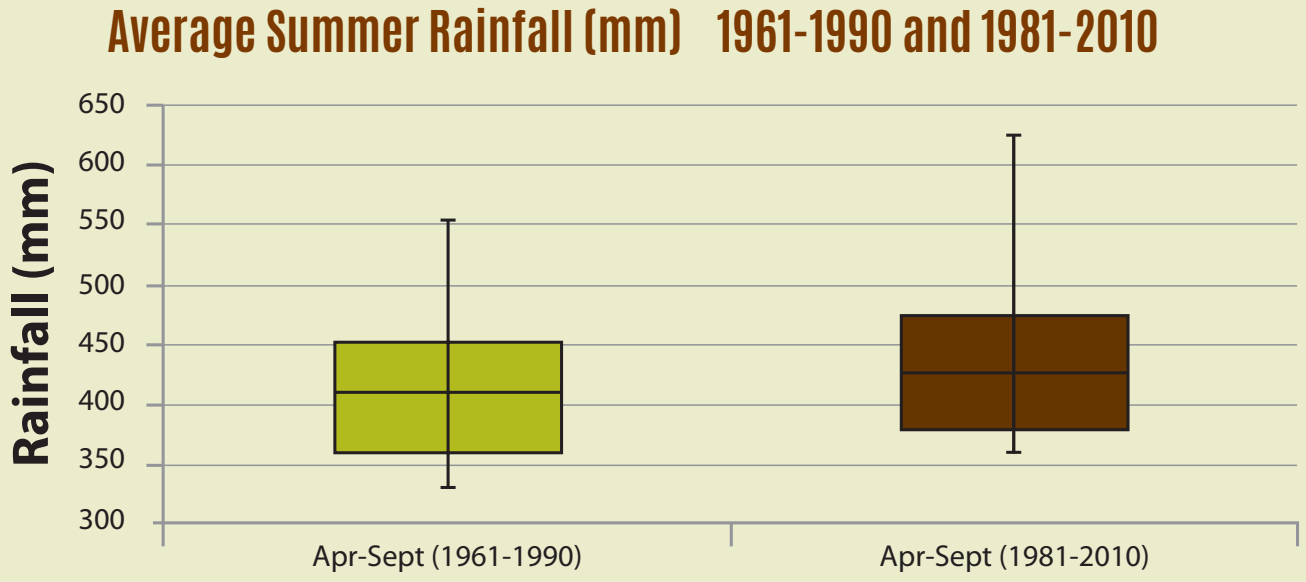


Figure 2.6: Contrast in nationwide summer rainfall (Apr–Sep)

data (rainfall, evapotranspiration and rain days) for the period from 1961–1990, with data collected in the period from 1981–2010. In the case of the number of rain days, Met Éireann long-term average rain days for 1961–1990 (Met Éireann, 2013) were compared to long-term average rain days for 1981–2010 for 12 weather stations. The findings of the study show that total rainfall across Ireland over the period 1981–2010 was slightly higher than that for the period 1961–1990 (Figure 2.6).

A similar result was observed for effective rainfall (total rainfall – potential evapotranspiration which occurs at comparable (or higher) rates than potential rates for grassland). Moreover, countrywide and regional analyses of rainfall data show that there was no significant change in rainfall intensity/number of rain days over the same period (Figure 2.7).

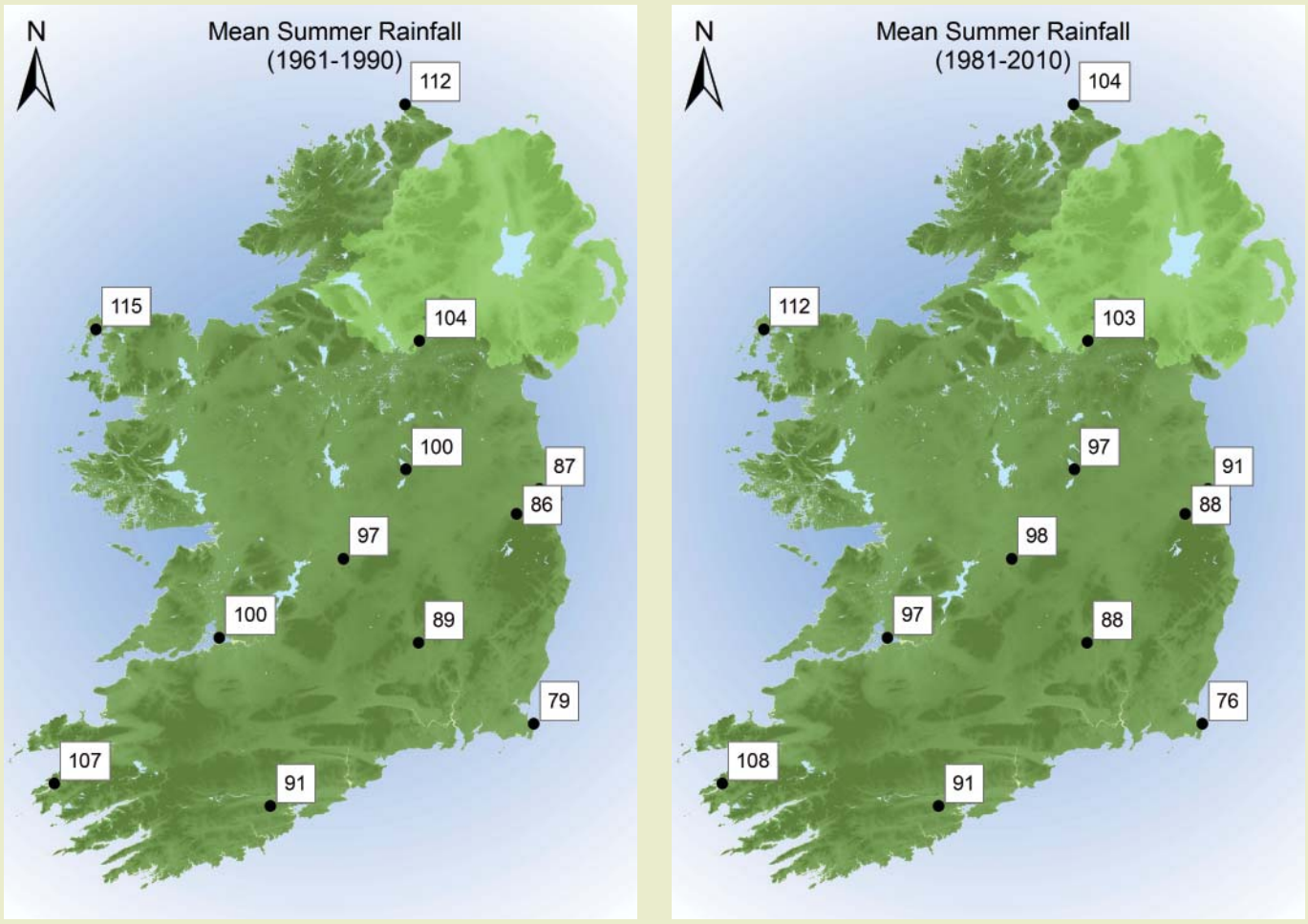


Figure 2.7: Nationwide variations in summer rainfall days

The results of the analyses of Met Éireann climatic data sets indicate that climatic conditions needed for supporting active raised bog have not deteriorated, and may have even slightly improved between 1990 and 2010. This in turn implies that the underlying causes giving rise to loss of active raised bog habitat are not related to climate but point to alternative drivers.

Studies, including Irish case studies, have demonstrated that intact bogs (where high bog is in good condition) are less sensitive to climatic fluctuations than degraded, drained bogs, which are especially sensitive to increased temperatures and drier conditions, and hence release more CO_2 to the atmosphere.

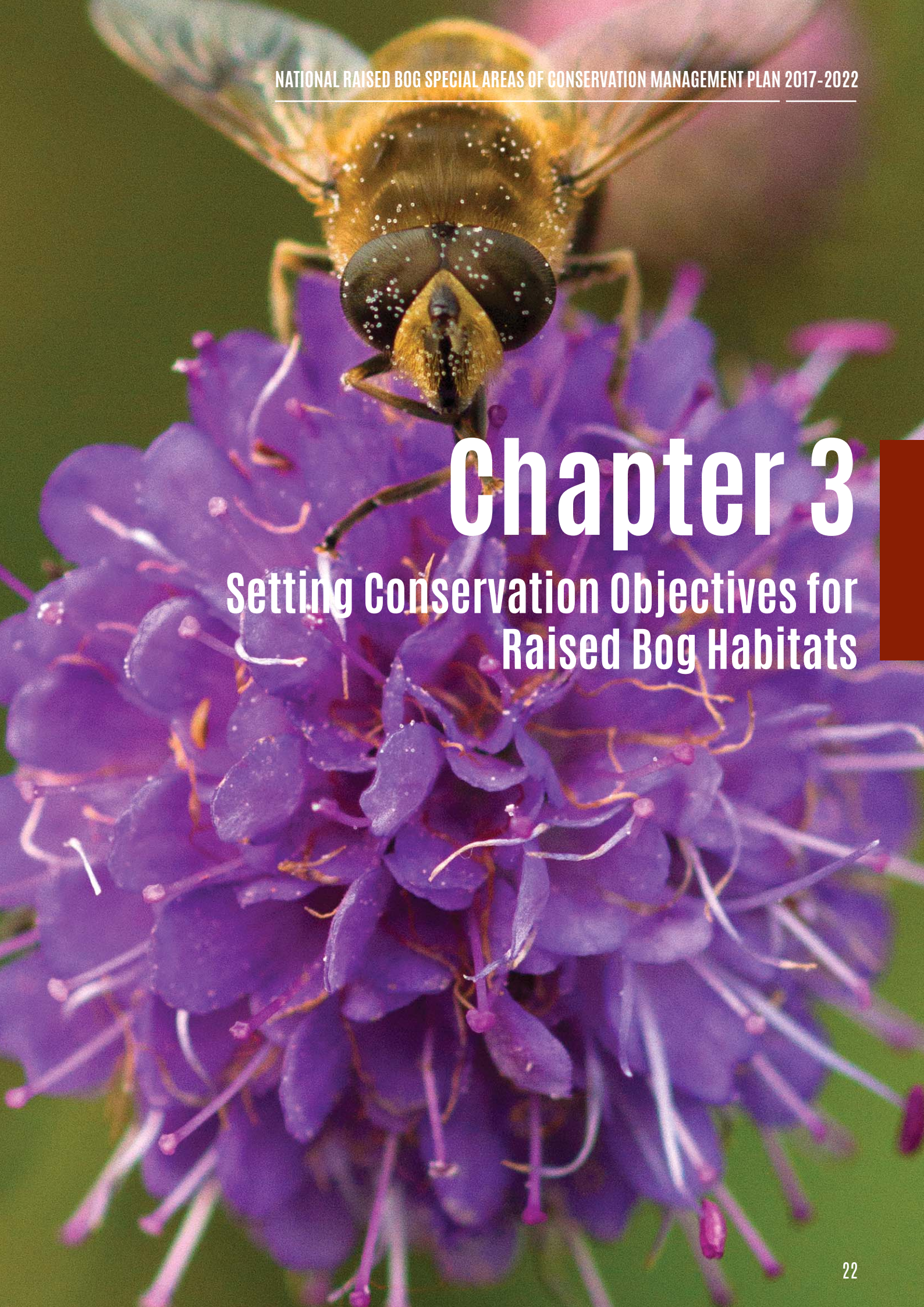
Impact of Poor Air Quality on Raised Bog Habitat

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.

Air pollution can change both the species composition and the functioning of peatlands. Reactive nitrogen (N) deposition (primarily NO_3^- and NH_4^+), 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 and Wallén, 2005).

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 and Hettelingh, 2011), a level which is exceeded over a significant portion of their range. An Irish study during the late 1990s undertaken by Aherne and 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 and Farrell (2000) was 10kg N/ha/yr. This is in line with the recommendation by Bobbink and 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.

As a result there is evidence that changes in air quality, particularly towards the eastern extent of the range of raised bogs, is likely to have had an impact on active raised bog habitat. Therefore further deterioration in air quality has the potential to become a significant risk to raised bogs in Ireland. As a result an air quality target has been set for each raised bog SAC within the site-specific conservation objectives based on the best available scientific evidence. While there is evidence that changes in air quality have started to have impacts on Irish raised bogs, it is clear that this has not been the cause of the observed decline in extent and quality of ARB habitat.



Chapter 3

Setting Conservation Objectives for Raised Bog Habitats

Chapter 3

SETTING CONSERVATION OBJECTIVES FOR RAISED BOG HABITATS

One of the main aims of the EU Habitats Directive is to ensure that the habitats and species listed in the Annexes achieve "favourable conservation status". In essence, this means that these habitats and species are being maintained in satisfactory condition and this situation is likely to continue for the foreseeable future.

As illustrated in Chapter 2, the conservation status of bog habitats listed in the Habitats Directive has deteriorated in Ireland and continues to do so. Ireland's commitment under the Habitats Directive is to have a robust raised bog network that conserves a representative sample of raised bog in Ireland that is sustainable into the future. This commitment includes replacing the area of ARB within the SACs network that has been lost since 1994 and improving the condition of raised bog habitats throughout the network. As a first step in restoration planning, this chapter sets out the conservation objectives for ARB both at national and site-specific levels.

As previously mentioned, there are two other related Annex I habitats, namely "degraded raised bogs still capable of natural regeneration" (i.e. DRB) and "depressions on peat substrates of the *Rhynchosporion*". Based on the close ecological relationship between these three habitat types, it is not necessary to set conservation objectives for all three habitats individually. It is considered that should favourable conservation condition for ARB be achieved, then favourable conservation condition for the other two habitats will also be achieved.

A conservation objective for a habitat aims to define how much, where and what conditions are necessary to maintain or restore that habitat at favourable conservation status.

Setting Conservation Objectives

The setting of a conservation objective is a scientific process that aims to define favourable conservation status for a particular habitat. This is achieved by identifying relevant attributes (characteristics, qualities or properties) and setting targets for each one that can be used to define its favourable reference value.

For habitats listed in the Habitats Directive, Article 1 of the Directive provides a definition of favourable conservation status as follows:

"The conservation status of a natural habitat will be taken as **'favourable'** when:

its natural **range** and **areas** it covers within that range, are **stable or increasing**, and

the specific **structure and functions** which are necessary for its long-term maintenance **exist** and are **likely to continue to exist** for the foreseeable future, and the **conservation status** of its **typical species** is **favourable**."

Conservation objectives for Annex I habitats can be set at different scales, from site-specific (e.g. SAC) to national and to European.

This plan does not include detailed site-specific conservation objectives for each of the raised bog SACs, as these are published as standalone documents on a site-by-site basis. However, the national conservation objective for ARB is defined here, which quantifies the overall area, distribution and general conditions required to restore ARB in the SACs network and at national level. The principles on which the site-specific ARB objectives are based are also set out. The restoration of ARB within SACs to favourable conservation condition will contribute to the overall restoration of favourable conservation status of the habitat at a national level.

National Conservation Objective for Active Raised Bogs

Because the current conservation status of ARB is bad, the national conservation objective is:

To restore the favourable conservation status of active raised bogs in Ireland.

The following sections set out the targets for range, area and a series of attributes relating to "structure and functions". This last parameter comprises the physical components of the habitat's "structure" and the ecological processes that drive them ("functions"). Targets for range and area are set at two levels – one for the national ARB resource and one for the SACs network.

Range

This is the geographic range that encompasses all significant ecological variations of ARB in Ireland. It must also be large enough to allow for long-term survival of the habitat. The range for SACs cannot decline from the current status.

Attribute	Target	Notes
National range	Range increasing from current situation	Target based on the current national range of ARB and DRB.
SACs range	Not less than current range, subject to natural processes	Target based on the current range of 53 raised bog SACs.

Area

Attribute	Target	Notes
National area	Area increasing and not less than 3,600 ha	Target based on the area of ARB (2,430 ha) and DRB (1,170 ha) present within the SACs and NHAs network in 1994. The estimated area of ARB within the new SACs and new NHAs network is 1,534 ha and DRB is 1,765 ha (totalling 3,299 ha) – see Chapter 4 for further details
SACs area	Area increasing and not less than 2,590 ha	Target based on the area of ARB (1,940 ha) and DRB (650 ha) present within the SACs network in 1994. It is estimated that the area of ARB in the current SACs network is 1,210 ha (1,244 ha including two new SACs) – see Chapter 4 for further details

Attributes relating to structure and functions

Ten attributes are listed that aim to encompass the conditions that are necessary for ARB to survive in the long term.

Attribute	Target	Notes
Hydrological regimes	Maintain/restore appropriate water levels and flow directions on each bog	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 should only be 10–15cm below the surface for very short periods of time. Long and gentle slopes (<0.3%) 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.

Attribute	Target	Notes
Supporting high bog habitat	Maintain/restore adequate high bog to support development and maintenance of active raised bog	Raised bog habitat that is classified as neither ARB nor DRB is still important in its own right, particularly as a supporting habitat for those listed in Annex I of the Habitats Directive. It is usually an essential part of the hydrological unit which supports ARB and DRB. The area of high bog in the SACs network in 1994 was 10,740 ha. The corresponding area in 2012 is 10,515 ha – meaning there are 225 ha less than at the time of designation.
Transitional areas between high bog and adjacent mineral soils	Maintain/restore semi-natural habitats with high water levels around as much of the bog margins as necessary	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 bogs and support high diversity of other wetland habitats (e.g. wet woodland, swamp and fen) as well as species requiring such wetland complexes. It will also provide flood attenuation and water purification services to the downstream areas. The estimated extent of such transitional areas within the SACs network is circa 6,000 ha.
Vegetation quality	Maintain/restore sufficient high quality vegetation (i.e. central ecotope and/or soaks). At least 50% of active raised bog habitat should be central ecotope and/or soaks	High quality indicators include hummock indicators: rusty bog moss (*Sphagnum fuscum*) and Austin's bog moss (S. *austinii*); pool indicators: feathery bog moss (S. *cuspidatum*), lesser cow-horn bog moss (S. *denticulatum*) and indicators of lack of burning events e.g. some lichen species (*Cladonia* spp.).
Microtopographical features	Maintain/restore adequate cover of high quality microtopographical features	A diverse good quality microtopography consists of bog moss-dominated pools, hollows, lawns and hummocks, which support the highest diversity of species.
Cover of bog moss species	Maintain/restore adequate cover of bog moss (*Sphagnum*) species to ensure peat-forming capacity	*Sphagnum* cover varies naturally across Ireland, ranging from relatively high cover in bogs in the east of the country to lower cover in the west in transitional areas of raised bog to blanket bog. Hummock forming species such as *Sphagnum austinii* are particularly good peat-formers.
Typical bog flora	Maintain/restore typical raised bog flora	Typical species include widespread species, as well as those with more restricted distributions but typical of the habitat's sub-types or geographical range.

Attribute	Target	Notes
Elements of local distinctiveness	Maintain/restore indicators of local distinctiveness	Such features include geological, topographical, archaeological, hydrological features (e.g. soaks, flushes) as well as notable species. This includes species that are listed in the Birds and Habitats Directives, red-listed species and other rare or localised species such as breeding red grouse (*Lagopus lagopus*).
Negative physical indicators	Bare peat and other indicators of degradation including algae-dominated pools and hollows and tear patterns are absent or insignificant	Such indicators are signs of degradation of ARB habitat.
Negative indicator species	Native negative indicators and non-native species are absent or under control	Indicators of disturbance include species indicative of drying out conditions such as abundant bog asphodel (*Narthecium ossifragum*) and deergrass (*Trichophorum germanicum*); harestail cotton-grass (*Eriophorum vaginatum*); abundant magellanic bog moss (*Sphagnum magellanicum*) in pools previously dominated by species typical of very wet conditions (e.g. feathery bog moss (S. *cuspidatum*)). Indicators of frequent burning events include abundant *Cladonia floerkeana* and high cover of carnation sedge (*Carex panicea*) (particularly in true 'Midlands raised bogs'). Most common invasive species include lodgepole pine (*Pinus contorta*), rhododendron (*Rhododendron ponticum*) and pitcherplant (*Sarracenia purpurea*).

Site-specific Conservation Objective for ARB

A site-specific conservation objective aims to define favourable conservation condition for a particular habitat or species at site level. For the purposes of distinguishing between national and site-specific conservation objectives, "favourable conservation condition" is used at site level, while "favourable conservation status" is used for the national conservation objective.

Following a similar process outlined above, conservation objectives are set for ARB in each SAC. The attributes listed above for the national conservation objective are also used as a basis for defining favourable conservation condition at a smaller scale. However, in some cases they have been refined to better describe the habitat's requirements at site level and additional attributes have been added. A supporting document, which presents the background information that has been used to set the conservation objective, is prepared for each site. The full list of attributes developed for use at site level is given below.

The site-specific conservation objectives for the raised bog SACs have seen set. The published conservation objective documents can be downloaded on a site-by-site basis via the protected sites page on the website of the NPWS of the Department of Culture, Heritage and the Gaeltacht at https://www.npws.ie/protected-sites

Attributes used for the site-specific conservation objective for ARB

Area

Attribute	Target	Notes
Habitat area	Restore area of active raised bog to a stated target area, subject to natural processes	The area target at site level is based on the current area of ARB and that of potentially active bog (i.e. DRB), based on hydrological modelling on the high bog, as well as potential bog peat-forming habitats on cutover bog.

Habitat distribution

This attribute is analogous to range at the national level.

Attribute	Target	Notes
Habitat distribution	Restore the distribution and variability of active raised bog across the SACs	It is important to conserve and restore the variability of ARB throughout a site to ensure diversity is maintained and to increase resilience.

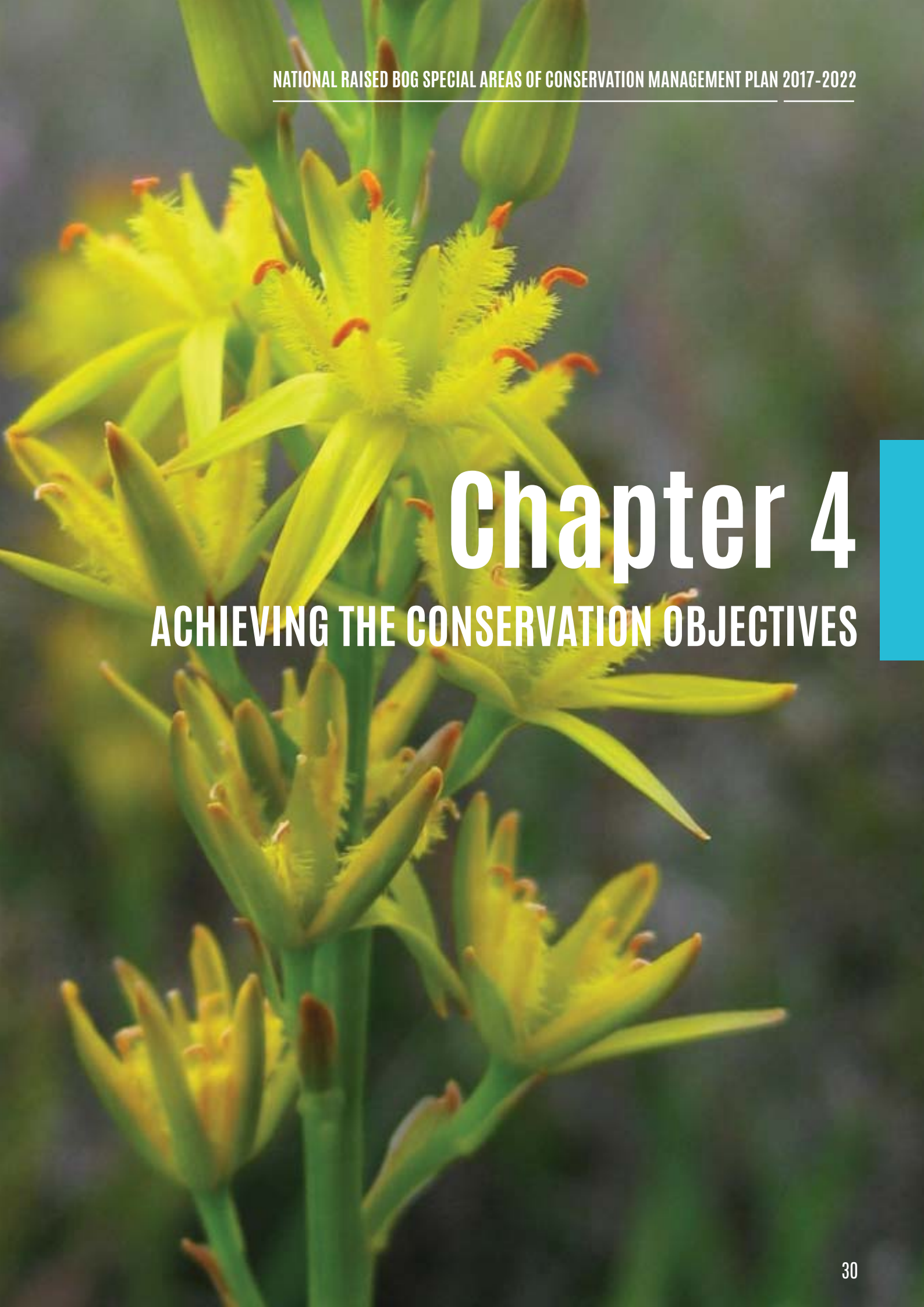
Attributes relating to structure and functions

Attribute	Target	Notes
High bog area	No decline in extent of high bog necessary to support the development and maintenance of active raised bog	This is similar to the national conversation objective target.
Hydrological regime: water levels	Restore appropriate water levels throughout the site	The national target relating to hydrological regime has been split into two (water levels and flow patterns) for the purposes of setting a site-specific objective. For ARB, mean water level needs to be near or above the surface of the bog lawns for most of the year. Seasonal fluctuations should not exceed 20cm, and should only be 10cm below the surface, except for very short periods of time. Open water is often characteristic of soak systems.

Attribute	Target	Notes
Hydrological regime: flow patterns	Restore, where possible, appropriate high bog topography, flow directions and slopes	ARB depends on mean 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.
Transitional areas between high bog and adjacent mineral soils (including cutover areas)	Restore adequate transitional areas to support and protect active raised bog and the services it provides	This is similar to the national conservation objective target.
Vegetation quality: central ecotope, active flush, soaks, bog woodland	Restore adequate central ecotope/active flush/soaks/bog woodland as appropriate	This is similar to the national conservation objective target.
Vegetation quality: microtopographical features	Restore adequate cover of high quality microtopographical features	This is similar to the national conservation objective target.
Vegetation quality: bog moss (*Sphagnum*) species	Restore adequate cover of bog moss (*Sphagnum*) species to ensure peat-forming capacity	This is similar to the national conservation objective target.
Typical ARB species: flora	Restore, where appropriate, typical active raised bog flora	This is similar to the national conservation objective target.
Typical ARB species: fauna	Restore, where appropriate, typical active raised bog fauna	This is similar to the national conservation objective target.
Elements of local distinctiveness	Maintain features of local distinctiveness, subject to natural processes	This is similar to the national conservation objective target.
Negative physical indicators	Negative physical features absent or insignificant	This is similar to the national conservation objective target.
Vegetation composition: native negative indicator species	Native negative indicator species at insignificant levels	This is similar to the national conservation objective target.
Vegetation composition: non-native invasive species	Non-native invasive species at insignificant levels and not more than 1% cover	This is similar to the national conservation objective target.
Air quality: nitrogen deposition	Air quality surrounding bog close to natural reference conditions. The total N deposition should not exceed 5kg N/ha/yr	Change in air quality can result from fertiliser drift, adjacent quarry activities or other atmospheric inputs. The critical load range for ombrotrophic bogs has been set as between 5 and 10kg N/ha/yr (Bobbink and Hettelingh, 2011).

Attribute	Target	Notes
Water quality	Water quality on the high bog and in transitional areas close to natural reference conditions	Water chemistry within raised bogs is influenced by atmospheric inputs (rainwater). However, within soak systems, water chemistry is influenced by other inputs such as focused flow or interaction with underlying substrates. Water chemistry in areas surrounding the high bog varies due to influences of different water types (bog water, regional groundwater, and run-off from surrounding mineral lands).

The conservation objective established for ARB in each SAC forms the basis for restoration planning at each site and provides a set of targets against which the success of the restoration plan can be assessed. The suite of measures available for achieving the site-specific and national conservation objectives are outlined in Chapter 4.



Chapter 4

ACHIEVING THE CONSERVATION OBJECTIVES

Chapter 4
ACHIEVING THE CONSERVATION OBJECTIVES

The review of raised bog conservation status in Ireland (see Chapter 2) and the setting of conservation objectives (see Chapter 3) identify the need to undertake urgent action to achieve national and site-specific conservation targets for Irish raised bogs. As a result, it is necessary to implement measures to protect, restore and increase the area and condition of the designated network of raised bogs.

National Raised Bog Area Targets

In order to compensate for permanent losses of ARB from the SACs network, **it is proposed to designate two new SACs with a total area of 1,060 ha of high bog, 34 ha of ARB and 149 ha of DRB**. These raised bog complexes are owned predominantly by Bord na Móna, with smaller areas under private ownership. These sites, which are of high ecological value, form part of the Peatland Raised Bog Restoration Programme that was carried out by Bord na Móna in recent years. This programme, which is ongoing, involves extensive restoration work including drain blocking and forms part of the company's commitments in its Biodiversity Action Plan (Bord na Móna, 2016).

As Table 4.1 shows, a total of **3,747** ha of active raised bog can be achieved within the network of designated sites in the long term if restoration works are implemented in a short to medium term. This figure is slightly above the **national active raised bog target (3,600 ha)** as set out in the conservation objective, but it does not take into account ongoing losses of ARB and DRB due to the effects of past damaging activities. It should be noted that further turf-cutting within the raised bog network and the effects of ongoing subsidence will make it increasingly difficult to meet national targets.

In addition, as outlined in Chapter 1, a comprehensive review of the raised bog NHA network was carried out and published in January 2014. The new network of 61 NHAs contains larger areas of ARB and DRB. It also includes a better representation of the ecological and geographical diversity of Irish raised bogs. Furthermore, the new NHA network has a much lower risk of short- to medium-term loss of ARB due to a lower intensity of turf-cutting and greater area of State-owned land. The presence of large bog complexes in the new network, which encompass greater habitat variety and natural habitat transitions, have greater potential for supporting mobile species such as red grouse and curlew.

It is intended that restoration of high bog areas will be followed by restoration of peat-forming conditions on cutover areas. It will be necessary to restore cutover areas as it will not be possible to achieve the ARB national conservation objective through restoration of the high bog alone. However, successful restoration of ARB on cutover areas is typically much more expensive and complex than restoration on high bog. In addition, successful restoration on cutover is expected to take much longer than on the high bog. Typically, restoration of DRB to ARB following implementation of restoration measures takes at least 10 to 20 years. While there are positive examples of restoration of peat-forming conditions on cutover areas, these areas typically lack the ecological diversity and attributes to be considered ARB. Furthermore, the types of peat-forming habitats that develop are more variable due to factors such as type and depth of peat substrate. Where rainfall and run-off from the high bog is the primary source of water, ombrotrophic (fed by rain) dominated bog peat-forming habitats are likely to develop. In contrast, where a minerotrophic influence (through springs/streams) is present, lagg or fen vegetation may develop. Areas of bog peat-forming habitats may eventually become ARB in the long term (50–100 years) and therefore are considered to contribute to the long-term targets for the habitat.

In order to identify cutover areas with the greatest potential for restoration to ARB, a methodology was developed to identify areas with suitable hydrological conditions. This methodology is similar to the approach used to identify DRB on the high bog and makes use of LiDAR data to identify areas of cutover bog that have the greatest potential for wet conditions to be maintained (such as enclosed depressions). The aim of cutover restoration is to raise the water table in the peat to as close to the ground surface as possible to enable peat-forming conditions to develop (see Appendix 2 for further details).

Table 4.1 Summary of area of active raised bog and degraded raised bog within the designated network of raised bog

Bog Habitat	SAC network (including 2 new SACs) (ha)	New NHA network (ha)	Total (ha)
Active Raised Bog	1,244	290	1,534
Degraded Raised Bog	1,263	502	1,765
Potential bog peat-forming habitats	298	150*	448*
Total	**2,805**	**942**	**3,747**

*Estimate based on percentage of cutover within SACs network expected to become peat-forming habitats

Protection and Restoration Measures for Raised Bogs

Detrimental impacts of activities on Irish raised bogs range from those that have been demonstrated to be largely reversible through natural processes, for example, re-colonisation/regeneration following localised burning on high bog, to others where active (engineered) intervention may be necessary to halt deterioration and potentially restore ARB.

In order to meet the conservation objectives for the raised bog SACs (Chapter 3), any measures put in place need to achieve the restoration of self-regulating eco-hydrological processes to conditions resembling those that occur in undisturbed raised bog ecosystems.

Areas identified as DRB are, by definition, capable of being restored to ARB. In order to meet conservation objective targets, it is desirable to restore as much of the current area of DRB to ARB as possible. Although this may occur spontaneously over a long time in a small number of places, active intervention will usually be necessary to speed up the process, achieve the overall objectives and to prevent further losses in some sites. Engineered options include a range of potential measures, requiring contrasting commitments of financial and human resources. In the context of this National Raised Bog Special Areas of Conservation Management Plan, measures that are sustainable in the long term with minimal maintenance requirements are considered the most appropriate way of achieving the conservation objective set for ARB.

Interventions can be subdivided into two broad categories.

1. Preventative measures including control of certain activities such as:

- Drainage of raised bog habitat and surrounding wetland habitats;
- Peat harvesting and turf-cutting;
- Planting of forestry;
- Burning; and
- Other human activities that significantly lower the water table, such as water abstraction from groundwater and quarrying.

2. Active intervention including:

- Drain blocking on high bog;
- Removal of forest plantations;
- Drain blocking in marginal areas;
- Marginal bunds; and
- High bog and cutover bog excavation/re-profiling

These active intervention measures aim to raise the water table in peat, in order to establish suitable hydrological conditions for peat to form. This will typically involve raising the water table to at or slightly above the ground surface only. It is not the aim to create deep pools (>50cm) as this inhibits the growth of *Sphagnum*, the desired species for peat rejuvenation. Restoration measures are focused on high bog and cutover areas and only in very rare occasions, where it is absolutely essential, include agricultural land. Restoration measures will only be implemented in agreement with landowners.

Restoration of Raised Bogs in Ireland

In the past, restoration of Irish raised bogs has been somewhat piecemeal, focused on a particular section of a bog and often constrained by issues such as landownership and available funding. Nevertheless, up to 2011, restoration works had been undertaken on 47 raised bog sites covering just under 2,500 ha of land. Some examples of successful restoration projects undertaken by the NPWS of the Department of Culture, Heritage and the Gaeltacht and partners are outlined in Table 4.3.

This management plan takes a more holistic approach to the restoration of the raised bog SACs network in order to meet national conservation objectives. The approaches recommended in this plan will be adopted by the Irish Raised Bog LIFE Project (LIFE14 NAT/IE/000032), one of the largest peatland restoration projects ever undertaken in Ireland. The project commenced in 2016 and is supported under the EU LIFE Programme 2014–2020.

IRISH RAISED BOG LIFE PROJECT (LIFE14 NAT/IE/000032)

The EU LIFE 2014–2020 Programme funded project 'Restoring Active Raised Bogs in Ireland's SAC Network 2016–2020' **(LIFE14 NAT/IE/000032)** aims to restore active raised bog on 12 raised bog SACs in the network. The 'Living Bog' project's main objective is to improve the condition of a total of 2,649 ha of raised bog through the implementation of best practice restoration techniques. This will support the development of necessary conditions for active raised bog growth, with the aim of achieving the long-term objective of 752 ha of active raised bog. The project will also promote awareness of the Natura 2000 Network of sites and nature conservation in general. The 12 SAC sites which will be part of the project are set out in Table 4.2 below.

Restoration plans, and integrated drainage management plans, will be developed for each of these 12 sites. As part of the restoration planning process the creation of a number of recreational amenities will be considered, such as the installation of boardwalks and walking trails. The project website http://www.raisedbogs.ie will include site-specific restoration data and a space for each of the 12 sites where local knowledge, history and culture can be celebrated. Active community participation is a key objective of the project and is currently underway.

Table 4.2: The 'Living Bog' Project sites

Site No.	SAC Name	SAC Code	County	ARB Objective (ha)
1.	Killyconny Bog	IE000006	Cavan/Meath	15.52
2.	Clara Bog	IE000572	Offaly	180.61
3.	Ferbane Bog	IE000575	Offaly	43.51
4.	Mongan Bog	IE000580	Offaly	63.18
5.	Moyclare Bog	IE000581	Offaly	35.37
6.	Raheenmore Bog	IE000582	Offaly	70.63
7.	Sharavogue Bog	IE000585	Offaly	41.54
8.	Carrowbehy/Caher Bog	IE000597	Roscommon	94.70
9.	Derrinea Bog	IE000604	Roscommon	24.97
10.	Garriskil Bog	IE000679	Westmeath	86.13
11.	Carrownagappul Bog	IE001242	Galway	73.06
12.	Ardagullion Bog	IE002341	Longford	23.48
Total				**752.70**

Further details and updates regarding this project are available through its website and its social media channels, which can be found at: https://twitter.com/LIFEraisedbogs and www.facebook.com/LIFEraisedbogs

Site-specific restoration plans for the raised bog SACs network

A review of published restoration studies/activities demonstrates the need for undertaking detailed site-specific characterisation, prior to implementing restoration programmes. As a result, detailed site-specific restoration plans have been developed for each raised bog SAC to outline the restoration measures required within each bog to meet site-specific and ultimately national conservation objectives.

These are considered long-term plans and will be developed further in partnership with stakeholders including landowners and local communities. This will ensure that restoration is carried out in such a way that the conservation requirements of the site can be met, whilst maximising liaison with and realising benefits to the local community. These plans will be available on the website of the NPWS of the Department of Culture, Heritage and the Gaeltacht at (https://www.npws.ie) during the proposed consultation process. The draft restoration plans comprise three key elements:

- Details of physical restoration measures proposed;
- Proposals for drainage management to be integrated into the restoration plans; and
- Information on how community benefits of the restoration plan will be optimised.

These plans are considered 'live' documents that will change and evolve as they are developed in partnership with key stakeholders including landowners, land users and local communities. In a minority of situations, some of the proposed restoration measures may affect landowners in adjacent lands. A system of restoration incentives including compensation, voluntary land purchase or management land agreements will be developed where necessary. The plans will be amended and updated as restoration measures are carried out, further site-specific data become available and greater knowledge and understanding of restoration techniques is developed.

The restoration plans identify technically feasible restoration measures for various zones of each bog including high bog, cutover bog and surrounding margins (see Figure 4.1 for an example of proposed restoration measures for an area in Killyconny Bog SAC, Co. Cavan/Meath where some restoration measures were undertaken in the past). Ongoing monitoring of each restoration plan will be undertaken to ensure that the intended restoration measures are successfully contributing to the achievement of site-specific conservation objectives. A sample of a summary draft hydrological restoration plan for Ardaguillion SAC in Co. Longford can be found in Appendix 6.

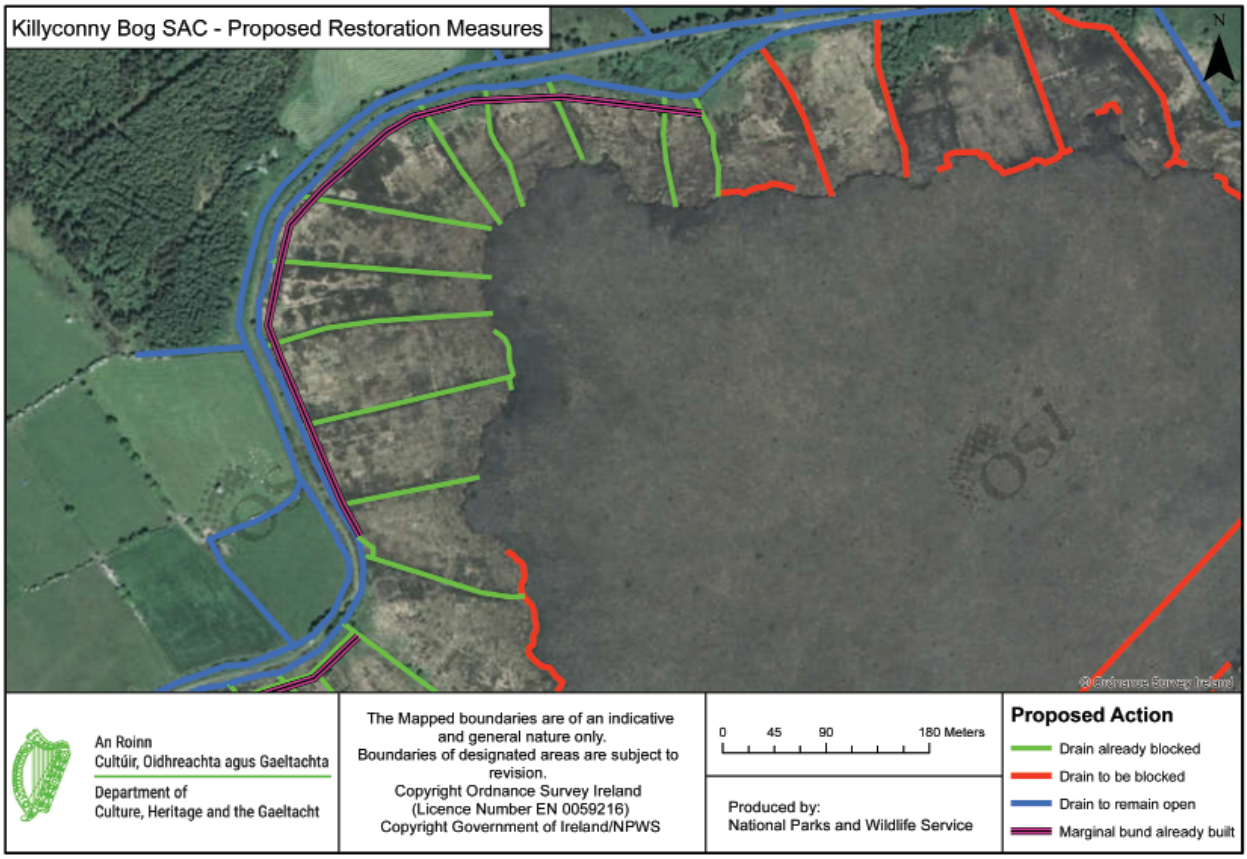


Figure 4.1: Map showing proposed restoration measures for an area in Killyconny Bog SAC, Cos Cavan/Meath

Environmental considerations

It is recognised that while the plan will bring benefits for raised bog habitats through restoration measures proposed, there is some potential for negative impacts on other qualifying interests of these SACs and potentially other European sites. In addition there is potential for impact on the wider environment as identified in the SEA carried out on the plan. In recognising this, the Department of Culture, Heritage and the Gaeltacht is committed to addressing these potential conflicts though site-specific assessments. To that end, site-specific AA and a broader environmental assessment will be undertaken for each of the 53 SACs and the two new SACs, to complement and fully inform the site-specific restoration plans.

The AA will consider whether there are other qualifying interests that may be impacted by the proposed restoration measures and where necessary recommend appropriate detailed site-specific mitigation measures, for example establishing appropriate buffers around sensitive species (such as Vertigo populations) or features (such as sink holes or turloughs). Where conflicts arise, the Department of Culture, Heritage and the Gaeltacht will develop a protocol to identify the appropriate response in view of site and national conservation priorities.

In addition, the restoration of a bog to active raised bog is likely, over time, to lead to ecological changes that may in turn affect species of flora and fauna that use the site in its degraded state. In the process of restoration these changes will be monitored and the impacts on habitats and species of conservation interest, both at site level and nationally, will be tracked, so that any significant negative long-term impacts at site or national level can be addressed by appropriate mitigation measures in view of the site and national conservation priorities.

The broader environmental assessment will consider the potential for site-specific measures to impact on biodiversity; flora and fauna which may use the sites but are not the subject features of the site; archaeology, architectural and cultural heritage features within or adjacent to the site; adjacent aquatic and terrestrial habitats which interact with the site; landscape character features; adjacent land uses; and soil quality as a minimum.

In cases where significant impacts or risks are identified, these will be addressed through site-specific mitigation measures which may include avoiding work at unsuitable times (e.g. bird nesting or breeding season); compilation of a construction environmental management plan to guide construction works; presence of suitably qualified personnel to oversee works e.g. archaeologists; liasion with local stakeholders; and water quality protection measures.

Addressing flooding concerns

One issue that is of concern to many stakeholders including turf-cutters, landowners and local communities relates to whether raised bog restoration could result in increased flooding in the surrounding area. This issue was raised by many stakeholders during the consultation phase of the draft National Raised Bog Special Areas of Conservation Management Plan. There is increasing evidence that bog restoration has the opposite effect by returning more natural hydrological conditions whereby flow is attenuated and reaches the surrounding watercourses more slowly than when drains were present. This is evident at bogs such as Killyconny Bog SAC, Cos Cavan/Meath, where extensive restoration measures have been carried out on high and cutover bog and there have been no adverse impacts on adjoining agricultural land. As previously stated, restoration measures to be undertaken will typically involve raising the water table to at or slightly above the ground surface only.

However, many individuals may remain unconvinced on these issues until several years after restoration has taken place. Therefore, in order to provide reassurance, within the site-specific restoration plans for each of the raised bog SACs there is an action assigned to prepare an integrated drainage management plan in conjunction with local stakeholders. A pilot drainage management plan has been developed for the main drainage channels around Carrownagappul Bog SAC, Co. Galway where localised incidents of increased water levels were reported by local landowners adjacent to the SAC (see Appendix 5 for the Summary Carrownagappul Bog SAC Pilot Drainage Management Plan). This plan identifies portions of the drainage network that require maintenance or further works (e.g. installation of new culverts) and provides for a long-term management solution of drains adjacent to the SAC. Management of these drains will be carried out in a way that the area to be restored will not be impacted.

Developing drainage management plans will require input from public authorities, the Office of Public Works (OPW) and local stakeholders to ensure that existing and potential drainage issues are adequately addressed and that concerns at each site are taken on board and where necessary drainage management measures are carried out prior to restoration works. It is likely that drainage management plans will require AA screening, AA as necessary and consent from relevant authorities before works are undertaken.

Best Practice in the Restoration of Irish Raised Bogs

Restoration of the entire hydrological unit of a raised bog, including high bog and surrounding margins/cutover bog is essential to ensure that restoration measures on one part of the bog are not simply offsetting further deterioration of other parts. Application of a standard approach to restoration will assist with maximising successful

rehabilitation of damaged raised bog, and reduce issues that can prevent the full potential of restoration measures being realised. As more comprehensive restoration of entire hydrological units is carried out, it is likely that further lessons will be learned and restoration techniques will continue to improve and develop.

A guidance document which outlines current best practice in the restoration of raised bogs in Ireland has been prepared as part of the 'Scientific Basis for Raised Bog Conservation in Ireland' project. This document has been prepared in consultation with groups and individuals that have been involved in carrying out restoration on raised bogs in the past, including the Department of Culture, Heritage and the Gaeltacht, Bord na Móna, Coillte and the Irish Peatland Conservation Council[10]. A workshop held by RPS, the Irish Peat Society[11] and the then Department of Arts, Heritage and the Gaeltacht in October 2015 and attended by academia, relevant State agencies, environmental non-governmental organsiations and scientists, provided information to establish best practice techniques in Irish raised bog restoration. It is intended that this document will guide anyone interested in the restoration and management of raised bogs such as turf-cutters, landowners and land users, community groups, environmental non-governmental organisations as well as practitioners involved in undertaking restoration measures. The guidance document will be published as part of the Irish Wildlife Manual series by the NPWS of the Department of Culture, Heritage and the Gaeltacht (www.npws.ie).

Past experience and success in the application of particular restoration measures ranges widely, and the full impact and benefits of these measures remain somewhat unquantified. A review of wetland restoration activities on uncut peatlands revealed that of 264 sites reviewed, active restoration measures had been undertaken on 59 bogs. Of these, drain blocking had taken place on 54 sites, sometimes in combination with the removal of forest plantations. The full success of these activities remains to be evaluated in detail. Nonetheless, the results from at least a subset of sites suggests that the restoration programmes implemented have been capable of at least partial restoration of DRB to ARB and may have prevented deterioration that would otherwise have occurred if the works had not been put in place.

High bog drain blocking

Blocking of drains within the high bog area is the most common restoration measure carried out at raised bogs in Ireland. The purpose of blocking high bog drains is to raise the water table within the peat, not only within the drain but also the adjacent areas. Where the water table is successfully maintained within 10cm of the surface, except for very short periods of time (Kelly and Schouten, 2002), the hydrological conditions are suitable for ARB habitat to develop.

Table 4.3 provides a list of those sites where increases in ARB habitat extent were reported in the *Raised Bog Monitoring and Assessment Survey 2013* (Fernandez *et al.*, 2014) following drain blocking on high bog. Particularly high increases in habitat extent were noted at Lisnageeragh, Carrownagappul, Garriskil and Ballykenny. Improvements in non-active raised bog habitat quality were reported at the sites listed and are also considered to have occurred at other sites such as at Killyconny Bog SAC in Co. Cavan.

Table 4.3: Examples of restoration using drain blocking on the high bog

Site Name	Organisation/(Co-Funding)	Estimated increase in ARB due to restoration works in the 2004-5 to 2011-13 period (ha)
Lisnageeragh (Co. Galway)	Department of Culture, Heritage and the Gaeltacht (NPWS)/Coillte (EU Cohesion/LIFE)	13.2
Carrownagappul (Co. Galway)	Department of Culture, Heritage and the Gaeltacht (NPWS) (EU Cohesion)	9.9
Garriskil (Co. Westmeath)	Department of Culture, Heritage and the Gaeltacht (NPWS)	5.5
Ballykenny (Co. Longford)	Department of Culture, Heritage and the Gaeltacht (NPWS) (EU Cohesion)	5.1

10. The Irish Peatland Conservation Council is an independent conservation organisation whose mission is to conserve a representative sample of the pealtands of Ireland for future generations to enjoy (www.ipcc.ie).
11. The Irish Peat Society is Ireland's National Committee of the International Peat Society which brings together organisations and individuals interested in peatlands and peat resources.

Table 4.3: Continued

Site Name	Organisation/(Co-Funding)	Estimated increase in ARB due to restoration works in the 2004-5 to 2011-13 period (ha)
Carn Park (Co. Westmeath)	Coillte (EU LIFE)	1.1
Raheenmore (Co. Offaly)	Department of Culture, Heritage and the Gaeltacht (NPWS) (EU Cohesion)	0.8
Cloonshanville (Co. Roscommon)	Coillte (EU LIFE)	0.7
Ballyduff (Co. Tipperary)	Department of Culture, Heritage and the Gaeltacht (NPWS) (EU Cohesion)	0.6
Fisherstown (Co. Roscommon)	Department of Culture, Heritage and the Gaeltacht (NPWS) (EU Cohesion)	0.5
Kilsallagh (Co. Galway)	Coillte (EU LIFE)	0.5
Clonfinane (Co. Tipperary)	Department of Culture, Heritage and the Gaeltacht (NPWS) (EU Cohesion)	0.3
Mongan (Co. Offaly)	Department of Culture, Heritage and the Gaeltacht (NPWS) (EU Cohesion)	0.1

Other raised bog restoration projects have been undertaken by Bord na Móna, Irish Peatland Conservation Council, Coillte and some community groups. Bord na Móna has supported the restoration of Abbeyleix Bog, Co. Laois (in conjunction with the Abbeyleix Bog Project) where an estimated 2.1 ha of ARB will be restored. Other Bord na Móna restoration projects were undertaken at Cuckoo Hill, Co. Roscommon and Ballydangan, Co. Roscommon.

An example of where drain blockage has been particularly successfully is at Lisnageeragh Raised Bog SAC in Co. Galway, where blocking 4km of drains since 1998 has resulted in a 13.2 ha area of DRB being restored to ARB between the 2004 and 2012 survey periods, Figure 4.2.

Two further examples of restoration processes using drain blocking are depicted in Plates 4.1–4.4. Plates 4.1 and 4.2 depict before and after drain blocking carried out by Bord na Móna at Cuckoo Hill Raised Bog, Co. Roscommon.

Current best practice in raised bog restoration recommends that dams are constructed at every 10cm fall in elevation to attempt to keep the water table within 10cm of the surface (Schouten *et al.*, 1994). A minimum of three dams per 100m is recommended and where peat dams are used a maximum of ten dams per 100m. A limit of 10 dams per 100m ensures that the surface of the bog is not significantly disrupted by an excessive number of borrow pits. Peat dams[12] are the most common material used for drain blocking in raised bogs; however, alternative methods include the use of plastic sheet piling which is inserted into the drain and driven down to an appropriate depth. In some cases, a combination of peat dams with plastic sheet piling can be effective where significant flow is experienced, as the plastic can prevent erosion of the peat in the dam while the peat forms a more effective seal in the drain than plastic alone.

Plate 4.3 depicts the early stages of recovery. The drain blocks increase the level of water in the drain and this initially becomes colonised by algae species which take up nutrients released from the drained bog. Over time the algae is displaced by *Sphagnum* species which tend to colonise the blocked drains from the sides.

Plate 4.4 depicts ARB re-established 10 years after drain blocking in 1996 at Clara (East) Bog SAC, Co. Offaly.

12. Where peat is taken from a 'borrow pit' close to the drain and then placed carefully into the drain and compacted to ensure it is sealed in place

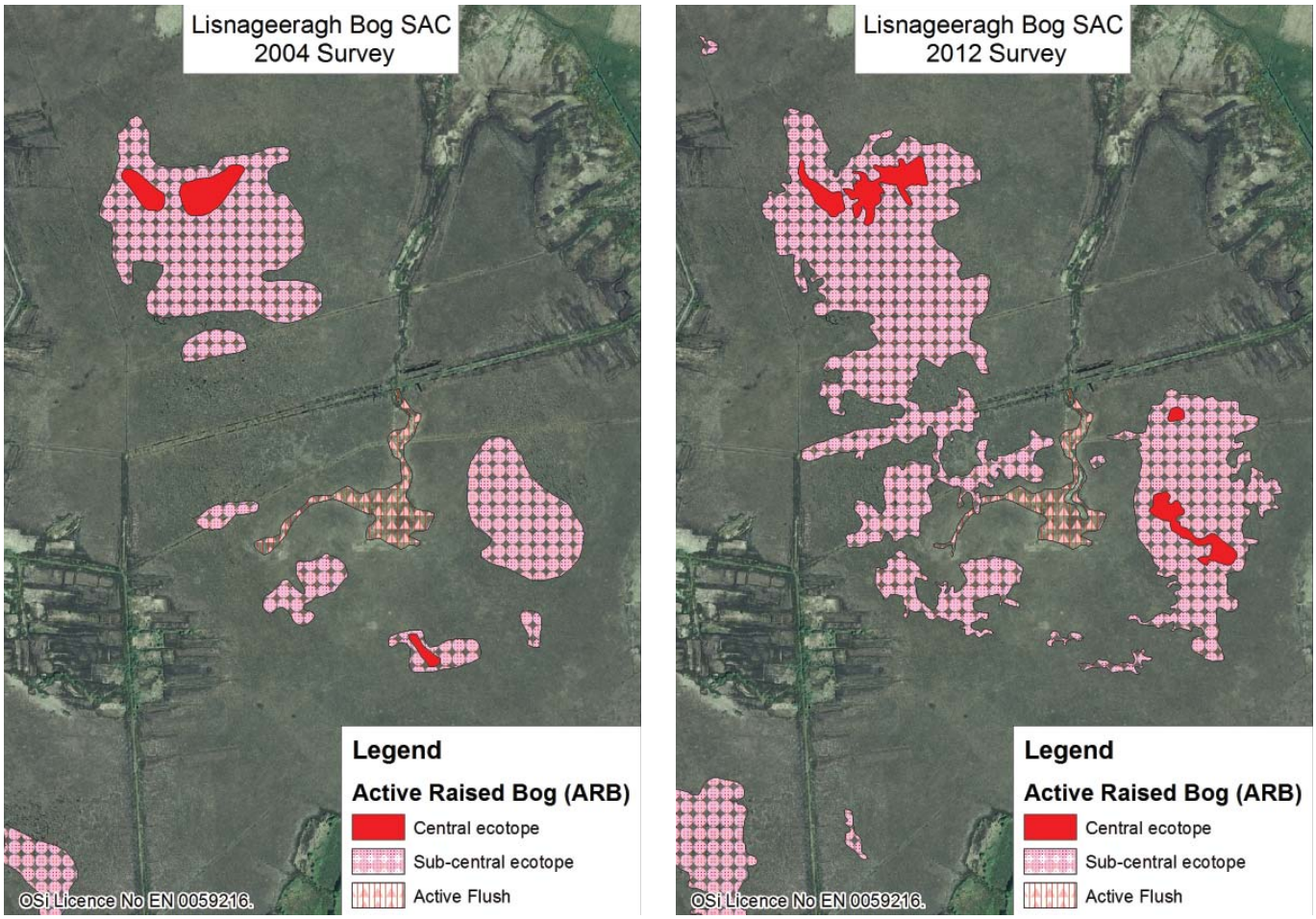


Figure 4.2: Lisnageeragh Raised Bog SAC, Co. Galway. Example of successful restoration using peat dams on the high bog. The increase of red (central ecotope) and pink (sub-central ecotope) shows the increase in active raised bog due to restoration

Plate 4.1 Before drain blocking at Cuckoo Hill raised bog (Co. Roscommon) by Bord na Móna

Plate 4.2 After peat dams drain blocking at Cuckoo Hill raised bog (Co. Roscommon) by Bord na Móna

Plate 4.3 *Sphagnum* species re-colonising a blocked drain at Cuckoo Hill raised bog Co. Roscommon

Plate 4.4 Clara Raised Bog SAC - ARB re-established 10 years after peat dams were introduced

Removal of forest plantations

Forestry plantations can have adverse effects on raised bogs by causing a lowering of the water table, through both drainage and increased rates of evapotranspiration. In recent years experience has been gained in Ireland on the removal of forest plantation on raised bogs and this can be a particularly successful measure when combined with drain blocking.

Coillte has recently completed a raised bog restoration project titled Demonstrating Best Practice in Raised Bog Restoration in Ireland which was jointly funded by EU DG-Environment, the Department of Culture, Heritage and the Gaeltacht and Coillte under the EU LIFE-Nature Programme. This is Coillte's second LIFE Project relating to the restoration of raised bogs and builds on experience gained during the first project where works were undertaken on 571 ha of raised bog in 14 sites. The recently completed project involved restoration measures on 685 ha of raised bog on 17 Coillte sites including both SACs and NHAs.

Plates 4.5 and 4.6 illustrate the positive impact of restoration measures on afforested raised bog, carried out by Coillte on Wooddown Raised Bog, Co. Westmeath. Plate 4.5 illustrates that prior to restoration measures hydrological conditions were unsuitable for supporting active raised bog. Following the implementation of restoration measures (tree felling and drain blockage) hydrological conditions now support *Sphagnum* regrowth at the same location as shown by Plate 4.6. Table 4.4 shows the resulting rise in the water table experienced at the site as a result of the restoration measures.

Plate 4.5: Wooddown Raised Bog NHA, Co. Westmeath, prior to restoration (Image: John Derwin, Coillte)

Plate 4.6: Wooddown Raised Bog NHA, Co. Westmeath, after restoration measures (Image: John Derwin, Coillte)

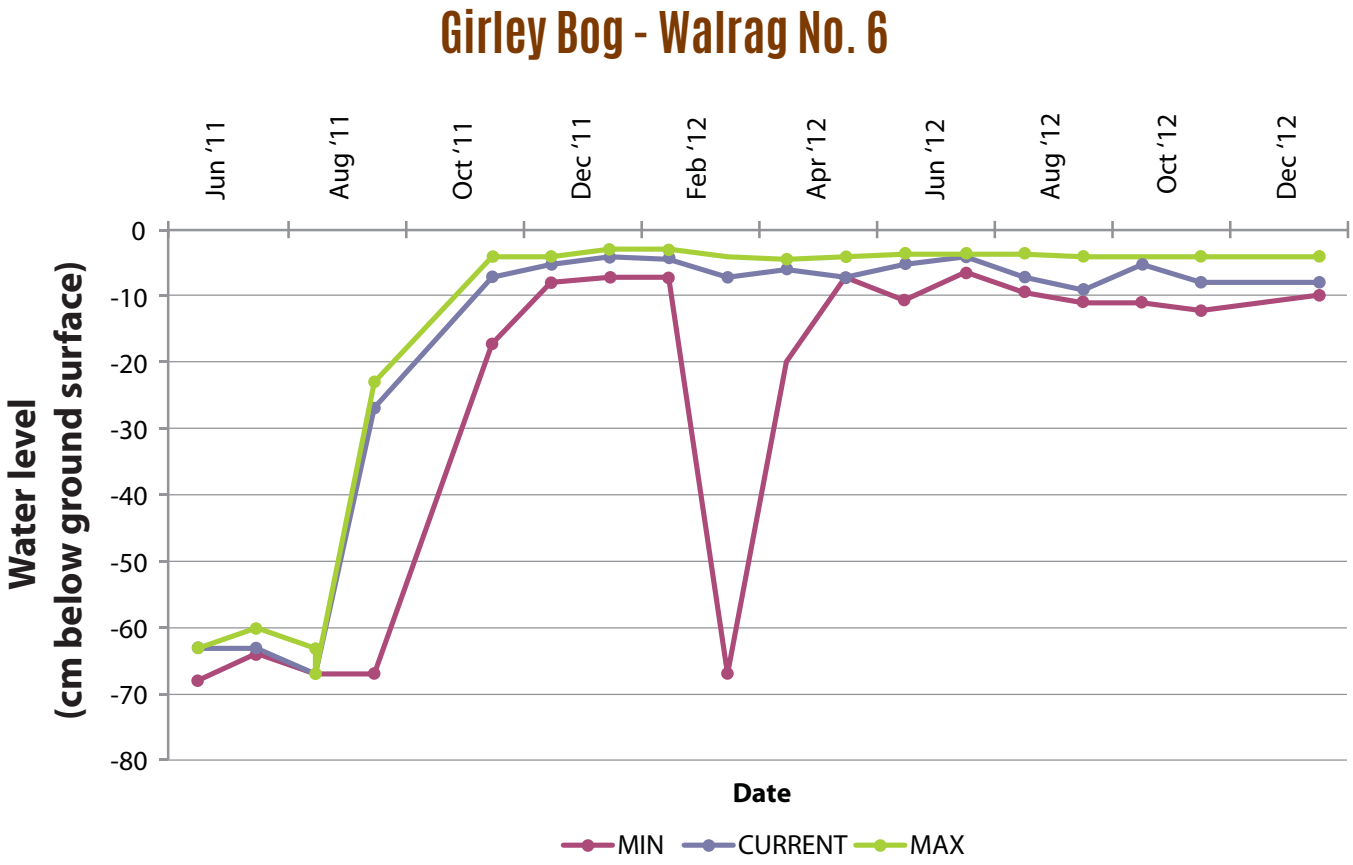


Table 4.4: Dramatic rise in the water table experienced at piezometer no.6 at Girley Bog, Co. Meath, as a result of the clear-felling of conifer forestry in August, 2011 (as part of Coillte LIFE Project restoration measures)

Drain blocking in marginal areas

Drains in marginal areas surrounding high bog are present around large sections of raised bogs in Ireland as they are designed to drain the facebank and spread grounds adjacent to the bog, thus facilitating turf-cutting and harvesting. Blocking drains in marginal areas therefore attempts to reduce the gradient between the water table in the peat and the water table in the surroundings to minimise the risk of ongoing impacts as a result of the drains. Raising the water table in cutover areas through drain blocking can also provide favourable hydrological conditions in areas with suitable topography to support the development of peat-forming vegetation.

Drains in marginal areas are typically blocked using peat or plastic dams. In some cases composite dams comprising plastic dams with a peat core can be used to reduce the risk of erosion. Drain blocking on cutover areas has been carried out at a number of raised bogs in Ireland to date, resulting in positive results, including at Killyconny Bog (Cos Cavan/Meath), Ballykenny Bog (Co. Longford) and Girley Bog (Co. Meath). No negative impacts on adjacent farm lands have been recorded. An example of successful drain blocking on marginal areas at Killyconny Bog is illustrated in Plate 4.7.

Plate 4.7: Successful establishment of peat-forming vegetation on marginal areas at Killyconny Bog SAC, Cos Cavan/Meath

Marginal bunds

Marginal bunds are typically used on flat or enclosed cutover areas where there is potential to create a large area of peat-forming habitats. This measure is used in combination with drain blocking to promote the retention of water on the cutover. These bunds are less than 1m in height and constructed from peat, with a low permeability core to prevent water flowing under the dam. A series of weirs or outlets is included within these bunds to ensure that water levels do not rise too high and the water can discharge into the boundary drain. The target water level on the cutover behind the dam is only between 0cm and 20cm above the surface (the optimum for *Sphagnum* regeneration). This measure is most suited to relatively flat cutover areas that receive adequate contribution of flow from the high bog to maintain saturated conditions.

This restoration measure has been successfully undertaken at Killyconny Bog SAC where a marginal bund was constructed along the margin of the cutover in 2008 as illustrated in Plate 4.8. The cutover in this area is very flat and a significant proportion of the flow from the high bog flows towards this area, making this an ideal location for this measure. Significant positive results have already been observed and no apparent negative impacts on the adjacent agricultural land have occurred.

Plate 4.8: Photo illustrating very shallow water (<20cm deep) being held behind a 1m high marginal bund at Killyconny Bog SAC (Co. Cavan/Meath)

High bog and cutover bog excavation/ re-profiling

Raised bog excavation and re-profiling is a potential restoration measure that can be carried out on high bog or cutover in order to create more suitable topographic and hydrological conditions for restoration of peat-forming vegetation. On high bog this measure is only suited to the most degraded sites that do not have any surface vegetation (e.g. former industrial harvested bogs). This measure is more likely to be suited to cutover areas or industrially harvested cutover areas where current conditions are not suited to peat-forming habitat development but where there is still a layer of ombrotrophic bog peat remaining.

Depending on available working conditions and extent of the area being re-profiled this measure is likely to involve use of specially adapted tracked excavators and/ or bulldozers to create a level surface. This measure may be feasible in sites that have been significantly damaged such as industrially harvested peatland areas. There are no known high bog sites restored using this approach in Ireland and there may be a risk of ecological damage occurring if it is used on any but the most degraded sites.

Efficacy of restoration measures

Based on the restoration experiences gained in Ireland, drain blocking of both open and overgrown drains and forestry plantation clearance, along with control of potentially damaging activities, have the greatest potential as restoration measures on Irish raised bogs.

However, where the hydrological relationship between the peat and the regional groundwater has been affected, resulting in increased rates of vertical seepage, it may prove extremely difficult to successfully restore ARB despite hydrological conditions on the surface appearing suitable. This is because water cannot remain at the surface for an adequate period of time. Thus, in order to adequately assess the future restoration potential of each bog, it is necessary not only to consider the physical conditions of the bog's surface, but also whether technically feasible restoration measures are available. In order to determine the area of DRB for each raised bog, both the topographic conditions and efficacy of restoration measures are assessed.

Chapter 5

MEETING THE NEEDS OF STAKEHOLDERS

Chapter 5
MEETING THE NEEDS OF STAKEHOLDERS

Sustainable Management of Ireland's Raised Bogs

Ireland has one of the highest proportions of the total European Union resource of the Atlantic raised bog habitat type (over 50%). As such, the State and its citizens have a special responsibility for its management and conservation at an international level.

Up until the mid-20th century, Ireland's peatlands were managed to meet local needs and to support economic growth. Later in the century, industrialised peat extraction was seen as a rational management of the resource in order to provide a national source of fuel and support rural employment. In the latter half of the 20th century it was being realised on a global level that there was a need to protect the Earth's natural resources and the concept of sustainable development came to the fore. The concept of sustainable development formed the basis of the United Nations Conference on Environment and Development held in Rio de Janeiro in 1992, which marked the first international attempt to draw up action plans and strategies for moving towards a more sustainable pattern of development.

Sustainable development is now defined as "development which meets the need of the present without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development, 1987). It is aimed at promoting well-being of citizens now and into the future. It requires creating a sustainable and resource-efficient economy founded on a fair and just society, respecting the three core pillars of sustainability: the environmental, economic and social (DECLG, 2012). But sustainability also includes cultural values, landscape, wider social needs, natural diversity and carbon regulation.

Ireland's raised bogs are a finite natural resource and their sustainable management is necessary to ensure the achievement of the main pillars of sustainability and to conserve them in the most appropriate manner for future generations. Originally, in the Republic of Ireland there was approximately 310,000 ha of raised bog. Of this, around 50,000 ha which can be classified as high bog habitat remains, with approximately 10,515 ha within the current raised bog SACs network and 7,480 ha within the current NHA network.

Ireland's raised bogs are a unique ecological asset and are valuable from a national, economic and global perspective. Like any capital asset, they have to be appropriately managed and invested in to obtain the best return for all stakeholders. This management plan advocates a sustainable environmental management approach in accordance with the vision and values set out in the National Peatlands Strategy. This approach aims to integrate the management of land, water, biodiversity, and other environmental resources to meet human needs while ensuring the long-term sustainability of ecosystem services and livelihoods. This reflects global, EU and national environmental and biodiversity policies such as the UN 2030 Agenda for Sustainable Development[13], the UN Strategic Plan for Biodiversity 2011–2020[14], the EU Biodiversity Strategy to 2020 (EC, 2011), Ireland's framework for sustainable development (DECLG, 2012) and Ireland's National Biodiversity Plan, Actions for Biodiversity 2017–2021(NPWS, 2017).

It is recognised that there are often competing interests in the management of designated peatlands and associated lands. There is a need to manage protected raised bogs in a balanced way and integrate current needs and uses with future ecological, economic and social conditions. This balance involves protecting traditional rights and providing fair compensation where there is a need to curtail exercise of those rights and pursuing sustainable development, protecting valuable resources and ensuring Ireland meets its legal obligations for nature protection.

Turf-cutting for Domestic Use and the Raised Bog SACs Network

As set out in the Programme for a Partnership Government (May, 2016), the Government recognises that domestic turf-cutters have a traditional right to cut turf and that this right is balanced with the conservation objectives for designated bogs and the legal obligations on the State.

Turf-cutting (commercial and domestic) will continue on raised bog sites that are not designated as part of the raised

13. UN Resolution 66/288 'The Future we want, Conference on Sustainable Development's Rio+20 conference. Resolution adopted by the General Assembly on 27 July 2012
14. Strategic Plan for Biodiversity 2011–2020 https://www.cbd.int/sp

bog SACs network or within an NHA, subject to necessary planning or regulatory requirements. Presently, those most directly and immediately affected by the conservation measures for the raised bog SACs network are those who own these bogs or use them or adjacent areas for certain activities, primarily turf-cutting and in some cases agricultural land reclamation.

The mechanisms described in this plan aim to address the concerns of turf-cutters, landowners and users as part of an overall raised bog designated network solution. This involves a balance of protecting traditional rights and providing compensation where these rights are curtailed and seeking to facilitate feasible alternatives where possible whilst ensuring Ireland continues to meet its legal obligations.

Cessation of Turf-cutting Compensation Scheme

To ensure Ireland meets its legal obligations under the Habitats Directive the cessation of an existing land use activity is generally required on raised bog SACs – namely, turf-cutting. It is recognised that turf-cutting is valued by many involved and those who are impacted by the cessation on turf-cutting are being provided with compensation.

In April 2011, with the approval of the Government, the then Minister for the Environment, Heritage and Local Government established the Cessation of Turf Cutting Compensation Scheme (CTCCS) to compensate landowners and turf-cutters affected by the restrictions on turf-cutting on the 53 raised bog SACs. This scheme is administered by the Department of Culture, Heritage and the Gaeltacht on behalf of the Minister. Prior to this, in 2010, an interim payment scheme was brought in as an emergency measure and €0.177m was spent on this scheme. In addition, a bog purchase scheme was established in 1999 and was enhanced in 2004. Up to December 2016, the State has spent approximately €29m to purchase land or rights in designated areas under this scheme, which closed to new entrants in 2010. The CTCCS was extended to raised bog NHAs in 2014. It is estimated that the current compensation schemes (including relocation) established by Government will pay out up to €78m to turf-cutters in designated bogs up to 2031.

The CTCCS has two main elements:

1. Annual Payment Scheme:
A payment of €1,500 per annum (index linked) for 15 years together with a once-off incentive payment of €500 on the signing of a legal agreement with the Minister is made to qualifying applicants (total €23,000). These payments can allow applicants to source alternative sources of fuel and are exempt from capital gains tax.

The qualifying criteria for the CTCCS and further details are available at http://www.npws.ie/peatlands-and-turf-cutting/turf-cutting-compensation-scheme

2. Bog Relocation Scheme:
As part of the Government's efforts to address the needs of turf-cutters, the then Minister for Arts, Heritage and the Gaeltacht agreed to work with local turf-cutting communities to explore and implement relocation solutions where possible, where turf-cutters could be moved from their raised bog within an SAC to a nearby non-designated bog where they could continue to source turf for their domestic use. This is as an alternative to financial compensation. Up to the end of December 2016, approximately €3.2m has been spent on relocation, with 575 applicants continuing to express an interest in relocation.

While applicants are waiting for relocation projects to be fully developed, they may receive interim compensation under the CTCCS. Relocation can be a complex process involving the investigation of suitable sites for turf quality and quantity, establishing the infrastructure/drainage works required, establishing the number that can be accommodated on the relocation site, assessing the cost and feasibility of land purchase or lease, and securing any necessary planning consents. Establishing the preferences of individual turf-cutters and their entitlements to participate in the scheme can also take time. There are eight stages in the process involved in the relocation of turf-cutters from SACs to non-designated bogs – this process is described in Appendix 7. Screening for AA of turf-cutting on non-designated relocation sites is also undertaken by the Department.

During the relocation process the Department issues letters to CTCCS applicants, who have expressed an interest in relocation, keeping them informed of progress and ascertaining their continued interest in relocation. Where possible the Department also endeavours to maintain contact with representatives of local turf-cutting communities. It is clear that relocation is an involved and time-consuming process for officials and for the turf-cutters. The experience to date is that most progress is made where turf-cutters are well organised and have individuals or groups who can provide strong leadership in representing their interests and in working with officials to tackle the various challenges that arise during the process.

To date, mostly larger scale relocation projects have been pursued, with the intention of addressing the needs of groups of turf-cutters together. However, some individual relocation solutions have also been put in place. Where feasible, the Department is prepared to provide each turf-cutter with a turbary right over approximately an acre of high bog plus an area of spread ground in a relocation site.

Arrangements for the relocation of turf-cutters to non-designated bogs have been made for a group from Clara

Bog SAC in Co. Offaly and a group from Carrownagappul Bog and Curraghlehanagh Bog SACs in Co. Galway. These groups are turf-cutting at the relocation sites, as are a number of individual turf-cutters at smaller relocation sites in Co. Westmeath and Co. Galway.

Cessation of Turf Cutting Compensation Scheme - statistics

The State has invested significant resources to compensate landowners and turf-cutters affected by the restrictions on turf-cutting on raised bog SACs. As of December 2016, over €17.7m (excluding relocation) has been paid out by the Department of Culture, Heritage and the Gaeltacht as compensation since the inception of the CTCCS in 2011, with a further €1.75m being spent on deliveries of turf.

Up to end December 2016:

- 3,235 applications for compensation under the CTCCS within raised bog SACs have been received and acknowledged by the Department.
- 597 applicants have expressed an interest in relocation from raised bog SACs to non-designated bogs.
- 2,226 payments have been made in respect of year 1 of 15; 2,218 payments have been made in respect of year 2 of 15; 2,062 payments have been made in respect of year 3 of 15; 1,951 payments have been made in respect of year 4 of 15; 1,945 payments have been made in respect of year 5 of 15; and 758 payments have been made in respect of year 6 of 15.
- 902 deliveries of turf have been made.

Updates of this information and the compensation scheme within certain raised bog NHAs are published regularly on the website of the NPWS of the Department of Culture, Heritage and the Gaeltacht at: https://www.npws.ie/peatlands-and-turf-cutting/cessation-turf-cutting-compensation-scheme/compensation-scheme-statistics

Summary of current position in relation to relocation site suitability assessment

A large number of potential relocation sites were identified, screened and subject to an initial site suitability assessment by the Department. This has included sites put forward by the TCCA or suggested by local turf-cutters.

Expert preliminary assessments have been completed on over 175 potential relocation sites for 38 raised bog SACs by Bord na Móna on behalf of the Department.

Stratigraphy assessments have been completed on 150 relocation sites for 35 raised bog SACs on behalf of the Department.

Full site suitability assessments have been completed on 56 relocation sites for 26 raised bog SACs on behalf of the Department. This includes an assessment of peat characteristics, peat depth and volume, site access, facebank and spread ground, drainage and identifies the potential number of turf-cutters that could be accommodated on each site.

The proposed de-designation of a number of NHAs as part of the NHA review will provide scope for additional relocation sites once the regulatory framework is in place.

Continued Turf-cutting without Damaging the Integrity of SACs

Implementation of conservation programmes developed for Irish raised bog SACs has, in some instances, proved controversial and difficult. Final resolution of all issues in relation to the protection of Ireland's designated raised bogs can only be brought about by everyone working together, within the law, with the State.

In general, as outlined in Chapters 2 through 4, turf-cutting and its associated drainage is damaging to the ecology and functioning of raised bogs and is incompatible with their conservation. For raised bogs selected for designation as SACs, it will in most cases not be possible for the State to consent to further turf-cutting, as the State is legally obliged to prevent such damage to these sites. There are, however, two sets of circumstances in which consent for turf-cutting could be provided. These can be referred to as Article 6(3) consents and Article 6(4) consents, in that the criteria for giving such consent are set down in Article 6(3) and Article 6(4) of the Habitats Directive, and in the relevant national transposing legislation. This avenue will be only considered where there are no feasible relocation sites available or not enough plots within a relocation site within a reasonable distance to an SAC to accommodate turf-cutters who wish to continue cutting.

Article 6 of the Habitats Directive

Managing and Protecting Natura 2000 Sites

1. For SACs, Member States shall establish the necessary conservation measures involving, if need be, appropriate management plans specifically designed for the sites or integrated into other development plans, and appropriate statutory, administrative or contractual measures which correspond to the ecological requirements of the natural habitat types in Annex I and the species in Annex II present on the sites.

2. Member States shall take appropriate steps to avoid, in the SACs, the deterioration of natural habitats and the habitats of species as well as disturbance of the species for which the areas have been designated, in so far as such disturbance could be significant in relation to the objectives of this Directive.

3. Any plan or project not directly connected with or necessary to the management of the site but likely to have a significant effect thereon, either individually or in combination with other plans or projects, shall be subject to AA of its implications for the site in view of the site's conservation objectives. In the light of the conclusions of the assessment of the implications for the site and subject to the provisions of paragraph 4, the competent national authorities shall agree to the plan or project only after having ascertained that it will not adversely affect the integrity of the site concerned and, if appropriate, after having obtained the opinion of the general public.

4. If, in spite of a negative assessment of the implications for the site and in the absence of alternative solutions, a plan or project must nevertheless be carried out for imperative reasons of overriding public interest, including those of a social or economic nature, the Member State shall take all compensatory measures necessary to ensure that the overall coherence of Natura 2000 is protected. It shall inform the Commission of the compensatory measures adopted.

   Where the site concerned hosts a priority natural habitat type and/or a priority species, the only considerations that may be raised are those relating to human health or public safety, to beneficial consequences of primary importance for the environment or, further to an opinion from the Commission, to other imperative reasons of overriding public interest.

   Article 6 is one of the most important articles in the Habitats Directive as it defines how Natura 2000 sites (SACs and SPAs) are managed and protected.

Paragraphs 6(1) and 6(2) require that, within Natura 2000, Member States:

- Take appropriate conservation measures to maintain and restore the habitats and species for which the site has been designated to a favourable conservation status; and
- Avoid damaging activities that could significantly disturb these species or deteriorate the habitats of the protected species or habitat types.

Paragraphs 6(3) and 6(4) lay down the procedure to be followed when planning new developments that might affect a Natura 2000 site. Thus:

- Any plan or project likely to have a significant effect on a Natura 2000, either individually or in combination with other plans or projects, shall undergo an **AA** to determine its implications for the site. The competent authorities can only agree to the plan or project after having ascertained that it will not adversely affect the integrity of the site concerned (Article 6(3); and
- In exceptional circumstances, a plan or project may still be allowed to go ahead, in spite of a negative assessment, provided there are no alternative solutions and the plan or project is considered to be of overriding public interest. In such cases, the Member State must take appropriate compensatory measures to ensure that the overall coherence of the Natura 2000 Network is protected. (Article 6(4)).

Consent under Article 6(3)

Article 6(3) of the Habitats Directive provides for consent to be given to plans or projects (such as proposals to undertake turf-extraction) only if it can be demonstrated that they will not adversely affect the integrity of any European site. A public authority can grant consent if AA screening (within the meaning of Article 6(3) of the Habitats Directive) concludes that the plan or project will not have a significant effect on a European site. If screening cannot conclude that there will be no significant effects then a Natura Impact Statement (NIS) is required to assess the impact of the proposals on any relevant European site(s) and their qualifying interests. In order to conclude the AA, the public authority must make a determination as to whether or not a plan or project would adversely affect the integrity of a European site, before a decision is taken to approve, undertake or adopt a plan or project, as the case may be.

The screening and AA of the impacts of a proposal are scientific exercises and focus squarely on implications of the activity for the qualifying interests of the site, conservation objectives and conservation condition of a site. The effects of such proposals must be assessed both alone and in

12. See European Communities (Birds and Natural Habitats) Regulations 2011

combination with other plans and projects. Given the clear scientific evidence of the negative effect of turf-extraction on raised bogs generally, for most such proposals it will not be possible for a public authority to consent to this activity under Article 6(3). However, in a limited number of cases it may be possible to demonstrate that turf-extraction on areas of raised bog may be undertaken in a manner that is in accordance with the provisions of Article 6(3) where it will not impact on site-specific conservation objectives and therefore the integrity of the site.

During the development of the draft National Raised Bog Special Areas of Conservation Management Plan, specific proposals for continued turf-cutting within SACs identified by the TCCA were considered. In a number of cases turf-cutting was ruled out, as it was determined, based on proximity to active raised bog and degraded raised bog habitats, that turf-cutting within the proposed areas was likely to have a direct or indirect impact on protected raised bog habitats or prevent restoration works essential for the conservation of the site. However, a number of sites were identified where it was not ruled out, following preliminary assessment (based on proximity to active raised bog and degraded raised bog habitats) that turf-cutting could be undertaken without having a negative effect.

In one case, Tullaher Lough and Bog SAC, Co. Clare it was possible to identify a significant area within the SAC where turf-cutting could continue without having an adverse impact on the raised bog. This is because analysis by the Department showed that the protected habitat is hydrologically separated from the proposed extraction area. It was possible, in this case, to allow a continuation of turf-cutting within a defined area as the proposed extraction area comprises extremely damaged and degraded areas of peatland that are not capable of regenerating. AA screening of this activity was carried out and Ministerial consent was received in this instance.

Since the publication of the draft National Raised Bog Special Areas of Conservation Management Plan, the Department has been working closely with the TCCA, other turf-cutters and stakeholders to establish whether turf-cutting may be feasible on a number of other SAC sites, in a manner that is in compliance with Article 6(3), where there are difficulties in finding relocation solutions. This includes a further examination of some SACs that were ruled out under the draft plan. The 14 sites being considered for utilising the provisions of Article 6(3) are outlined in Table 5.1.

Following on from the preliminary desktop assessments, scientific assessments have been carried out at a number of these sites and are scheduled to be carried out at the remainder. These scientific assessments typically include a programme of initial site investigations followed by a more detailed programme of site investigations to fully assess impacts of turf-cutting on the Natura 2000 Network.

Initial site investigations include a desktop study to assess proximity of Annex I habitats (including active raised bog and degraded raised bog) to areas where turf-cutting is proposed. Where information on existing habitats did not exist, an ecological survey of the areas of interest was required to be carried out to inform this assessment. Initial hydrological investigations consisted of assessing peat thickness through hand coring and a perimeter hydrochemical survey coupled with flow gauging (to identify upwelling regional groundwater in marginal areas).

Table 5.1: Sites considered for utilising provisions of Article 6(3) for domestic turf-cutting activities

Site Code	Site Name
000592	Bellanagare Bog
000595	Callow Bog
002348	Clooneen Bog
002110	Corliskea/Trien/ Cloonfelliv Bog
000301	Lough Lurgeen Bog/Glenamaddy Turlough
000440	Lough Ree
002340	Moneybeg and Clareisland Bogs
002331	Mouds Bog
002353	Redwood Bog
002998	River Moy
000231	Barroughter Bog
002332	Coolrain Bog
002352	Monivea Bog
002351	Moanveanlagh Bog

These surveys led to the design of a series of much more detailed field investigations which aim to characterise the properties of the peat and the underlying inorganic substrate and bedrock units. Through the collection of this detailed information it is possible to quantify the impact of turf-cutting activities on Annex I raised bog habitats. This enables an assessment to be carried out to determine whether continued turf-cutting is likely to impact on site-specific conservation objectives on raised bog habitats, as well as other qualifying interests/species of conservation interest of the European site and any other European sites with the potential to be affected.

To date initial investigations have been carried out at eight sites, with detailed investigations complete at three sites including Lough Ree SAC (Fir Bog and Clooncraff/ Cloonlarge Bog), Moneybeg and Clareisland Bogs SAC and Lough Lurgeen Bog/Glenamaddy Turlough SAC.

The assessments are being carried out in accordance with the best available scientific information and have been presented at numerous national and international conferences to date. A paper on the use of geographical information system-based hydrological modelling for development of a raised bog conservation and restoration programme was published in June 2017 (Mackin *et al.*, 2017). It is intended that other peer-reviewed articles will be published to further strengthen the scientific evidence used as part of these assessments.

Article 6(3) case study: Lough Ree SAC (Fir Bog and Clooncraff Bog)

Following discussions with the TCCA, Lough Ree SAC (Fir Bog and Clooncraff Bog) was taken forward for assessing the feasibility of turf-cutting on certain areas under Article 6(3). This site was selected as there is a lack of sufficient relocation options that will accommodate all turf-cutters seeking relocation (given the high numbers) and a preliminary assessment had indicated that turf-cutting in accordance with Article 6(3) may be feasible in some parts of the bog subject to further investigations.

A preliminary desktop study identified parts of the bog which do not appear to support any areas of ARB and do not appear to have potential to support ARB in future. These areas were targeted during initial site investigations to identify areas for further more detailed investigations. These investigations comprised a targeted ecological survey to update ecotope mapping and assess the potential presence of ARB or other Annex I habitats. In addition, initial hydrological investigations consisted of assessing peat thickness through hand coring and a perimeter hydrochemical survey to identify upwelling regional groundwater in marginal areas.

Following initial hydrological surveys, two areas within the bog, known as Fir Bog and Clooncraff Bog (Figure 5.1), were taken forward for further assessment. Initial hydrological surveys indicated that these areas were the least likely to encounter issues such as upwelling groundwater and these areas were satisfactory to the requirements of local turf-cutters.

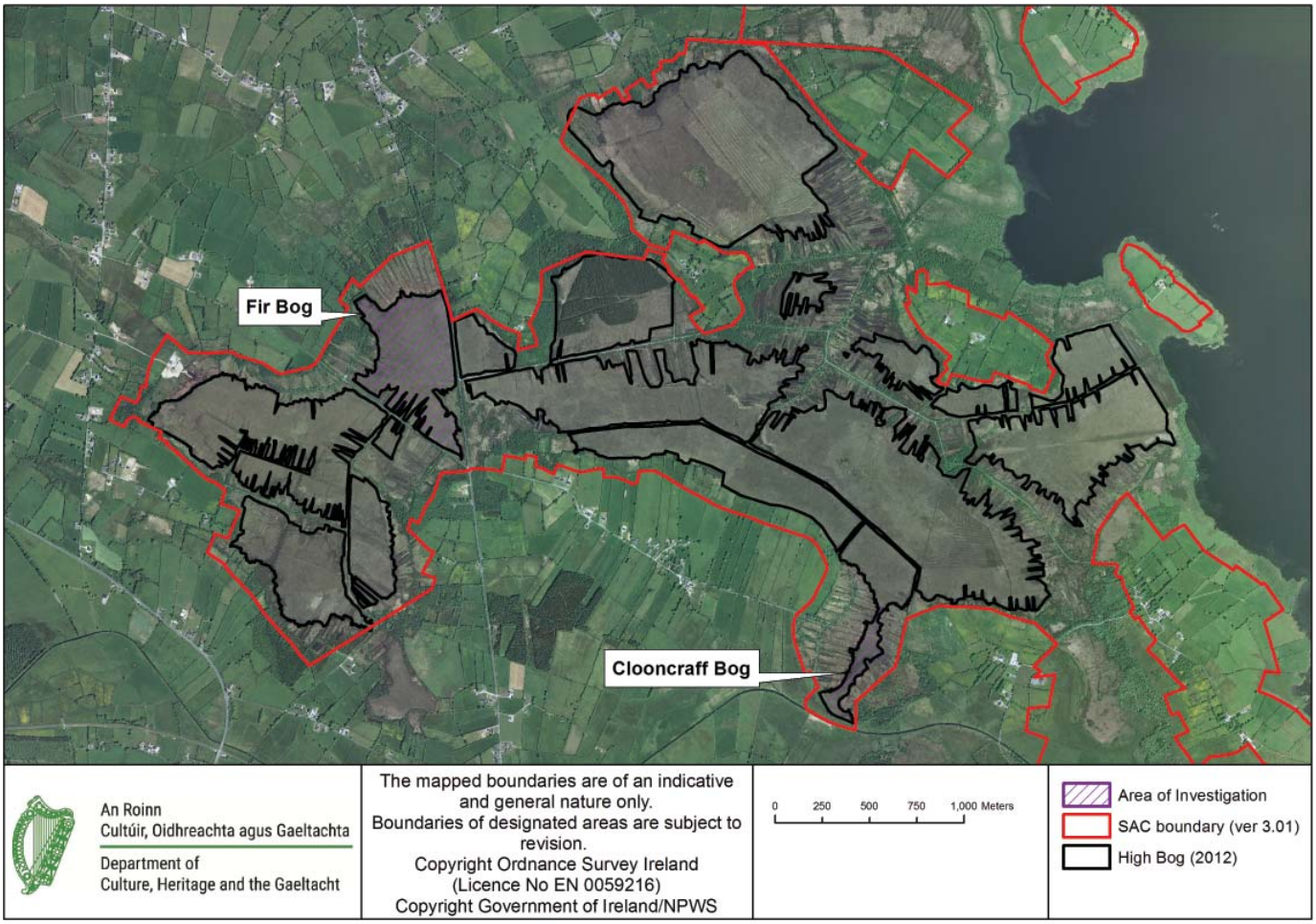


Figure 5.1: Areas where detailed investigations were carried out at Fir Bog and Clooncraff Bog

A detailed programme of investigations was carried out at Fir Bog and Clooncraff Bog comprising:

- Geophysical survey to assess depth to bedrock and the nature of the inorganic substrate separating the peat from the rock. This utilised a method known as Electrical Resistivity Tomography.
- Geophysical survey to assess the depth/thickness of peat in significant detail. This utilised a method known as Ground Penetrating Radar.
- Drilling to bedrock using a portable window sampler at selected locations, to assess characteristics of inorganic substrate coupled with installation of piezometers (to measure water levels) in the peat and extending deeper into the inorganic substrate.
- A detailed programme of peat sampling and analysis along transects extending in from facebanks to central parts of the bog where impacts of drainage are considered negligible. The samples were then analysed to permit the bog profile following drainage to be reconstructed and to identify the peat substrate.

Further details of the assessments undertaken at Lough Ree SAC are contained in Appendix 4. Overall results from the detailed programme of investigations show that turf-cutting at Fir Bog and Clooncraff Bog will not impact on the current site-specific conservation objective (NPWS, 2016a) for ARB at Lough Ree SAC, providing turf-cutting is limited to locations where there is negligible risk of impacts to groundwater. This requires turf-cutting to be restricted to the revised areas outlined in Figure 5.2, comprising a total of 25 ha of high bog. A Natura Impact Statement has been prepared to assess the impacts of turf-cutting not only on raised bog habitats but also any other qualifying interests of Lough Ree and other European sites with the potential to be impacted. This has demonstrated that turf-cutting within the proposed locations will not impact the integrity of any European site. Presently turf-cutting is not permitted on these sites until the appropriate consents are received from the relevant public authorities.

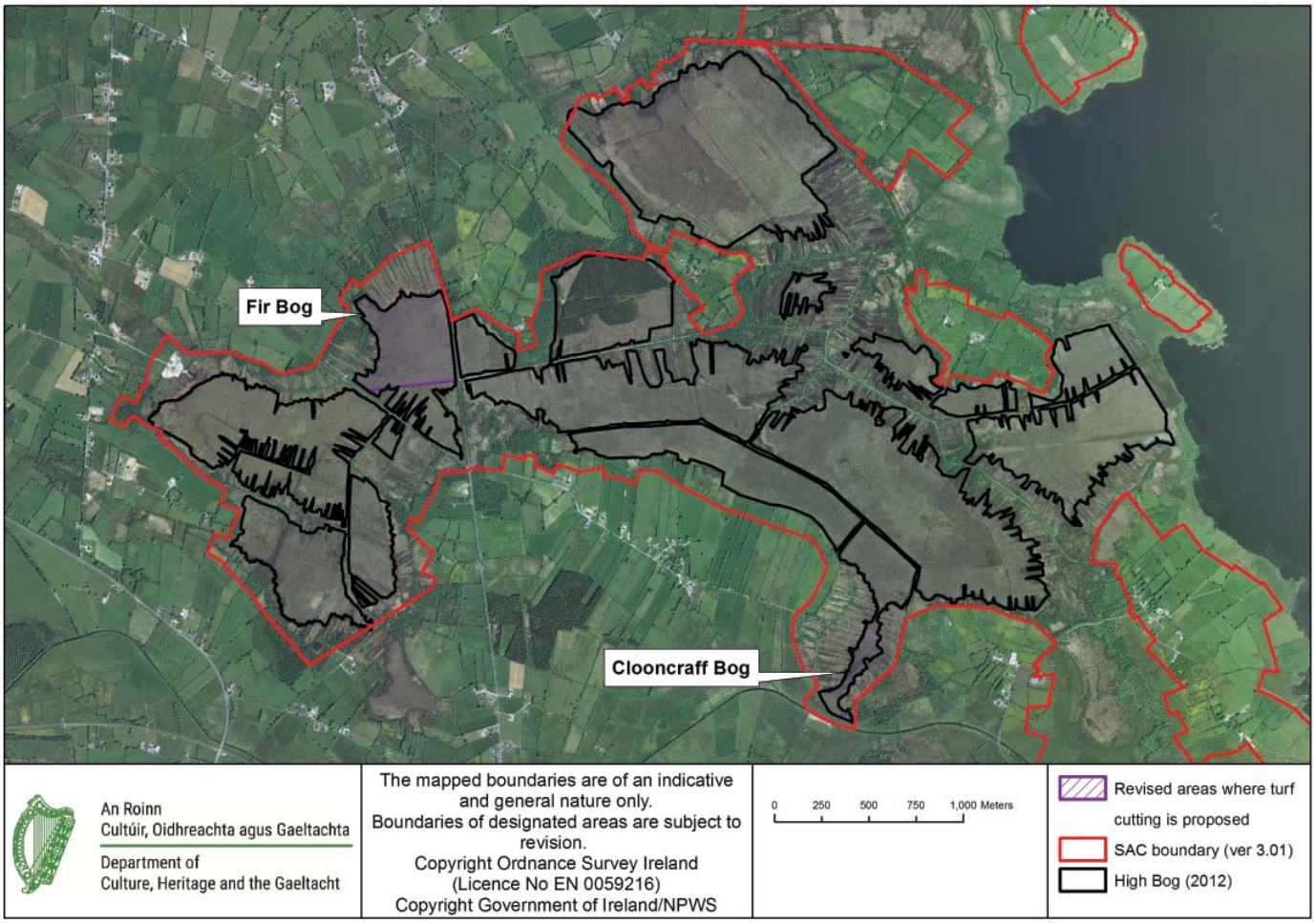


Figure 5.2: Areas where turf-cutting can be carried out at Lough Ree SAC without impacting on site-specific conservation objectives for ARB

Application of Article 6(3) to other SACs

In the case of Moneybeg and Clareisland Bogs SAC, a programme of initial investigations including complete ecotope mapping of both bogs was followed by a detailed programme of surveys comprising of extensive peat sampling and a comprehensive Ground Penetrating Radar survey. In this case it has been necessary to revise the areas originally identified to ensure that turf-cutting will not impact on site-specific conservation objectives for ARB. Overall, it has been possible to conclude that turf-cutting within the areas outlined in Figure 5.3 will not impact on the current site-specific conservation objectives (NPWS, 2016b). Similar to Lough Ree SAC above, turf-cutting is not permitted on this site until the relevant consents are obtained from the appropriate public authorities.

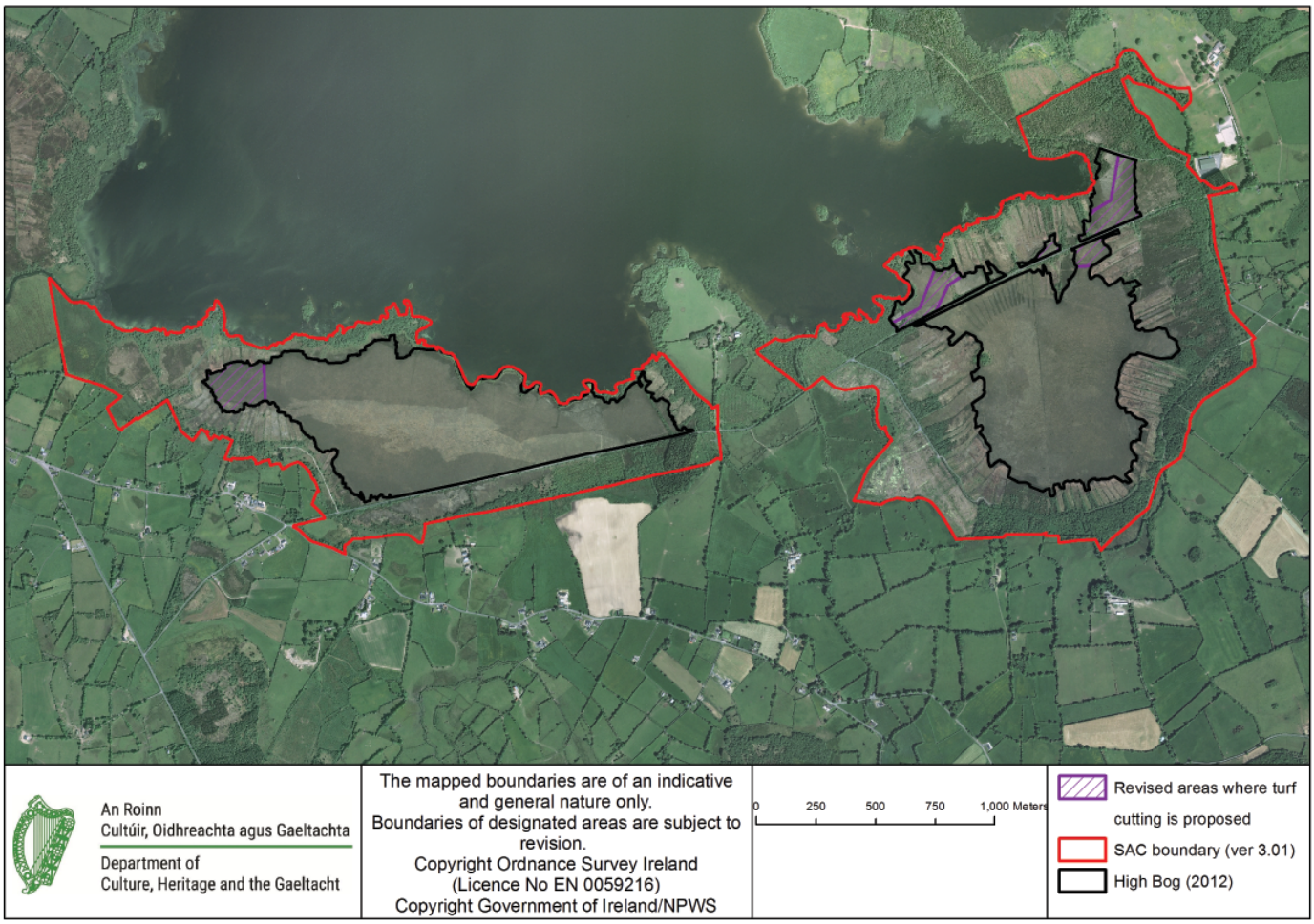


Figure 5.3: Areas where turf-cutting can be carried out at Moneybeg and Clareisland Bogs without impacting on site-specific conservation objectives for ARB

In the case of Lough Lurgeen Bog/Glenamaddy Turlough SAC, an area of extremely damaged high bog as well as an area containing some small high bog remnants were identified by the TCCA. In this case, it has been possible to conclude that these areas are hydrologically isolated from the parts of the site supporting the qualifying interests of this SAC. Therefore, it has been possible to conclude that turf-cutting within the areas identified in Figure 5.4 will not impact on site-specific conservation objectives. As with Lough Ree SAC and Moneybeg and Clareisland Bogs SAC, turf-cutting is not permitted on this site until the relevant consents are obtained from the appropriate competent public authorities.

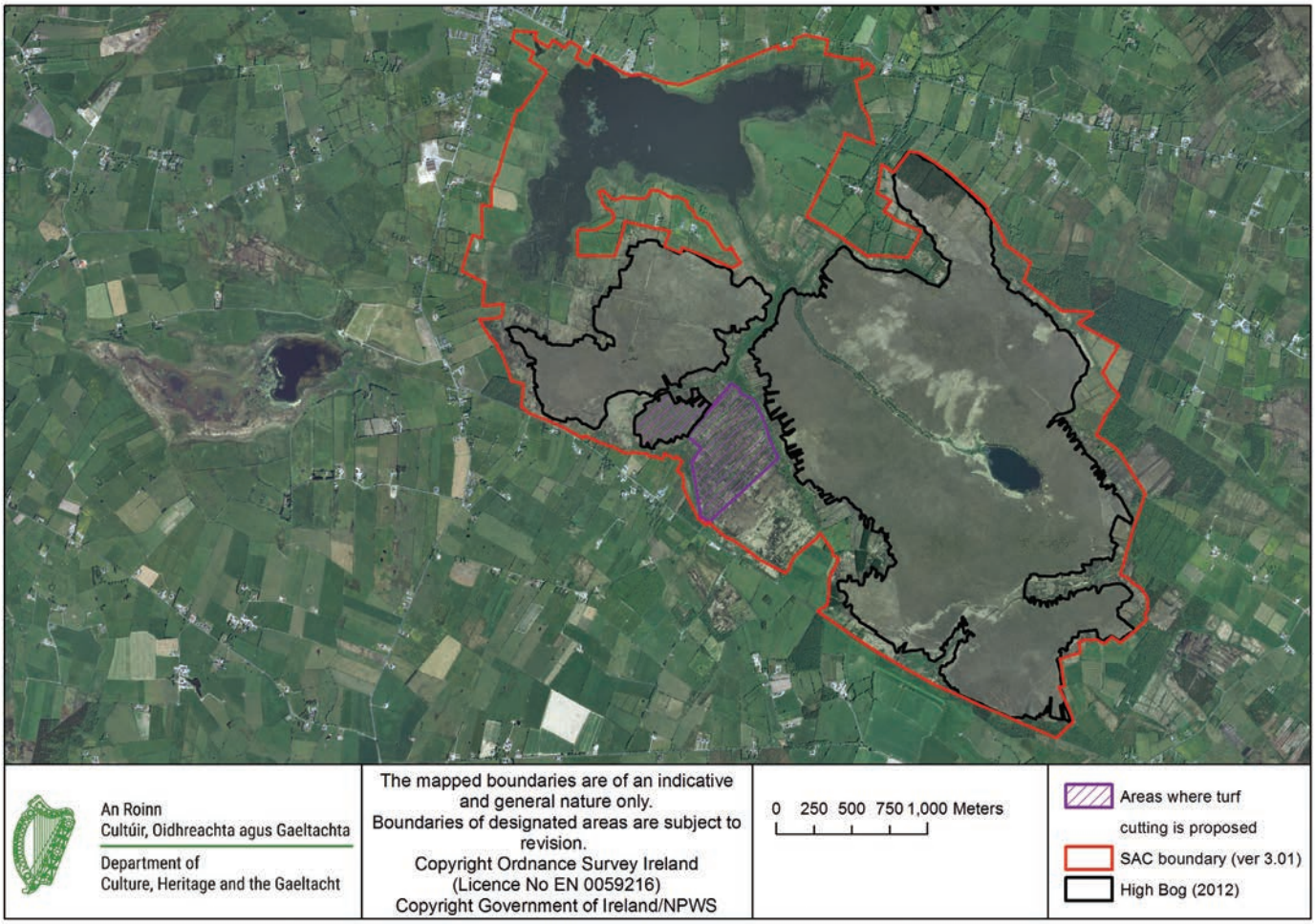


Figure 5.4: Area within Lough Lurgeen Bog/Glenamaddy Turlough SAC where high bog remnants can be cut without impacting on site-specific conservation objectives for ARB

Initial investigations have already been carried out at Monivea Bog SAC, Redwood Bog SAC, Callow Bog SAC, Bellanagare Bog SAC, Corliskea/Trien/Cloonfelliv Bog SAC, Coolrain Bog SAC, Moanveanlagh Bog SAC and Cloongoonagh Bog (River Moy SAC) comprising flow and hydrochemistry surveys along with peat coring. The initial survey results have been collated and detailed field surveys designed to assess the potential impact of turf-cutting in each of the areas proposed. Detailed surveys have been carried out at Monivea Bog SAC, Redwood Bog SAC, Callow Bog SAC, Bellanagare Bog SAC, Corliskea/Trien/Cloonfelliv Bog SAC, Cloongoonagh Bog (River Moy SAC) and Clooneen Bog SAC. Where data analysis and interpretation identifies knowledge gaps further information may be required through additional site investigations. An initial phase of detailed surveys commenced at Moanveanlagh Bog in October 2017 and a second, final phase will commence in late 2017/early 2018.

For the remaining SACs (Mouds Bog SAC and Barroughter Bog SAC), it is hoped that initial investigations may be initiated as soon as possible.

In summary, it can be concluded that continued cutting on small areas within some SACs is possible with consent under Article 6(3). Consent in general will be subject to AA and if screened in as needing an AA the project/plan will be required under current legislation to go through the planning process and will be subject to the consent of the relevant competent public authorities. In the interim, no cutting should take place on these sites.

Where a landowner or turbary right holder does not wish to cut turf on the site, it will be necessary to establish whether the landowner or turbary right holder of the land in question is interested in or willing to allow turf-cutting or the commencement of turf-cutting on the land. This issue and other relevant issues will be explored further with turf-cutters in the context of implementing this plan (see Chapter 7).

Invoking Article 6(4) for Domestic Turf-cutting

The Habitats Directive makes provision under Article 6(4) for damaging activity to be undertaken on SACs in exceptional circumstances. This provision applies when the AA process concludes with a negative assessment, whereby a proposal is likely to have an adverse effect on the integrity of a site and certain tests provided for in Article 6(4) of the Directive can be met.

In short, the tests include the following:

1. The alternative put forward for approval is the least damaging for habitats, for species and for the integrity of the Natura 2000 site, regardless of economic considerations, and that no other feasible alternative exists that would not affect the integrity of the site.
2. There are imperative reasons of overriding public interest, including "those of a social or economic nature" for the project/plan to be undertaken. Being an exception to Article 6(3), this provision can only be applied to circumstances where all the conditions required by the Directive are fully satisfied. In this regard, it falls on whoever wants to make use of this exception to prove, as a prerequisite, that the aforementioned conditions do indeed exist in each particular case.
3. Once the lack of suitable alternatives and the acceptance of imperative reasons of overriding public interest are fully ascertained and documented, all compensatory measures (measures intended to offset the negative effects of the plan or project so that the overall ecological coherence of the Natura 2000 Network is maintained) have to be taken. Compensatory measures should be considered only when the application of other safeguards, such as mitigation measures, is not sufficient. The compensatory measures adopted must always be then communicated to the Commission.
4. In considering plans and projects involving activities such as turf-cutting, where priority habitats (such as active raised bog) are affected, an opinion of the European Commission is required before consent can be given to a damaging activity.

The European Commission has issued guidance (EC, 2007) on the application of Article 6(4). In the 20 years since the Habitats Directive has come into force there have been fewer than 20 cases throughout the EU involving priority habitats that have secured consent under Article 6(4). These cases were for specific projects, many for the benefit of a national economy.

Any case put forward for turf-cutting under Article 6(4) would be considered an exceptional circumstance and has to be in the context of an overall solution for protected raised bogs to ensure that the integrity of the raised bog SACs network remains intact. Invoking Article 6(4) will be considered in conjunction with other measures being available such as relocation, restoration and financial compensation.

Where imperative reasons of overriding public interest exist, an assessment to consider whether compensatory measures will, or will not, effectively offset damage to the SAC will be required. These measures can consist of restoration, designation of new habitat, improving the remaining habitat proportional to that which is lost or prevention of further erosion of the coherence of the raised bog SACs network. If a case for invoking Article 6(4) for domestic turf-cutting within raised bog SACs is made, it will need to be demonstrated that the compensatory measures will be successful. It is likely that the State will need to apply generous compensatory measures such as designating additional site(s) as SACs of scientific value to make up for any damage to existing SACs.

The possible application of Article 6(4) to raised bog SACs

The central recommendation of the Quirke Report (Quirke, 2012) was that a national plan be put in place to reflect the legal parameters of the Habitats Directive. A plan, covering the future restoration and management of all 53 raised bog SACs, could consider the flexibility provided by pursuing the provisions of Article 6(4), if it is required, for a small number of SACs. The European Commissioner agreed in 2012 to work with the Irish Government in exploring the possibilities of such an approach where it would deliver an agreed network solution and secure the long-term conservation of Ireland's raised bog SACs.

A key objective of this plan is to seek solutions that avoid damage to the SACs. This is the central requirement of Article 6 of the Directive. **Pursuing a case under Article 6(4) will only be considered if the needs of turf-cutters cannot be met through relocation to nearby bogs or if other alternatives are not feasible.**

Following extensive work by turf-cutters and the Department in identifying potential relocation sites, it is clear that relocation is a solution for the vast majority of SACs. However, in a small number of cases, based on the information available, the relocation site identified may not be suitable or there may be difficulties in accommodating all turf-cutters requiring relocation in the available alternative site(s). It is only for these SAC sites that potential flexibility could be sought, based on these criteria.

A number of raised bog SACs have been put forward by turf-cutting representatives as possible sites for continued cutting as discussed in the section on Article 6(3) above. Consideration will be given by the State only in certain circumstances to the utilisation of the provisions of Article 6(4) where it has been concluded following an assessment that turf-cutting would not be possible under Article 6(3).

This comprises cases where there are significant problems in identifying suitable relocation sites and where there are a substantial number of turf-cutters seeking to continue turf-cutting.

In considering whether the Article 6(4) tests could be met in relation to continued turf-extraction at a small number of sites, an assessment of alternative solutions is required, the sites need to pass the imperative reasons of overriding public interest test, compensatory measures would need to be found and the opinion of the European Commission is required if priority habitat would be impacted.

Assessment of Alternative Solutions

In line with the requirements for the protection of the Natura 2000 Network, the revision and/or withdrawal of a proposed plan or project should be considered first when significant negative effects on the integrity of a site have been identified, particularly in the case of effects on priority habitats and/or species protected under the Habitats Directive. The 'zero option' should be examined at this stage.

Subsequently, the possibility of resorting to alternative solutions which better respect the integrity of the site in question must be explored and in particular, their relative performance with regard to the conservation objectives of the Natura 2000 site, the site's integrity and its contribution to the overall coherence of the Natura 2000 Network. Such solutions are generally identified within the framework of the assessment carried out under Article 6(3).

Zero option

Considerable efforts have been made to resolve the issue of preserving and restoring the raised bog SACs network. The approach to date has been to endeavour to resolve the issues through negotiation and working together with all stakeholders. While many turf-cutters are availing of the compensation available, some areas have proved problematic due, for example, to a lack of alternative non-designated sites as set out above.

Consideration of developing a case for Article 6(4) for a limited number of areas must be seen against the objective of an overall network solution to resolve the situation to the satisfaction of both Ireland and the European Commission. If it is decided to not even pursue the possibility of a case for Article 6(4) at this stage, then it is likely to cause serious impediments to reaching agreement on an overall network solution despite the time and resources that have been put into that approach.

Relocation

As part of the process rational, comparable assessment criteria were set that could be applied to objectively determine that no alternatives sites for turf-cutting were available, recognising also that each site will have its own particular circumstances.

The following criteria were applied in determining whether alternative sites for turf-cutting were available:

1. A distance of up to 15km from the SAC is reasonable. The Department has found that the success of the relocation process is, in part, linked to sourcing sites as near as possible to the original SAC. For bogs identified at distances over 15km the number of turf-cutters willing to engage in relocation to non-designated sites reduces considerably.
2. Sites should be suitable for turf-cutting, and:

- There should be adequate quantity and quality of turf to allow for a domestic supply of turf for the individual to be relocated commensurate with the plot they are leaving or for a defined period of time.
- Adequate spread ground should be available.
- Suitable access and drainage should be in place or the cost of developing these necessary infrastructures should not be excessive.

3. Use of the bog for turf-extraction can be provided to the turf-cutter on a long-term basis.

Where there is an opportunity for turf-cutters to be accommodated through relocation to another undesignated bog within a reasonable distance, this clearly amounts to an alternative and the first criterion would not be met.

Financial compensation

The provision of financial compensation under the CTCCS, administered by the Department of Culture, Heritage and the Gaeltacht, allows applicants to source turf outside the SAC sites or to purchase an alternative source of fuel. For the sites being considered for utilisation of the provisions of Article 6 of the Habitats Directive, a significant number of turf-cutters at these sites are unwilling to enter into the scheme and accept the financial compensation available.

Lump sum payments under the CTCCS

Under the CTCCS the Department has been making the annual compensation available as a lump sum payment to qualifying applicants on a site-by-site basis. These applicants have expressed a clear and ongoing commitment to relocation but there are difficulties in pursuing relocation options for them in terms of a relocation site being available or the capacity of an identified relocation site. Any significant roll out of lump sum payments would have implications for the annual allocation made available to the Department of Culture, Heritage and the Gaeltacht for turf compensation within the budgetary process.

Imperative reasons of overriding public interest test

As outlined previously, an imperative reason of overriding public interest is an interest capable of justifying, within the meaning of Article 6(4) of the Habitats Directive, the implementation of a plan or project which is both 'public' and 'overriding', which means that it must be of such an importance that it can be weighed up against the Habitats Directive's objective of the conservation of natural habitats and wild fauna and flora. Works intended for the location or expansion of an undertaking satisfy those conditions only in exceptional circumstances.

Concerns raised by turf-cutters since the cessation on turf-cutting on raised bogs have been consistent over the years. Many perceive the cessation as a measure "which will deprive them of a vital, natural resource situated on or near their homes or properties and which forms a fundamental part of their livelihood, their sustenance and their heritage" (Quirke Report, 2012). As indicated also by the public consultation on the draft National Raised Bog Special Areas of Conservation Management Plan, there is a strong local and regional dependence on turf in Ireland. At an individual or a bog level, the cutting of turf is a private interest for the sole benefit of the individuals who own the land or turbary rights and also the contractor who is paid for the services provided. When viewed at that level, it is difficult to see an imperative reason of overriding public interest in a small number of individuals continuing to undertake turf-cutting for their private benefit, at the cost of the public good of preventing damage to the SAC. In particular, the option exists for these individuals to apply for and receive financial compensation under the CTCCS or relocate to a non-designated bog, where feasible.

However, when looked at from the national perspective the conclusion could be different. If the availability of flexibility in a small number of sites, due to a genuine and demonstrable lack of feasible alternatives for turf-cutters, would secure an agreed national network solution to the long-term conservation of Ireland's raised bog SACs, which is clearly in the public interest, then the overriding public interest becomes clearer. In short, the long-term conservation of the raised bog SACs network could be an imperative reason of overriding public interest that might be invoked to allow flexibility in a small number of SACs, where alternatives do not exist.

National level

Since the 1990s there has been an impasse between the State, in its remit to fulfil its objectives under the Habitats Directive, and certain elements of the turf-cutting community. After years of negotiations and discussions, the introduction of compensation, relocation and planned-for restoration measures, the State is of the belief that a national solution to the raised bog SACs conservation issue is very close. In this context, if the availability of flexibility in relation to a small number of SAC sites, due to a genuine and demonstrable lack of relocation alternatives for turf-cutters, who for social, cultural and economic reasons wish to continue to cut turf, would secure an agreed national network solution to the long-term conservation of Ireland's raised bog SACs, which is clearly in the public interest, then the overriding public interest becomes more apparent.

Social: The Irish people have been closely connected to peatlands by a long history of cultural and economic development. Turf-cutting by citizens for their own domestic fuel needs has been a valued traditional activity across many peatlands. As Justice John Quirke concluded in his Peatlands Forum Report 2012 "those most affected by the restrictions are the turf-cutting communities who for generations, and in some cases for centuries, have enjoyed ownership, property and turbary rights on the relevant bogs". It is these turf-cutting communities that have been requested to forego property rights in the raised bog SACs in the greater interests of the wider community. The turf-cutting communities have demonstrated their willingness to accept financial compensation or relocation to non-designated bogs in return for the non-exercise of the right to cut turf. However, it is considered necessary to explore the possibility for allowing turf-cutting on a limited number of SAC sites so that efforts can continue to secure agreement across the turf-cutting communities to a network solution to the restoration and conservation of the raised bog SACs.

Economic: The characteristics of turf-cutting for domestic fuel have changed significantly from the days of hand cutting with the sleán[15]. Nowadays, most turf is cut by machine and harvesting of the turf is done by hand. The cutting of the turf provides employment for turf-cutting contractors and their employees. It supports a certain number of jobs in rural, economically disadvantaged communities. Turf is seen by many as more economically advantageous than other sources of fuel such as oil or gas. These alternative sources of fuels could be considered by some to have globally more of an environmental impact than domestic turf-cutting.

Mitigation measures and compensatory habitat

The loss in ARB and DRB arising from the continuation of turf-cutting through an Article 6(4) process will need to be balanced by the designation of generous areas of raised bog as compensatory habitat. For the small number of sites on which turf-cutting may be permitted in accordance with Article 6(4), cutting would be limited to a specific area(s) within the site if this would allow for the remainder of the site to be restored. In the national context this will mean that the national target for ARB restoration within SACs will still be met.

For each raised bog SAC, where it is proposed that Article 6(4) of the Habitats Directive will be utilised, AA and an application for consent through the planning process will likely apply.

15. Instrument used to cut peat by hand.

Summary - Invoking Article 6(3)/6(4) for Domestic Turf Cutting

The Government believes that the implementation of this National Raised Bog Special Areas of Conservation Management Plan will result in Ireland's conservation targets for raised bog being met. The vast majority of turf-cutters are accepting financial compensation or relocation to non-designated bogs, and if approved a minority of turf-cutters may cut on SACs by utilising the provisions of Article 6(3) and Article 6(4) of the Habitats Directive. For the small number of sites on which turf-cutting may be permitted in accordance with Article 6(3) or 6(4), cutting would be limited to a specific area(s) within the SAC to allow for the remainder of the site to be restored.

Managing the Raised Bog SACs Network for Other Land Uses

The National Peatlands Strategy recognises that the management and use of peatlands takes place in a complex regulatory environment with overlapping sectoral policies, legal frameworks and licence and consents requirements. Raised bogs due to their nature are a complex and dynamic environment and positive management of this resource is required with the involvement of all stakeholders. The rights and interests of landowners and land users of the raised bog SACs network will be considered in this regard.

In order to protect ecologically important sites, certain potentially harmful works are restricted within European sites. These works, referred to as Activities Requiring Consent (and previously commonly referred to as Notifiable Actions), vary depending on the type of habitat present. Regulation 28 of the European Communities (Birds and Natural Habitats) Regulations 2011 gives the Minister for Culture, Heritage and the Gaeltacht the power to make Directions in respect of Activities Requiring Consent. Every SAC and SPA in Ireland is subject to a Direction in relation to Activities Requiring Consent. Any user contemplating undertaking such activities must seek the consent of the Minister. There may be instances where this does not apply, such as where the activity is subject to the consent of another public authority or has been authorised as part of an agreed farm or land management plan.

Under Article 6(3) of the Habitats Directive any project/plan that is likely to have a significant effect on a European site must be subject to AA of its implications for the site in view of the site's conservation objectives. The competent national authorities shall agree to the plan or project only after having ascertained that it will not adversely affect the integrity of the site concerned and, if appropriate, after having obtained the opinion of the general public. The Environmental Impact Assessment (EIA) Directive imposes an obligation that certain decisions which are likely to have significant environmental impacts may only be taken after a proper assessment of those environmental impacts have been undertaken.

A wide range of public authorities plays a role in determining how the raised bog SACs network is used. Uses are influenced in part by publicly funded financial supports and incentives. In accordance with the vision and values that have been set out in the National Peatlands Strategy, the approach to the management of the raised bog SACs network will be based on a broader appreciation of the benefits derived from our peatlands. Public authorities will be responsible for delivering the objectives of the National Peatlands Strategy in their functional areas in keeping with its vision, values and principles.

A series of land uses can take place mostly on the surrounding cutover areas of the raised bog SACs network once these are compatible with the conservation objectives of the site.

Fire management

Fire can be a major threat to the raised bog SACs network. Under the National Peatlands Strategy, a code of best practice will be established regarding the use of fire as a land management tool, to avoid accidental damage and to limit environmental harm. For the raised bog SACs proposed for restoration, fire plans will be developed in conjunction with the implementation of conservation measures.

Waste management

Unauthorised dumping within the raised bog SACs network is a serious issue that affects all stakeholders. A resolution to the issue will require the co-operation of local authorities, local communities, the Environmental Protection Agency (EPA), Coillte, Bord na Móna, landowners and the Department of Culture, Heritage and the Gaeltacht. As part of the site-specific plans to be developed for the raised bog SACs a waste management strategy will be incorporated into the plans where relevant.

Heritage management

Ireland's national assemblage of archaeological finds is dominated by artefacts identified in Irish bogs and provided to the National Museum of Ireland. Almost 3,000 individual artefacts within the national collection, including some of the most prestigious metal hoards, were found in bogs as peat was cut by hand along the fringes of our raised bogs. Many midland bogs have revealed the remains of human sacrifice, with recent examples such as Clonycavan and Old Croaghan and Cashel Man adding significantly to our knowledge of the past. As well as depositing objects and human remains (bog bodies) for ritual and preservation purposes, peatlands were accessed for resources and were traversed for purposes of communication and economy for millennia. Thousands of monuments – including platforms, toghers and post rows – have been identified in Ireland's midland bogs, with clusters of these sites at narrow crossing points between dryland areas and at the margin of bogs in ecologically diverse

zones. Occasionally, family groups sought a permanent refuge in these wetlands and constructed their settlements or crannógs within them (Moloney *et al.*, 1993).

The waterlogged, anaerobic and acidic conditions provide for the preservation of organic and some inorganic remains. Archaeologists excavating in dryland contexts can find approximately 10% of the material culture of a settlement, while those excavating in a wetland context can find around 90% including artefacts of wood, textile, bone, skin, shell and antler. Thus, it can be seen that the potential for recovery of such material in raised bogs is high. Studies in pollen, plant and insect remains and tephra can elucidate changes in past woodland cover, in climate, temperature and precipitation and can chart volcanic eruptions thousands of miles away.

It is a requirement of the National Monuments Acts that any archaeological object (an object which has no known owner and which has a value in excess of its intrinsic value) identified should be reported to the local Gardaí and to the Director of the National Museum of Ireland within a short time scale of its finding. A finder's reward is paid on foot of such reporting and provision of the artefact to the legal owner, the State.

Private owners of peatlands, or those who commission or carry out work, have obligations in terms of works in proximity to monuments included in the Record of Monuments and Places under Section 12 of the 1994 National Monuments Amendment Act. Any disturbance to peat or excavation of peat has the potential to uncover items or features of archaeological significance and the potential for discovery should be provided for by suitable mitigation in all programmes of work relating to these environments.

Monuments which are known about are illustrated on the Department's website at www.archaeology.ie and information about the identification of newly recognised monuments is always gratefully received at national. monuments@chg.gov.ie.

Water management

Under the National Peatlands Strategy, policies and decisions relating to the use of peatlands shall take full consideration of potential impacts on water quality and the attainment by the State of mandatory water quality standards. Maintaining and restoring Irish raised bogs will lead to a decrease in waterborne carbon leaching to levels comparable with intact bogs as well as reducing losses of peat silt and ammonia. Raised bog restoration can help Ireland meet different regulatory targets including in the Water Framework Directive, which sets targets to achieve 'good ecological status' in European water bodies. Already, the restoration of bogs in the UK has prevented further decline in drinking water quality (Martin-Ortega *et al.*, 2014).

Restoring the natural functioning of wetlands may provide a range of benefits, including improved water quality and flood attenuation. In many instances bog restoration can return more natural hydrological conditions whereby flow is attenuated and reaches the surrounding watercourses more slowly than when drains were present. As part of the restoration plans for the raised bog SACs it is proposed that initially the existing drainage network in the environs of the EU LIFE project's 12 SAC sites will be examined and integrated drainage management plans developed in partnership with landowners and relevant public bodies where necessary. Through this survey work the need for specific maintenance and upgrade of the drainage network will be identified where necessary so that peak flows can be adequately conveyed along the network as part of an overall flood management strategy. Whilst restoration of raised bogs may have a limited capacity to attenuate flooding during the infrequent, high rainfall events, it is accepted that they can assist in achieving targets set under other policy areas (including the Water Framework Directive, the Habitats Directive, the National Biodiversity Plan, and the UN Framework on Climate Change).

The OPW is the agency through which the Government exercises its responsibilities in respect of river drainage and flood relief. When it is carrying out any arterial drainage works within or close to an SAC, it is obliged to carry out an assessment of any potential impacts. Again, just like a landowner, farmer or any other agency, the OPW is required to be confident that the works will have no significant negative impact on the designated site before the works can commence. The Department of Culture, Heritage and the Gaeltacht works closely with the OPW to ensure its operations not only do not cause any negative impacts but also to advise where beneficial works for local drainage purposes can be pursued. The Department will work in the future with OPW in exploring options where restoration measures on raised bogs may contribute to flood risk management.

Agriculture

In general, farming activities on surrounding mineral soils and reclaimed cutovers have minimal impacts on the raised bog SACs, and in fact in some cases farming practice can enhance the protected site. Intact high bog is difficult for large animals to cross and the vegetation is not palatable or nutritious. However, areas of cutover on better draining ground can be valuable grazing land. If the farming activity is low intensity then these cutover areas can be of high biodiversity value – a compromise can be met between the needs of the farmer and the nature value of the land.

Management by farmers can enhance the biodiversity value of the lands in question and improve the conservation value of the adjacent peatlands. Wild flowers can flourish and insects which depend on them can thrive on cutover bogs. One plant which can flourish is Devil's-bit Scabious (*Succissa pratensis*). Although it is an attractive flower in its own right with small round, blue flower-heads, it is also the food plant of the Marsh Fritillary (*Euphydryas aurinia*), one of Ireland's rarest butterflies and an Annexed species in the Habitats Directive. Raised bogs and adjacent semi-natural wet grasslands are essential habitats for the survival of curlews in Ireland, one of the most threatened bird species in the country. More than half of the breeding pairs left in the country nest on raised bogs.

Forestry

Under the National Peatlands Strategy a review of forest policy will consider and assess whether sufficient safeguards are currently in place to ensure that inappropriate afforestation does not occur on peatland. The forest policy review will take into account, amongst other things, the impact of planting on hydrology, impacts on carbon loss and sequestration and the potential for adverse impacts on neighbouring watercourses. Forest Service guidelines set out the current system for forestry consents and conditions for compliance with regulatory frameworks and statutory provisions. Forestry can be deemed suitable on certain cutover areas of raised bogs and compatible with the conservation objectives of the site. The Department of Culture, Heritage and the Gaeltacht normally regards native broad-leaved trees (e.g. alder, oak, birch) as the preferred option, since they would be more compatible with the SAC designation status (non-native conifer trees are typically less attractive in biodiversity terms and can become invasive).

Recreation

Given that our raised bogs are some of Ireland's remaining "unfenced country", as Seamus Heaney termed them, they can be considered almost as wilderness areas and they have an obvious attraction for certain pursuits and as an area for being in contact with nature. There is considerable scope to encourage local clubs and community groups to pursue projects aimed at rehabilitating raised bogs compatible with the management of the raised bog network. This is already happening at some bog sites, a good example being the Ballydangan Bog Red Grouse Project which aims to prevent the decline and, in the long term, increase the numbers, of red grouse and other breeding birds on Ballydangan Bog, Co. Roscommon (on lands owned by Bord na Móna).

Beekeeping is a hobby which has grown in popularity in recent years and cutover bog can provide an ideal location with hundreds of acres of flowering heather for bees to feed on. The tranquillity of the bog would seem to be in keeping with the spirit of the hobby.

Substantial opportunities exist for the enhancement of raised bogs as sustainable tourism and recreation amenities and to return a community dividend. The open, natural environment of an SAC can be an ideal place for physical exercise, relaxation, social interaction and can provide general benefits to health and well-being. Having these amenities in turn encourages inward investment through eco-tourism and other industries.

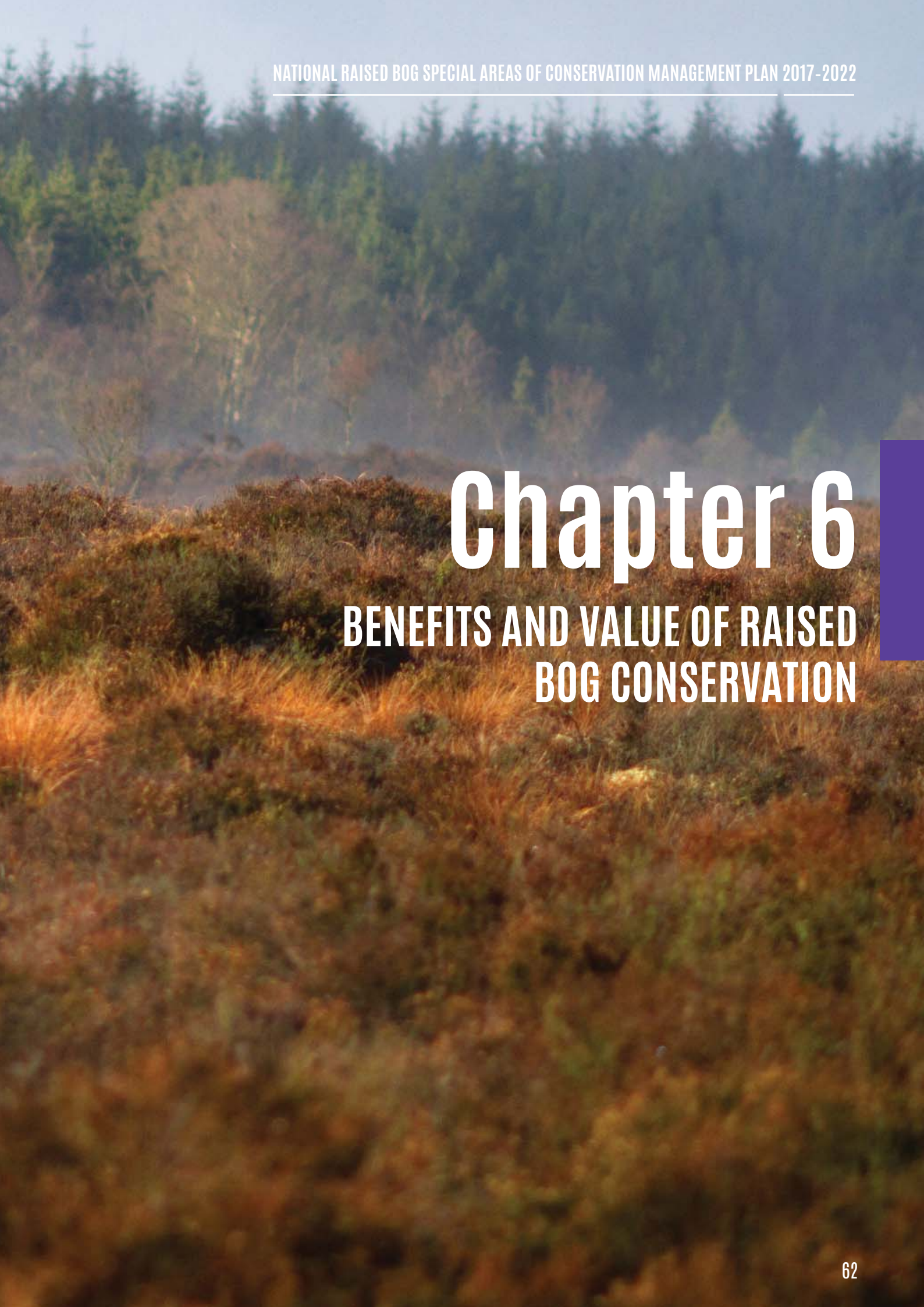
Through consultation with the local community and other stakeholders, through the site-specific restoration plans, it will be possible to develop ideas for maximising socio-economic benefits for the local community through conservation and restoration. These might include building or improving existing facilities (i.e. tracks, boardwalks, bog bridges), encouraging the creation of small tourism enterprises, promoting the benefits to human health and well-being and enhancing the value of a site as an educational resource (both for ecological features and potential industrial archaeological and architectural heritage features that may be present within and surrounding the site). There is significant potential for investment in upgrading, expanding and maintaining these facilities as access routes for amenity and recreation.

Boardwalks and bog bridges have been built and paths improved in many raised bogs across the country and are very popular among the locals as well as being successful in attracting visitors to the sites. The following are some examples: Abbeyleix Bog (Co. Laois), Carn Park Bog SAC (Co. Westmeath), Carrowbehy/Caher Bog SAC (Co. Roscommon), Carrownagappul Bog SAC (Co. Galway), Cloonshanville Bog SAC (Co. Roscommon), Girley Bog NHA (Co. Meath), Monivea Bog SAC (Co. Galway) and Scohaboy Bog NHA (Co. Tipperary). An excursion around Girley Bog is now a regular fixture in the annual Hay Festival in Kells, Co. Meath where both the natural and artistic aspects of the bog are explored.

At Clara, Co. Offaly, a multi-purpose building has been constructed to house a raised bog interpretative centre and town library, which has become a focal point for nature education and tourism. The construction of a boardwalk over a portion of Clara Bog SAC also provides a local recreational facility and offers further potential to attract tourists interested in the outdoor experience (see Plates 5.1 and 5.2).

Plate 5.1 Interpretative display at Clara Raised Bog SAC, Co. Offaly

Plate 5.2 Boardwalk at Clara Raised Bog SAC



Chapter 6

BENEFITS AND VALUE OF RAISED BOG CONSERVATION

Chapter 6
THE BENEFITS AND VALUE OF RAISED BOG CONSERVATION

Intact peatlands, like many other ecosystems throughout Ireland and globally, provide valuable benefits to society. Such nature-generated benefits are known as "ecosystem services". Changes brought upon ecosystems can have significant effects, often unintended, on the provision of such services. These effects may be felt at different locations or over different time frames. By evaluating ecosystem services (both monetary and non-monetary), it is possible to quantify the benefits and trade-offs of exploitation and restoration of ecosystems.

Ecosystem services provided by peatlands include water filtration and supply; climate regulation via carbon storage and sequestration; and cultural benefits such as preservation of artefacts and recreational opportunities. Some services, whilst delivering useful products (such as horticultural peat and peat for energy generation), are regarded as non-sustainable as they involve disturbances to the ecosystem that are irreversible on any timescale relevant to society.

Figure 6.1 gives an overview of the ecological functions of a typical raised bog, along with potential uses and associated ecosystem services and benefits, which are divided into 'non-sustainable' uses or 'sustainable' services and benefits. These benefits are further discussed below in the context of this plan, describing each ecological function and what happens when a bog is degraded, be it drained or cut for turf and, conversely, when it is restored with the objective of returning it to a more natural state.

There is growing global interest in ending non-sustainable uses of peat and bringing back 'sustainable' services and benefits that peatlands provide to society as a whole through restoration. Positive results have already been demonstrated in Germany, for example, where a suite of ecosystem services was brought back 10 years after rewetting a degraded peatland (Zerbe *et al.*, 2013).

Together with remnants of primeval forests, Ireland's raised bogs form part of our oldest surviving ecosystems. They are a key part of Ireland's natural heritage and an important part of Ireland's "natural capital". Natural capital is the term used to describe the "elements of nature that produce value – directly and indirectly – to people, such as the stocks of forests, rivers, soil, minerals and oceans" (DEFRA, 2013). These stocks work together to deliver ecosystem goods and services that in turn provide benefits to society.

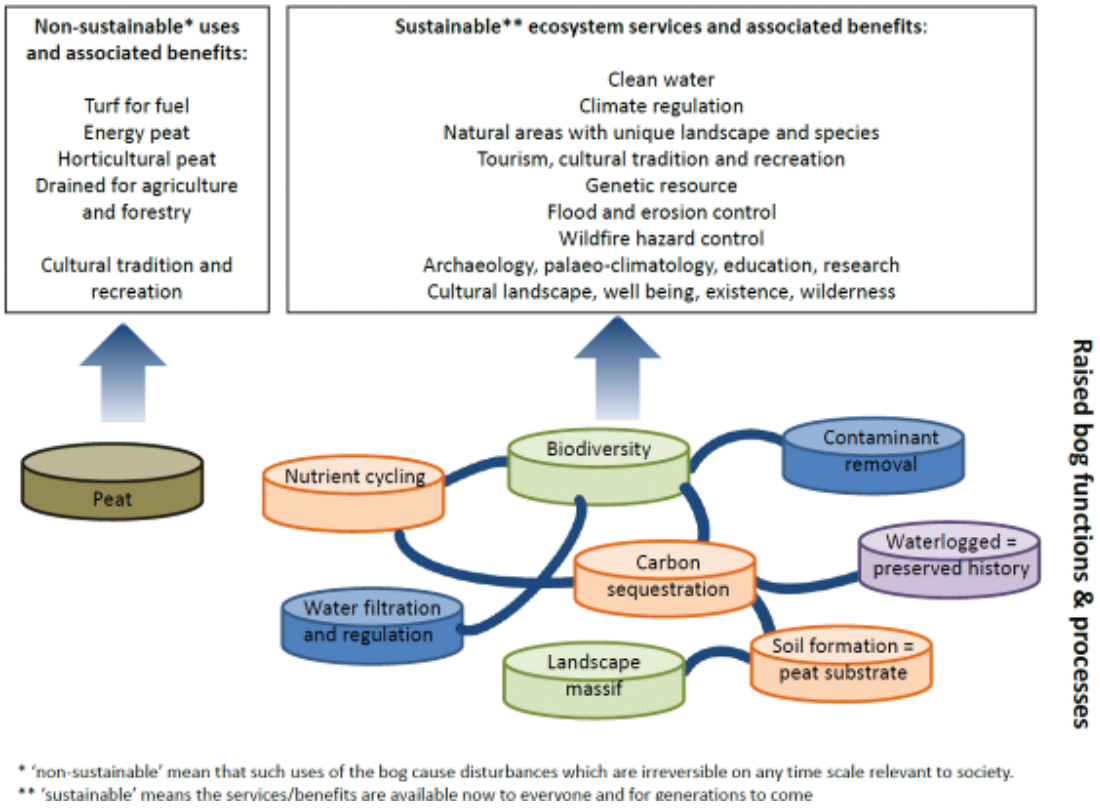


Figure 6.1: Raised bog ecosystem functions, uses, services and associated benefits

There are generally four recognised categories of ecosystem services (The Economics of Ecosystems and Biodiversity (TEEB)[16]):

1. **Regulating services:** the services that ecosystems provide by acting as regulators e.g. regulating the quality of air and soil or by providing flood and disease control.
2. **Provisioning services:** ecosystem services that provide the material or energy outputs from ecosystems. They include food, water and other resources.
3. **Habitat or supporting services:** habitats provide everything that an individual plant or animal needs to survive: food, water and shelter. Each ecosystem provides different habitats that can be essential for a species' lifecycle.
4. **Cultural services:** these services can include recreation, health and well-being, culture, aesthetic appreciation, art, design, spirituality and sense of place.

As mentioned earlier, raised bogs can provide many such ecosystem services, including reducing carbon emissions, assisting with flood regulation, providing a home for our most threatened habitats and species and a place to improve the mind and body. The following section describes the most relevant services and functions that raised bogs in good condition can provide:

- Carbon storage and carbon sequestration
- Support of habitat and species biodiversity
- Water purification and flood attenuation
- Landscape and recreation
- Cultural heritage preservation
- Peat as a resource

Carbon storage and carbon sequestration

Associated services/benefits: climate regulation and mitigation against climate warming through removal of carbon dioxide (CO_2) from the atmosphere.

Bogs contain 75% of all the soil organic carbon in Ireland and one hectare of raised bog contains the same amount of carbon as that being emitted annually by 1,040 cars. In contrast to most other ecosystems, which rapidly recycle biomass, thus releasing carbon dioxide, water and nutrients, bog biomass does not decay completely and builds up as peat due to the very wet and acid environment. A healthy, undrained bog can store carbon indefinitely. Healthy bogs are not only the guardians of this carbon store, but their vegetation continually fixes carbon from the atmosphere, some of which then remains in the ecosystem as the peat accumulates.

When a raised bog is either drained or cut, causing the bog to become drier, decomposition of the peat increases, the bog no longer accumulates carbon and starts to release

16. www.teebweb.org

carbon dioxide to the atmosphere, thereby contributing to climate warming. The area that is usually used for turf-cutting i.e. the outer edge of a raised bog, has been shown to emit six to seven times more carbon dioxide than the centre of the bog (Renou-Wilson *et al.*, 2011).

Total carbon dioxide emissions from bogs, where peat is extracted for either industrial energy production, domestic turf or horticulture, together with off-site emissions from the associated energy related production (when the peat is burnt) and horticultural production (when the peat eventually decomposes), amounts to approximately 8.7m tonnes of carbon dioxide to the atmosphere every year (Wilson *et al.*, 2013). Of this, it is estimated that 2.46m tonnes is emitted by bogs exploited for domestically cut turf, with an additional 1m tonnes emitted to the atmosphere through the burning of turf in the residential sector. In total, this is equivalent to around a third of the emissions from the transport sector for 2013 (Duffy *et al.*, 2013).

Case Study: Role of bogs in climate change

Peatlands are the largest long-term carbon store in the terrestrial biosphere and among the Earth's most important carbon stores, substantially larger than the carbon stock in the entire forest biomass of the world. Over the last 10,000 years, Irish bogs have taken enormous amounts of carbon dioxide from the atmosphere and stored it in their peat deposits. The few natural (near intact) bogs in Ireland are currently sequestering carbon at an estimate rate of 266,000 tonnes of carbon dioxide per year, therefore 'cooling' the atmosphere. When bogs are drained and peat is extracted and burnt, the preserved carbon and nitrogen are released, which contributes to the warming of the atmosphere and subsequent climate change. These emissions can be reduced when a bog is rewetted, so bog restoration can play a vital role in national climate change mitigation policies where the objective is to decrease national carbon dioxide emissions to the atmosphere.

Plate 6.1: Example of rewetted cutover bog in Co. Roscommon which can change the cutover peat from a source to a sink of carbon dioxide.

Supporting Habitats and Species Biodiversity

Associated services/benefits: maintenance of unique and threatened flora and fauna, genetic resources and unique landscape.

As outlined in Chapter 2, Ireland's raised bogs support nationally and internationally important biodiversity and are rare on national, European and global scales. Raised bogs that are actively forming peat are on the list of 'priority' habitats under the Habitats Directive because they are threatened with extinction in Europe. Raised bog landscapes are nowadays only present in remote areas of Europe and the remaining bogs, including those under conservation, are known to be mostly damaged and undergoing further degradation. This has repercussions for the species that live in these habitats, many of which are "niche species", meaning that they are adapted to the unique environment of a raised bog. Such species (e.g. *Sphagnum austinii* and *S. fuscum*) have become very limited in their distribution because of the massive decline of the naturally wet conditions that they thrive in. When the bog is degraded, drained or cut, the bog species are unable to compete with other 'common' species (like heathers, sedges and grasses) and disappear locally as there are not similar wet and acid landscapes in the surrounding environment.

Raised bogs typically host transitional habitats surrounding the high bog itself, many of which are also Annexed habitats within the EU Habitats Directive. Examples include: alkaline fens, bog woodlands, Cladium fens, transition mires and petrifying springs. As well as Annexed species such as *Lycopodium* species, *Sphagnum* species and white cushion moss *(Leucobryum glaucum)* can also be found on raised bogs. Such areas add variety to a bog complex and they in turn are host to many uncommon species, including the attractive Marsh Fritillary *(Euphydryas aurinia)* butterfly, an Annex II species of the Habitats Directive.

Peatlands in Ireland contain unusual and rare species, with some only recently discovered. The breeding birdlife of peatlands could be broadly arranged along a spectrum. One end of this spectrum is represented by specialised species like red grouse, golden plover and the increasingly rare curlew often occurring in extremely low densities with species like meadow pipit and skylark occurring at the other end of the spectrum. The latter species, although more common and widespread, are also of high conservation importance in Ireland as it is these birds which form the food base for birds of prey associated with peatlands, including merlin and hen harrier.

Case Study: Biodiversity on the bogs: moss species, thought to be extinct, re-found at Clara Bog, Co. Offaly

A moss (waved fork-moss (*Dicranum undulatum*)), previously deemed extinct in Ireland, was re-found in Clara Raised Bog in 2015 by Dr George Smith who stated that "because the only known populations could not be found again and because of the damage caused to raised bogs in the area due to turf-cutting, waved fork-moss was judged to be extinct in Ireland"[17] The species is mostly found on bogs and is rare throughout most of Europe. Restoration works at Clara have given a second chance to conserve a species thought extinct as well as helping maintain the Irish floral diversity.

Plate 6.2: Waved fork-moss (*Dicranum undulatum*) at Clara Bog (Image: courtesy of George Smith, www.blackthornecology.ie)

Water Purification and Flood Attenuation

Associated services/benefits: clean water, regulation of catchment water supply and hydrochemistry.

Intact raised bogs, like all wetlands, play an important part in regulating water within a catchment and in maintaining water quality. Bog mosses, which are the main vegetation component of a healthy raised bog, can hold 20 times their own weight in water and together with the peat mass, they help to filter contaminants and release 'clean' water. Raised bogs may fulfil an essential role as source areas for rivers, especially in maintaining low flows during dry periods. Under certain geographical conditions, raised bogs can help to control the flow of water within a catchment, thus mitigating flooding downstream by reducing the speed at which water leaves the catchment area. However, the storage capacity of a bog is limited and depends on the composition of the top (living) layer of the bog and the quality and intactness of the bog margins. Peat cutting and associated drainage, and loss of vegetation, can increase the amount and speed of water leaving the bog. This water contains higher amounts of carbon and particulate organic carbon (brown water) and nitrogen than natural bog water due to erosion and to leaching of nutrients from the decomposing peat (Holden *et al.*, 2004).

Case Study: Role of bog in water purification

Bogs are great sinks of atmospheric pollutants and therefore purify the water downstream. When drained, bogs lose their capacity for water purification and flood control. Currently in the UK, water companies are investing in peatland restoration to benefit from the natural water purification of peatlands. Catchments where bogs have been drained and the peat extracted produce "browning" of the water downstream, which requires costly chemical cleaning before it can be released for human consumption. This is because chlorine – a common disinfectant – reacts with dissolved organic carbon , leaving toxic by-products. To prevent this happening, iron and aluminium sulphate are first added to the water, forcing organic carbon to clump together and drop to the bottom to be removed before chlorine is added. Browning of water also prevents light penetration, resulting in less suitable habitat for fish. It is therefore critical to keep bogs wet and stop further drainage that releases dissolved organic carbon in order for Irish peatlands to deliver their wide range of critical ecosystem services.

Case Study: Garron Plateau, North Antrim

Northern Ireland Water owns approximately 2,000 hectares of water catchment land at the Garron Plateau in North Antrim. This area is the largest expanse of intact blanket bog in Northern Ireland. It is an Area of Special Scientific Interest but the habitat was found to be in unfavourable condition. Overgrazing and trampling by livestock had resulted in exposure of bare peat. Also the site was damaged when drainage ditches were dug through the bog, giving rise to exposed peat which was susceptible to erosion, thus adversely affecting raw water quality and natural bog hydrology.

In order to reverse the damage, a management plan was developed in liaison with the Royal Society for the Protection of Birds and the Northern Ireland Environment Agency. The plan has been delivered by working with local farmers to reduce grazing density levels and by blocking drains in the bog to raise the water table. This "rewetting" of the bog will restore natural hydrological conditions and promote colonisation by *Sphagnum* moss, an essential component of a functioning bog.

17. http://www.blackthornecology.ie/general/extinct-moss-re-found-raised-bog/

This innovative blanket bog restoration project is the first of its type undertaken by Northern Ireland Water and will deliver the following benefits:

- Prevent peat erosion and reduce treatment costs at Dungonnell Water Treatment Works associated with removal of colour from peat-stained raw water.
- Re-establish natural hydrological conditions and restore the function of the bog in sequestering CO2 from the atmosphere, reducing greenhouse gases and global warming.
- Improve stability of raw water provided to the reservoir through filtering effects and improved regulation of supply through retention effects.
- Preserve bog features that support a wide variety of plant and animal species – this will contribute to our duty to conserve biodiversity.
- Provide non-material benefits, e.g. recreation, enjoyment of landscape and biodiversity, cultural heritage, spiritual enrichment and educational opportunities and experiences. The Northern Ireland Water Land Use Policy makes provision for these services and Dungonnell is approved for activities such as fishing, dog walking and running.

Plate 6.3: Dungonnell peat dams

Landscape and Recreation

Associated services/benefits: tourism, recreation, well-being, cultural inspiration.

The unique landscape settings, alongside the unique assemblages of flora and fauna of raised bogs provide opportunities for recreation, education and cultural inspiration.

Nature is now generally accepted as providing a source of well-being and thus can be accorded an economic value. Outdoor experiences in the open landscape (such as bogs) are increasingly used as a recreational and spiritual resource and such landscapes have provided inspiration throughout history for poets, painters and other artists. Raised bogs may be the only remaining wild areas left in some parts of the country, and are an invaluable asset for natural, cultural and well-being tourism, for which there is an increasing demand in a changing society.

Studies in Ireland (Collier and Scott, 2009; Bullock and Collier, 2011) and Scotland (Market Research Partners, 2008) have shown that people place a high value on the conservation of wild places. These cultural landscapes can act as bridges linking people, including landowners and turbary right owners, with nature. The use of raised bogs thus requires a balance between the use of the landscape as an economic resource and its preservation as a component of the natural and cultural heritage as outlined earlier in this publication.

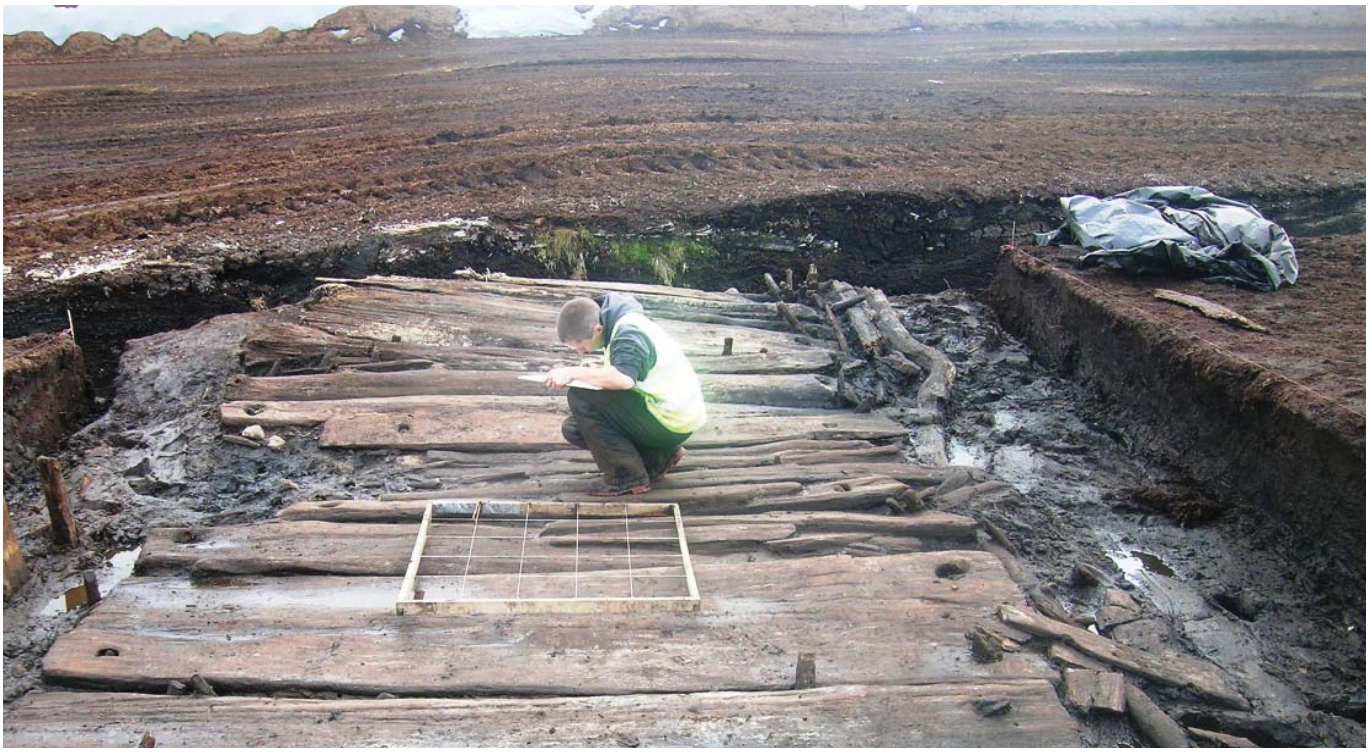
Cultural Heritage Preservation

Associated services/benefits: source of historical knowledge.

Bogs record their own history as peat can preserve archaeological artefacts (e.g. bog butter and bog bodies) (see the "Bog body and related finds" exhibition in the National Museum of Ireland, www.museum.ie). Un-decomposed plants parts including seeds and pollen and animal remains can be used to document past biodiversity and can tell us more about our past climates.

In the past, peatlands were used as repositories for the deliberate deposition of a range of high value bronze and gold weapons and ornaments, as well as for the ritual execution and deposition of human remains. In addition to the remains of normal occupation and settlement sites, bogs also contain evidence that they were traversed and accessed. Our predecessors built thousands of toghers or wooden pathways and roadways to utilise the resources of the bog and to cross their dangerous surfaces.

Bogs provide opportunities for the development of knowledge and understanding through palaeo-archaeology and palaeo-climatology as well as via general research, education and training. Intact peat is a



repository of information about the wider environment, not only about past climate but about regional vegetation, human settlement and even cosmic radiation. With new research techniques constantly being developed, the depth and breadth of information that can be obtained is unprecedented. This information is destroyed when peat is cut and burned and when decomposition is accelerated as the remainder of the bog dries out.

Peat as a Resource

Associated services/benefits: source of domestic fuel, peat for electricity generation, horticultural peat, cultural tradition and recreation.

When a bog is drained and the turf is extracted, it fulfils a production function, albeit a non-sustainable one. This production relates to the capacity to provide a resource that can be economically valued. This includes peat used as domestic fuel, for electricity generation or for horticultural products. Turf-extraction is a type of ecosystem use that has clear economic values, but only in the short term as it is not a renewable resource on a human timescale (unlike wood). Turf-cutting can be valued at the household level in the savings that can be made on alternative fuel purchases or in terms of profit for the contractors, in other words a private benefit.

Turf-cutting is also appreciated as a cultural tradition, a notable feature of the Irish landscape and as such, is a social public good. Such land use and tradition are widely practised around the country and turf-cutting is and can continue on a large number of non-designated raised bogs of lower nature conservation value following implementation of this plan.

Recovery of Ecosystem Services and How People will Benefit

The protection and restoration of Ireland's raised bog network as set out in this plan will result in ecosystem services being retained and enhanced for the benefit of society as a whole within the network of designated sites. Therefore, it is expected that following implementation of the proposed programme of conservation and management measures (see Chapter 7) these protected areas can provide a suite of associated benefits, such as supply of clean water, supporting climate regulation and flood attenuation as well as providing opportunities for amenity, cultural and spiritual inspiration.

The restored bogs will be able to accumulate peat again and sequester carbon. This plan, therefore, directly supports Ireland's aim to reduce its national greenhouse gas emissions by firstly conserving those bogs that are currently sequestering carbon and secondly, by providing mitigation measures to reduce the carbon emissions from currently drained/cut bogs.

The United Nations Framework Convention on Climate Change established the Wetland Drainage and Rewetting system as a new activity which parties can choose to report on for the second commitment period of the Kyoto Protocol. It was introduced to emphasise the significant role of drained organic soils as a source of greenhouse gas emissions and to give credit to activities for peatland rewetting and restoration. Therefore removal of carbon by rewetted bogs can be reported and used to meet Ireland's national emission targets (Bonn *et al.*, 2014).

Bog restoration will also lead to a decrease in waterborne carbon leaching, to levels comparable with undrained/ uncut bogs. Peatland restoration will not only bring back the water-related ecosystem services, but at the same time will help Ireland meet different regulatory targets including those set out in the Water Framework Directive. In the UK, bog restoration has helped to prevent further decline in drinking water quality (Martin-Ortega *et al.*, 2014).

Bog restoration also re-creates the natural heterogeneity of habitats, which is critical for the development and retention of the diversity of unique flora and fauna. Restoration will also ensure that the knowledge contained within the peat is preserved for the future.

This plan envisages that the cultural and production services of raised bogs, in the form of turf-cutting, is not entirely lost. Relocation of turf-cutting from protected raised bogs to other sites will mean that Ireland can harness all of the benefits (including cultural and traditional benefits) of a national resource for everyone.

Research in Ireland has shown that where peat has been extensively extracted in the Midlands, local people value the rehabilitation of the cutaway through conversion to either a peatland or wetland landscape (Collier and Scott, 2010). Unlike other ecosystems, attempts to create a new ecosystem from scratch are difficult for raised bogs, which took millennia to develop in the landscape. While the rehabilitation of cutover bog strategy is critical for future biodiversity and potential carbon sequestration, the final outcome in terms of total benefits regained is still unknown. Therefore, in accordance with the 'precautionary principle' and those of sustainable management and development, it is the best option to protect and restore what is left of the uncut bogs of high nature conservation value for future generations. Restoration efforts that target improvements on the currently least degraded sites (e.g. the SACs network), as suggested in this plan, offer the best hope for recovering the full range of ecosystem services. To maximise the recovery of the full suite of ecosystem services the plan adopts an integrated approach to the conservation and management of all the sites of significant conservation value that remain, rather than a site-by-site approach as was done in the past.

The aim of this plan is to ensure that while turf-cutting needs are met for individuals, and the associated cultural heritage is preserved in non-designated sites, the other benefits that raised bogs bring to society can be retained or restored on the estimated remaining 9% of the resource. Therefore, the plan can bring an overall positive impact on ecosystem services provided by raised bogs, without compromising on cultural and traditional benefits. Without such a plan, there may be continued loss of the aforementioned benefits, the cost of which would be borne by all of society.

Chapter 7
THE NEXT STEPS

Chapter 7
THE NEXT STEPS

Although many actions have been taken to date, this plan is the first step in a co-ordinated sustainable management approach to the raised bog SACs network. Many people have expressed their views on how the network should be managed or not, on who should be the custodians of our raised bogs, on what activities should be allowed to continue and what Ireland needs to do to return the ARB to favourable conservation status. What happens next is one of the most crucial steps to ensure success of the plan.

Programme of Conservation Measures

In order to achieve the protection and conservation of Ireland's raised bog SACs a programme of conservation measures has been developed which will be implemented in three cycles of six years. This plan will be reviewed and updated every six years to ensure that necessary amendments are made, and that the plan outlines the best available scientific knowledge at the time of publication. The first cycle will commence in 2017 and conclude in 2022 and will operate during the lifetime of this management plan. The programme, derived from existing legislative and conservation initiatives, will consist of measures to rehabilitate and restore designated peatlands, to implement the Review of Raised Bog Natural Heritage Area Network (NPWS, 2014), to continue with preventative measures and to provide support to initiatives that contribute to the objectives of this plan.

The programme includes monitoring, review and further plan iteration measures to assess the progress and effectiveness of the long-term strategies put in place under this first National Raised Bog Special Areas of Conservation SAC Management Plan, the National Peatlands Strategy and the 2014 Review of Raised Bog Natural Heritage Area Network. The programme also includes demonstration projects to support this plan's implementation. Educational and awareness programmes (targeted at both the general public and local authorities) are also incorporated, as are legislative measures.

Preventative measures

Ireland has legal obligations to provide protection to its raised bog SACs. Landowners, turbary right owners and turf-cutting contractors have been informed of the cessation of activities applying to SACs through direct correspondence, public advertisement and ongoing engagement. A compensation scheme is in place for those impacted by the cessation of turf-cutting on raised bog SACs and NHAs.

Sanctions available for breaches of the cessation applicable to activities on these sites include prosecution under the European Communities (Birds and Natural Habitats) Regulations 2011, prosecution under the European Communities (Environmental Liability) Regulations 2008 and cross compliance reporting which may affect payments from the Department of Agriculture, Food and the Marine.

Prosecutions have been pursued in a number of cases for breaches of these regulations. An inter-agency programme (involving staff of the Department of Culture, Heritage and the Gaeltacht, An Garda Síochána and the Air Corps) of monitoring for turf-cutting has been put in place over the past number of turf-cutting seasons. This programme involves aerial and on the ground activity.

As discussed in Chapter 5 the Department of Culture, Heritage and the Gaeltacht in this plan is exploring the utilisation of the provisions of Article 6(3) (and Article 6(4) if necessary) for a small number of SACs to identify areas suitable for turf-cutting which will not impact on the integrity of these sites. In line with the European Communities (Birds and Natural Habitats) Regulations 2011, other activities, which may be damaging to raised bog SACs (e.g. commercial forestry), are controlled through consent systems by the relevant consent authorities. Preventative measures for any other damaging activities can be assessed as part of the restoration plans for the SACs.

Restoration

As previously described in Chapter 4 site-specific restoration plans are necessary for each raised bog SAC and implementation of these plans form a major part of the programme of conservation measures. As part of this management plan, draft site-specific restoration plans have been developed for 53 SACs as well as the two new raised bog complexes due to be designated as SACs. The plans will include the restoration of high bog and surrounding cutover bog, which is essential to meet national and site-specific conservation objectives.

The focus of restoration activities within the first cycle of the National Raised Bog Special Areas of Conservation Management Plan will primarily be on the high bog, with some restoration of selected cutover areas. As outlined, the Department of Culture, Heritage and the Gaeltacht successfully bid for funding under the EU LIFE Programme 2014–2020 for the restoration of active raised bog on 12 Irish raised bog SACs (LIFE14 NAT/IE/000032). The project funding of €5.4m will make a significant positive start to the restoration process. This project will work on the implementation of the site-specific restoration plans in consultation with stakeholders on 12 SACs. These plans will be developed further to include drainage management plans and will also outline community benefits such as the installation of boardwalks or walking trails where feasible. For the remainder of the raised bog SACs in the network, the draft hydrological restoration plans will evolve over the current and upcoming cycles into complete restoration plans for each of the raised bog SAC sites, again in full consultation with stakeholders.

Research

The national restoration programme being undertaken in the next six years is based on the most up-to-date scientific methodologies available and using best practice models gained from other restoration projects such as Coillte LIFE and Bord na Móna's programme. Whilst this work is being completed, key research will be undertaken simultaneously to improve management and restoration practices into the future. This research to be undertaken by the Department of Culture, Heritage and the Gaeltacht, the EPA and other institutions includes (as highlighted in the National Peatlands Strategy):

- Investigation of the greenhouse gas emissions from peat soils under various management practices;
- Identification and review of practical peatland restoration projects and techniques to assess their effectiveness in terms of hydrology, carbon storage and sequestration potential and biodiversity at all levels;
- Research into the use and calculation of the economic value of ecosystem services;
- Research into the socio-economic benefits of raised bog conservation at local and national level;
- Research into how to encourage community conservation involvement, promotion of private tourism opportunities associated with raised bogs conservation, development of best practise guidelines and long-term sustainable education resources; and
- Identification of the factors that contribute to the engagement of local communities in projects to protect and enhance the natural environment.

Further research into the following topics will be needed:

- Identification of key supporting conditions for active bog vegetation, including regional variation;
- Quantifying the impact of drain blocking in producing the hydrological supporting conditions on high bog and cutover;
- Understanding the basis for and the extent of vertical losses to regional groundwater;
- Understanding the cause and predicting the extent of subsidence and its effects on bog hydrology and ecology;
- Understanding the conditions required for peat formation on cutovers to assess the potential for restoration of the cutover to contribute to high bog support, achievement of conservation objectives for the whole site and the delivery of ecosystem services (e.g. flooding and water quality); and
- The impact of raised bogs for flood attenuation and climate change mitigation.

These areas of research will be assessed and prioritised based on scope, costs and duration with a view to forming a programme of peatlands research projects.

Monitoring and Reporting Programme

A monitoring programme will be put in place at the start of the restoration programme and will continue after the programme has ceased. The main objective of the programme is to assess the degree of success of restoration works by measuring and documenting the effectiveness of these works. This will allow estimates to be made of the comparative costs and benefits of different restoration options. Monitoring should take place both before (i.e. baseline surveys) and after restoration works. The programme will include the following elements:

- Hydrological monitoring – this includes two main actions: a) monitoring the hydrological impact of restoration works on cutover and high bog and b) monitoring the potential hydrological impact of restoration works on adjoining lands.
- Vegetation monitoring – this includes also two main actions: a) monitoring of high bog vegetation and b) monitoring of cutover vegetation.

Assessment of the ecosystem functions of a bog after restoration works

This will ascertain how actions, both on the high bog and cutover, undertaken as part of restoration works will improve/enhance the ecosystem services (i.e. biodiversity, flood management, water quality and climate regulation/ carbon storage).

Summary of Conservation Programme

The programme of conservation measures for the first six-year cycle (2017–2022) includes a commitment for protection and restoration activities within all raised bog SACs and the new network of NHAs. In addition to the detailed protection, restoration and replacement measures, this plan's proposed programme of conservation measures requires a framework of activities drawn from existing legislation and conservation initiatives as summarised in Table 7.1.

Table 7.1: Summary of Designated Raised Bog Network Conservation Programme (First Cycle 2017–2022)

Measure	Where	When	Who	Estimated Cost (2017–2022)
1. Notification and designation of two new SACs	Primarily Bord na Móna-owned land	2017	Department of Culture, Heritage and the Gaeltacht	€0.005m (excludes cost of compensation/ relocation for affected turf-cutters)
2. Restoration through implementation of best practice restoration techniques of the raised bog designated network entailing: (refer to Chapter 4 for further details)	53 raised bog SACs (and two SACs to be designated) and sites from new NHAs network			
• Implementation of EU LIFE Project – 'Restoring Active Raised Bog in Ireland's SAC Network 2016–2020'	12 raised bog SACs	2016–2020	Department of Culture, Heritage and the Gaeltacht (NPWS)/ LIFE Project Team/ European Commission	€5.4m (75% EU funded)
• Restoration measures on SACs and NHAs to support national conservation objectives for the raised bog network, development of restoration plans and restoration incentive measures. Development of site-specific conservation objectives for raised bog NHAs. Supporting guidance documents and code of practice	Selection of sites in SACs network and sites from new raised bog NHAs network	2017–2022	Department of Culture, Heritage and the Gaeltacht (NPWS) Other bodies: Coillte/ Bord na Móna/ Community Groups/ other stakeholders	€12m

Table 7.1: Summary of Designated Raised Bog Network Conservation Programme (First Cycle 2017–2022)

Measure	Where	When	Who	Estimated Cost (2017–2022)
3. Preventative measures (cessation of damaging activities including drainage and turf-cutting, planting of commercial forestry, spread of fires, and other human activities)	53 current raised bog SACs (and two sites to be designated) and sites from new NHAs network	2017–2022	Department of Culture, Heritage and the Gaeltacht (NPWS) and other stakeholders, relevant statutory bodies and consent authorities	Cessation of Turf-Cutting Compensation Scheme (financial compensation, turf deliveries and relocation) €26.1m *(Note: fire management/ waste management/ invasive species management/ other human activities costed as part of restoration measures)*
Other measures:				
Pursue applying provisions of Article 6(3) through scientific analysis to identify areas in SACs suitable for turf-cutting which will not impact on the integrity of the sites (see Chapter 5)	Small number of selected sites after consultation and agreement with local turf-cutting communities	2017–2018	Department of Culture, Heritage and the Gaeltacht (NPWS)/Stakeholders	€0.1m per site (cost can vary per site and depending on level of scientific investigations required)
Explore applying provisions of Article 6(4) for certain SACs, if necessary		2017–2018	Department of Culture, Heritage and the Gaeltacht (NPWS)/ Stakeholders	€0.1m per site (cost can vary per site and depending on level of scientific investigations required)
Continue with enforcement measures and aerial monitoring of SACs	All raised bog SACs	Ongoing	Department of Culture, Heritage and the Gaeltacht (NPWS)/Garda Siochána/Defence Forces	Not costed within this plan – ongoing activities
Development of drainage management plans	Raised bog SACs	2017–2022	Department of Culture, Heritage and the Gaeltacht (NPWS)/ OPW/local authorities/ landowner)	€0.300m

Table 7.1: Summary of Designated Raised Bog Network Conservation Programme (First Cycle 2017–2022)

Measure	Where	When	Who	Estimated Cost (2017–2022)
4. Implementation of Review of Raised Bog NHA Network	Current and new NHAs networks	2017–2018	Department of Culture, Heritage and the Gaeltacht (NPWS)	Not costed in this plan – ongoing activities (cost of restoration of a number of raised bog NHAs is included under measure 2)
5. Support to other organisations/individuals for conservation measures in raised bog SAC network	Selected sites	2017–2022	Department of Culture, Heritage and the Gaeltacht (NPWS) and other stakeholders	€0.5m
6. Mid-cycle Review of the National Raised Bogs Special Areas of Conservation Management Plan	National	2020	Department of Culture, Heritage and the Gaeltacht (NPWS)	€0.2m
7. Preparation of Second National Raised Bogs Special Areas of Conservation Management Plan	National	2022–2023	Department of Culture, Heritage and the Gaeltacht (NPWS)	€1.0m
8. Raised Bogs Community Engagement, Education and Awareness Programme	National	2017–2022	Department of Culture, Heritage and the Gaeltacht (NPWS), public authorities and other stakeholders	€0.5m
9. Raised Bogs Ecotope Surveying and Monitoring Programme	National	2017–2022	Department of Culture, Heritage and the Gaeltacht (NPWS)	€1.0m
10. European Communities (Birds and Natural Habitat) Regulations 2011–2015, Environmental Impact Assessment Regulations and Environmental Liabilities Regulations implementation to prevent damaging activities, where relevant and appropriate	National	Ongoing	Department of Culture, Heritage and the Gaeltacht (NPWS) and other relevant authorities	Not costed in this plan – ongoing activities

Table 7.1: Summary of Designated Raised Bog Network Conservation Programme (First Cycle 2017–2022)

Measure	Where	When	Who	Estimated Cost (2017–2022)
11. Raised Bogs Research Programme	Raised bog network	Ongoing	Department of Culture, Heritage and the Gaeltacht (NPWS) and other relevant bodies/agencies	€0.2m
12. Ensure legislative and policy linkage to other plans and programmes including River Basin Management Plans and Catchment Flood Risk Management Plans	National	Ongoing	Department of Culture, Heritage and the Gaeltacht (NPWS)	No cost applicable to this plan

The estimated cost of the programme of measures is in the order of over €22m over the six-year planning cycle, excluding the cost of €26.1m envisaged for the CTCCS. These values exclude the associated public sector costs of the Department of Culture, Heritage and the Gaeltacht and other Government departments and organisations that will continue to play an important role in the plan's implementation.

It is important to note that the national and SACs conservation objectives for ARB habitat cannot be achieved within the time frame of the first six-year planning cycle (2017–2022). Restoration measures will be implemented but it is expected to take at least 10 years after drain blocking on the high bog is completed before the effects of restoration works start to be realised. A more rapid response is, however, expected in reversing the current downward trend of ARB area before notable increases in area of ARB start to develop. It is expected to take even longer for positive results to be realised in relation to restoration of cutover areas. While there are examples of rapid restoration to peat-forming conditions on cutover areas, these areas lack the ecological diversity and attributes of fully developed ARB habitat. There is potential that this may be considered ARB in the long term (50–100 years).

The achievement of the national conservation objectives for raised bogs identified in this plan will also require the implementation of the NHAs Management Plans (primarily restoration plans) in due course. This assumes that restoration measures commence on all raised bog SACs and NHAs within the three planning cycles (2017–2036). Given this prediction is it feasible that the entire national raised bog restoration programme would be completed in less than 20 years.

One of the most important features of successful peatland restoration and conservation is having the supports in place to maintain the benefits of the programme into the future. It will take large-scale co-operation, resources and funding to maintain the investment in the raised bog SACs (and NHAs) network for this plan to succeed.

The Prioritised Action Framework Under the Habitats Directive and Funding for the Plan

The Habitats Directive is unusual in EU terms in that it has specific provisions in it relating to EU co-financing. Article 8.4 of the Directive requires the European Commission to adopt a prioritised action framework of measures involving co-financing to be taken for SACs nominated for designation under the Directive. This involves a process of agreeing financing priorities with Member States for the use of various EU funding instruments.

In November 2014 Ireland's Prioritised Action Framework 2014–2020 under the EU Habitats Directive[18] was published. This framework, which has been approved by Government, identifies a range of actions needed to help improve the status of Ireland's habitats and wildlife. The possible sources of funding for these actions, across the various operational programmes, are also identified.

The European Commission has adopted a Partnership Agreement[19] with Ireland (November, 2014), setting down the strategy for the optimal use of European Structural and Investment Funds throughout the country for the period 2014 to 2020. These funds are designed to support a wide range of agreed policy objectives within the EU, including those related to the restoration, preservation and enhancement of biodiversity (including in Natura 2000 and high nature value areas) and the shift towards a low carbon economy. EU funds under the EU Multi-Annual Financial Framework 2014–2020 can substantially contribute to achieving these objectives, in particular through use of the EU Agriculture, Fisheries and Cohesion Funds and the LIFE Fund.

The Partnership Agreement 2014 to 2020 between the Irish Government and the European Commission outlines that the cost of delivering strategies for peatlands restoration will be €25m over 10 years.

The Department of Culture, Heritage and the Gaeltacht has received significant support under the EU LIFE Programme for the €5.4m project to restore active raised bog in 12 SACs within the raised bog SACs network. This project will underpin the philosophy of building support for restoration and conservation with local communities and provide guidelines for best practice restoration techniques. On top of the funding under the Irish Raised Bog LIFE Project (IE/NAT/000032) a further €9m has been committed for peatlands restoration in the Government's capital plan, Building on Recovery: Infrastructure and Capital Investment 2016–2021 (DPER, 2015) for peatlands restoration. Funding of €1m was provided by the Government for peatlands restoration in 2015, 2016 and again for 2017.

Whilst EU LIFE funding may offer some further opportunities for assistance for peatlands conservation, management and restoration, other European Operational Programmes will also be investigated, including regional development, research and innovation and INTERREG programmes.

Managing into the Future

As outlined in earlier chapters, raised bogs must be appropriately managed and restored to achieve national biodiversity targets. This must be attained through co-operation of turf-cutting interests, land users and landowners. Educational and awareness programmes together with the involvement and engagement of local communities is recognised as an essential element for the management and conservation of biodiversity, particularly peatlands, and is referenced in several national documents including:

- Action for Biodiversity (2017–2021) by the Department of Culture, Heritage and the Gaeltacht. This includes the objective of increasing awareness and appreciation of biodiversity and ecosystem services (Objective 3) with the target of enhancing the appreciation of the value of biodiversity and ecosystem services amongst policy makers, businesses, stakeholders, local communities and the general public (Target 4).
- The EPA Bogland report (Renou-Wilson, 2011). This also recognises the importance of local communities as stewards of peatlands resources and their involvement in peatlands management. The importance of early and extensive communication with stakeholders, and peatlands awareness and educational programmes, to show the benefits of peatlands conservation is also highlighted in the document (Action 7 – management of peatlands for and with the people).
- The National Peatlands Strategy (NPWS, 2015). This recognises the importance of increasing awareness and understanding of the importance of Ireland's peatlands: "The importance of responsible peatlands management

18. Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora and Directive 2009/147/EC of the European Parliament and of the Council of 30 November 2009 on the conservation of wild birds: FORMAT FOR A PRIORITISED ACTION FRAMEWORK (PAF) FOR NATURA 2000 for the EU Multi-annual Financing Period 2014–2020, Ireland https://www.npws.ie/sites/default/files/general/PAF-IE-2014.pdf

19. Partnership Agreement Ireland 2014–2020. Ireland 1 January 2014 – 31 December 2020 in accordance with Articles 14 and 15 of Regulation (EU) N0 1303/2013 of the European Parliament and of the Council of 17th December 2013 November 2014 https://ec.europa.eu/info/publications/partnership-agreement-ireland_en

and how it can impact on the wider community is not widely understood or appreciated by the general public. This strategy aims to increase awareness and understanding by the public, by landowners and by decision-makers of the value of peatlands and the implications of good and bad management practices (Vision 19)." In addition, the strategy includes two actions related to the promotion of the potential use of peatlands for tourism and recreational purposes. Action 29 states: "The enhancement of peatlands as sustainable tourism and recreation amenities, which have the potential to return a community dividend, will be considered as part of.. (this plan) ..and other appropriate plans." More specifically, Action 30 states: "The consideration of peatlands as an amenity formed part of Ireland's application under the LIFE programme and will be part of relevant future restoration plans."

To this end a raised bogs community engagement, education and awareness programme will be supported under this plan.

Development of community based conservation and management groups, which can act as custodians of these local bogs, is recognised as one of the best ways to ensure the long-term protection of habitats and species whilst maximising the benefits to local communities. The recently created Community Wetland Forum, under the umbrella of Irish Rural Link, currently includes over 10 community-led wetland conservation groups (e.g. Abbeyleix group, Cabragh group, Corlea group, Cloughjordon group and Clara group). It functions as a forum for exchange of information, support to other groups, production of best practice guidelines, community involvements, recreational activities experience (walks and talks), volunteer opportunities, stewardships options and management agreements. Many of these groups emerged as community responses to immediate threats to the survival of their respective wetlands and as a result of the far-sighted view of these groups of the multiple socio-economic benefits that the conservation of these sites can provide.

These networks can be used as a platform for community engagement where different stakeholders (e.g. community based groups, landowners and volunteers) working on the conservation of wetland sites can share information and experiences and support each other.

Continued engagement with turf-cutters and other stakeholders

The elements of this plan dealing with relocation, compensation and invoking Article 6(3) and Article 6(4) of the Habitats Directive have emerged from extensive consultation and discussions with turf-cutting interests and landowner representatives of raised bog SACs. Engagement with turf-cutters and representative groups will continue to be undertaken to build awareness of the sensitivities of the sites in order to avoid further damage, as well as to gather information required to further develop and implement site-specific restoration and management plans. Such information includes the number of turf-cutters who would be prepared to relocate to nearby undesignated sites; the number who qualify for compensation; and the number who might prefer financial compensation instead of relocation. It is vital that turf-cutters and their representatives engage with the Department in a meaningful way in order for this information to be gathered to allow progress on relocation to continue.

Local liaison committees, representing turf-cutter interests, will be central to agreeing and implementing local solutions and also to providing a vital service in terms of dispute avoidance and resolution between the State authorities and individuals. In due course, liaison committees could also include interested members of the general public, both individuals and groups, and authorities both local and national interested in the management of a site for nature conservation. The formation of local liaison committees will be encouraged and supported by the Department.

The liaison committees will be centrally involved in the planning and execution of the site-specific restoration and management plans and will be involved in the ongoing management of the sites and in developing amenity opportunities for the benefit of the local community. The undertaking of necessary works will, to the maximum extent possible and subject to public procurement requirements, use local expertise and capacities. Where necessary, training opportunities will be provided to further develop local capacity.

The Department of Culture, Heritage and the Gaeltacht will, with the consent of landowners, pursue the cases for Article 6(3) through the required regulatory processes for the sites as set out in Chapter 5. The Department will continue to liaise with the European Commission with regard to any Article 6(4) cases.

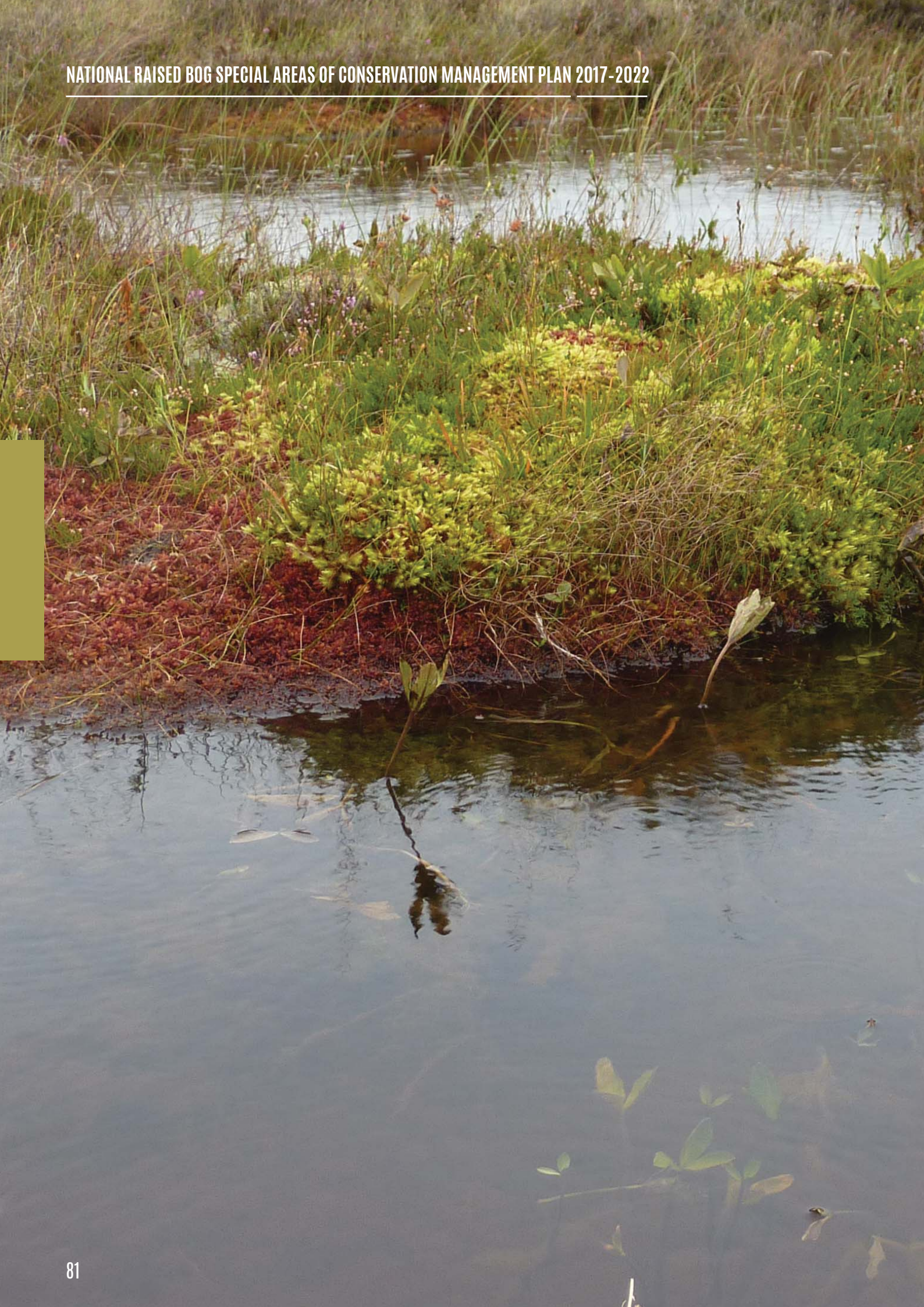
Implementing the Plan

The first National Raised Bog Special Areas of Conservation Management Plan will be in place for a six-year period from 2017 to 2022. The Department of Culture, Heritage and the Gaeltacht will oversee its implementation. The task of assisting in the delivery of this the plan will fall to a number of State and semi-State bodies, including the Department of Culture, Heritage and the Gaeltacht; the Department of Housing, Planning and Local Government; the Department of Communications, Climate Action and Environment; and local authorities, Coillte and Bord na Móna. It will also require the co-operation of all stakeholders including the Peatlands Council, turf-cutters, landowners, local communities and environmental groups.

The success of the plan in terms of achieving its objectives in relation to both conservation and addressing the needs of those affected will be monitored. Monitoring will be carried out in accordance with Table 10.1 of the SEA which is published in conjunction with this plan.

The Department of Culture, Heritage and the Gaeltacht will report on the progress of implementation to the Peatlands Council and Government. A mid-term review will be undertaken in 2020 and a final report will be initiated in 2022. The second National Raised Bog Special Areas of Conservation Management Plan will be then developed for the period 2023 to 2029 and the third plan for the period 2030 to 2036. The final phase of the restoration programme for the designated raised bog network will occur during the period 2030 to 2036. The implementation of the plan will complement the work of the Peatlands Strategy Implementation Group and will be guided by ongoing research and monitoring.

Management Plan Deliverables	Delivery
Raised Bog Restoration Programme commenced (Phase 1)	Q4 2017
Mid-Term Report	December 2020
Final Report	December 2022
Restoration Programme (Phase 2)	2023–2029
Second National Raised Bog Special Areas of Conservation Management Plan	2023–2029
Third National Raised Bog Special Areas of Conservation Management Plan	2030–2036
Restoration Programme (Phase 3)	2030–2036



Appendices

Appendix 1

Ireland's Raised Bog Special Areas of Conservation

Table A1.1: Raised Bog Special Areas of Conservation (SACs) in Ireland

Site Code	Site Name	Bog name(s) where different to SAC name	County List
000006	Killyconny Bog (Cloghbally) SAC		Cavan, Meath
000231	Barroughter Bog SAC		Galway
000248	Cloonmoylan Bog SAC		Galway
000285	Kilsallagh Bog SAC		Galway
000296	Lisnageeragh Bog and Ballinastack Turlough SAC		Galway
000297	Lough Corrib SAC	Addergoole Bog	Galway, Mayo
000301	Lough Lurgeen Bog/Glenamaddy Turlough SAC		Roscommon, Galway
000326	Shankill West Bog SAC		Galway
000382	Sheheree (Ardagh) Bog SAC		Kerry
000391	Ballynafagh Bog SAC		Kildare
000440	Lough Ree SAC	Clooncraff and Cloonlarge Bogs	Longford, Roscommon, Westmeath
000497	Flughany Bog SAC		Mayo, Sligo
000566	All Saints Bog and Esker SAC		Offaly
000572	Clara Bog SAC		Offaly
000575	Ferbane Bog SAC		Offaly
000580	Mongan Bog SAC		Offaly
000581	Moyclare Bog SAC		Offaly
000582	Raheenmore Bog SAC		Offaly
000585	Sharavogue Bog SAC		Offaly, Tipperary
000592	Bellanagare Bog SAC		Roscommon
000595	Callow Bog SAC		Roscommon
000597	Carrowbehy/Caher Bog SAC		Roscommon
000600	Cloonchambers Bog SAC		Roscommon
000604	Derrinea Bog SAC		Roscommon
000614	Cloonshanville Bog SAC		Roscommon
000641	Ballyduff/Clonfinane Bog SAC		Tipperary
000647	Kilcarren-Firville Bog SAC		Tipperary
000679	Garriskil Bog SAC		Westmeath
001242	Carrownagappul Bog SAC		Galway
001818	Lough Forbes Complex SAC	Ballykenny and Fisherstown Bogs	Longford, Roscommon
002110	Corliskea/Trien/Cloonfelliv Bog SAC		Galway, Roscommon
002298	River Moy SAC	Derrynabrock, Tawnaghbeg Kilgarriff, Gowlaun and Cloongoonagh Bogs	Mayo, Roscommon, Sligo
002331	Mouds Bog SAC		Kildare
002332	Coolrain Bog SAC		Laois
002333	Knockacoller Bog SAC		Laois
002336	Carn Park Bog SAC		Westmeath
002337	Crosswood Bog SAC		Westmeath
002338	Drumalough Bog SAC		Roscommon
002339	Ballynamona Bog and Corkip Lough SAC		Roscommon
002340	Moneybeg and Clareisland Bogs SAC		Meath, Westmeath

Site Code	Site Name	Bog name(s) where different to SAC name	County List
002341	Ardagullion Bog SAC		Longford
002342	Mount Hevey Bog SAC		Meath, Westmeath
002343	Tullaher Lough and Bog SAC		Clare
002346	Brown Bog SAC		Longford
002347	Camderry Bog SAC		Galway
002348	Clooneen Bog SAC		Longford
002349	Corbo Bog SAC		Roscommon
002350	Curraghlehanagh Bog SAC		Galway
002351	Moanveanlagh Bog SAC		Kerry
002352	Monivea Bog SAC		Galway
002353	Redwood Bog SAC		Tipperary
002354	Tullaghanrock Bog SAC		Roscommon
002356	Ardgraigue Bog SAC		Galway

Appendix 2

Approach to Assessing the Eco-Hydrological Condition of Ireland's Raised Bogs

Modelling the potential for raised bog restoration

The physical conditions under which active raised bog (ARB) survives and develops, were assessed by modelling specific bogs to understand their hydrological function. Using this approach it is possible to identify areas that can be considered degraded raised bog (DRB) still capable of natural regeneration. The basis for this modelling process is research initially carried out on two Irish Midland raised bogs during the 1990s, and subsequently applied to an additional five Irish Midland raised bogs. The modelling process involved relating suitable supporting topographic conditions (including surface shape, slope and drainage patterns) to locations where ARB was found. These conditions were, in turn, used to forecast potential restoration areas where topography is suitable for ARB to develop following restoration measures such as drain blocking.

The core aspect of the eco-hydrology model is based on the concept of Potential Acrotelm Capacity (PAC) developed by van der Schaaf (2002b), where PAC indicates the potential of raised bog topography to support ARB. Overall, the model proposes a means of assessing whether areas will remain sufficiently wet to sustain raised bog vegetation. More precisely, the model assumes upstream flow path length (L) and local surface slope (s) are the fundamental physical parameters underpinning the survival of ARB, which is also influenced by a dimensionless flow path shape factor (f). The resulting PAC (in terms of kilometres) is defined by the formula:

$$PAC = \frac{L}{fs}$$

PAC = Potential Acrotelm Capacity (km)
L = Upstream Flow Path Length (m)
s= Local surface slope (m km-1)
f = dimensionless flow path shape factor

However, it is has proven difficult to adequately define f, since there are often so many variations in flow path shape. As a result van der Schaaf considered a value of f=1 as a reasonable compromise in most cases. Overall this formula suggests that areas with long upstream flow paths coupled with gentle slopes are most likely to support ARB. In addition it is important to note that this formula assumes static topographic conditions. Where topographic conditions remain dynamic e.g. significant ongoing subsidence, the PAC values obtained would be expected to vary with time. It is also assumed that the only significant losses of effective rainfall occur via overland flow and not by various forms of vertical flow through fissured peat, cracks or swallow-holes.

The threshold value after which DRB occurs, using the PAC approach as defined by van der Schaaf and Streefkerk (2002), is based on typical PAC values observed in the ecotopes typically associated with bog margins (marginal and facebank ecotopes) based on the seven Irish Midland raised bogs studied. The study concluded that areas with a PAC value > 50km may eventually become active through restoration measures. By contrast, areas where PAC values are < 50km but > 30km, potential for recovery to ARB is unclear, while areas with a PAC value of < 30km would be impossible to restore without major technical operations such as large dams.

In the programme of work undertaken by RPS, the PAC formula was applied to raised bogs making use of LiDAR technology which was not available to van der Schaaf and Streefkerk during their original research. LiDAR is a remote sensing technology that measures vertical surface elevation by illuminating a target with a laser and analysing the reflected light. The data is collected in the field using a low flying aeroplane. This gives much more detailed and accurate raised bog topographical maps than can be collected by traditional surveying techniques.

LiDAR data were collected for all 53 raised bog SACs and 75 raised bog Natural Heritage Areas (NHAs), which enabled a more accurate eco-hydrological model to be developed by providing detailed topographical information of the raised bogs' drainage patterns and slope.

A number of observations were made when this process was applied to the raised bog SACs:

Firstly, there were areas where ARB was present, yet the model did not adequately indicate that conditions were suitable for ARB development. After assessing the local surface slope and flow path lengths in these areas, it was concluded that flow path length could be better represented by contributing catchment area.

Secondly, it was observed that the model generated some over-estimation of areas of potential restoration of ARB on several Midland sites, indicating that threshold values obtained from the PAC method typically associated with bog margins are too low. Moreover, there was a notable under-estimation of areas of potential restoration to ARB in locations with higher rainfall. This highlights bias arising in using the PAC formula developed for a limited number of sites in the Midlands. This discrepancy arises as the model does not account for rainfall variation across the country as recognised by the original researchers.

To account for discrepancies in the PAC method, the following two modifications to the topographic model formula and modelling process were applied.

1. In order to account for accumulation along more than one flow path leading to a point, an alternative parameter was proposed in place of flow path length. This parameter accounts for contributing catchment area, providing an improved measure of the upstream catchment area contributing to a certain point, particularly when flow path convergence occurs. The altered formula, known as modified flow accumulation capacity (MFAC), also acts as a means of consistently accounting for the flow pattern/shape and therefore enables better use of the improved detail available with the LiDAR data. The formula was also adapted to produce the same units (km) as in the original PAC formula:

$$MFAC = \frac{\sqrt{A}}{s}$$

MFAC = Modified Flow Accumulation Capacity (km)
A = Upstream contributing catchment area (flow accumulation) (m^2)
s = Local surface slope ($m\ km^{-1}$)

2. After the modelling process had been modified to consider the correspondence between MFAC and ARB distribution, statistical analysis was undertaken to determine the median MFAC values within the main ecological categories (Figure A2.1). Using this relationship enabled a climatic factor to be developed to take account of regional variation in climatic conditions.

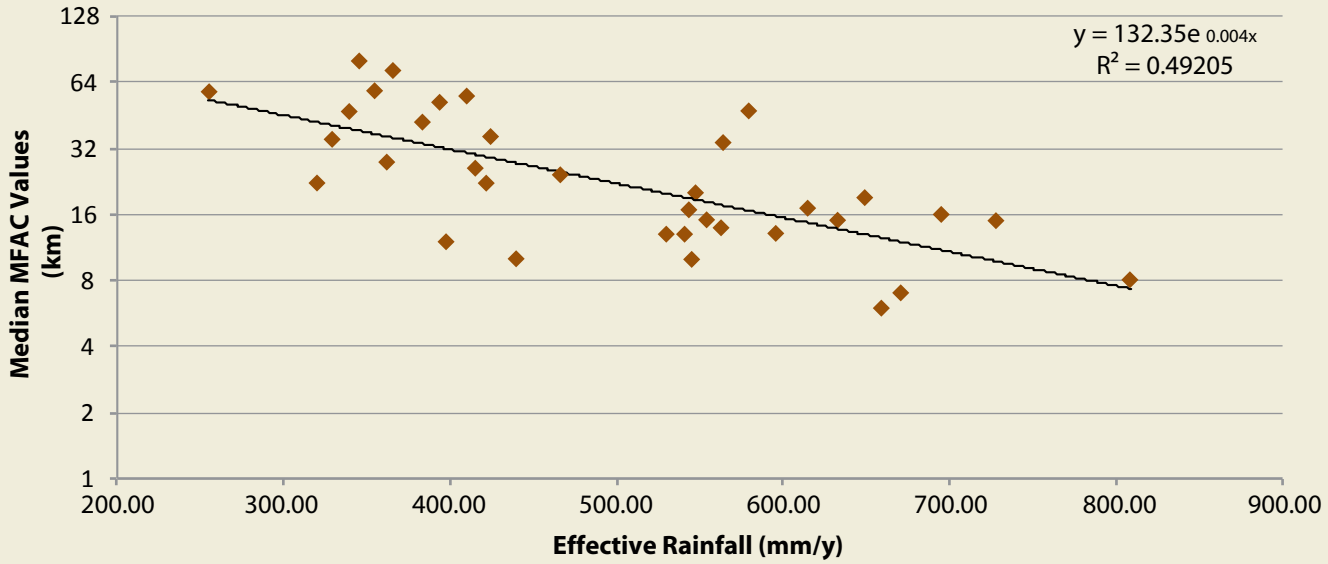


Figure A2.1: Correlation between median MFAC and rainfall

The application of the eco-hydrological modelling process is illustrated by the following series of diagrams (Figures A2.2 – A2.7) related to Clara Bog SAC, Co. Offaly.

The model is based on the assumption that suitable restoration measures are available and that vertical losses of water through the peat to depth are largely inhibited. Where this is not the case, the eco-hydrological model may over-predict the potential for restoration of ARB, as despite suitable topographic conditions being present these alone are ineffective at maintaining a stable and high water table within the peat.

This issue is addressed by assessing the efficacy of potential restoration measures. For example, where there is an obvious reason for the absence of ARB in an area where the model predicts it should occur, such as the presence of functional drains in or adjacent to that area of the bog, it is assumed that restoration by drain blocking will be highly effective in restoring ARB (high efficacy). In contrast, where such obvious reasons for the absence of ARB are not apparent, it is assumed that restoration will be relatively ineffective and the restoration potential predicted by the model is reduced (low efficacy).

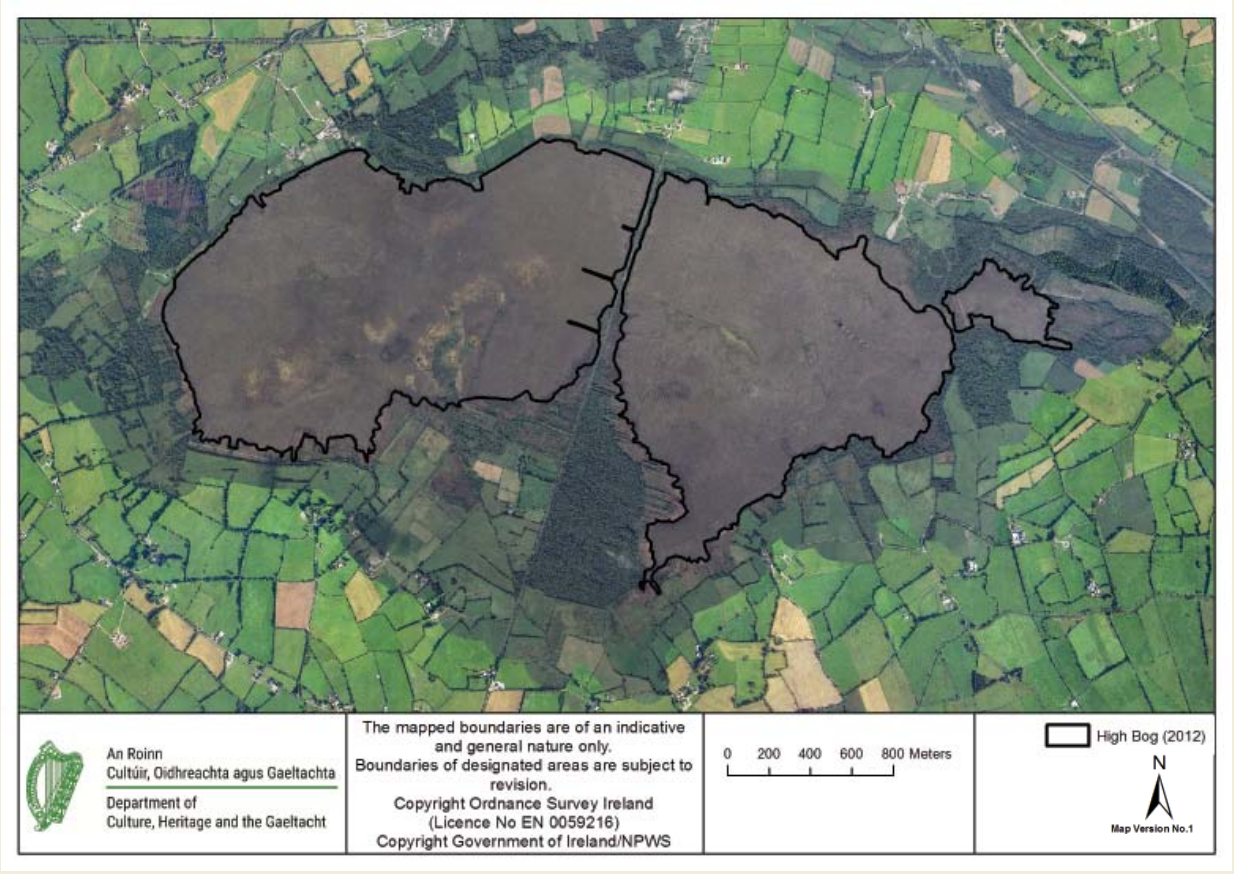


Figure A2.2: Clara Bog SAC, Co. Offaly, ortho-rectified aerial photo showing boundary of high bog

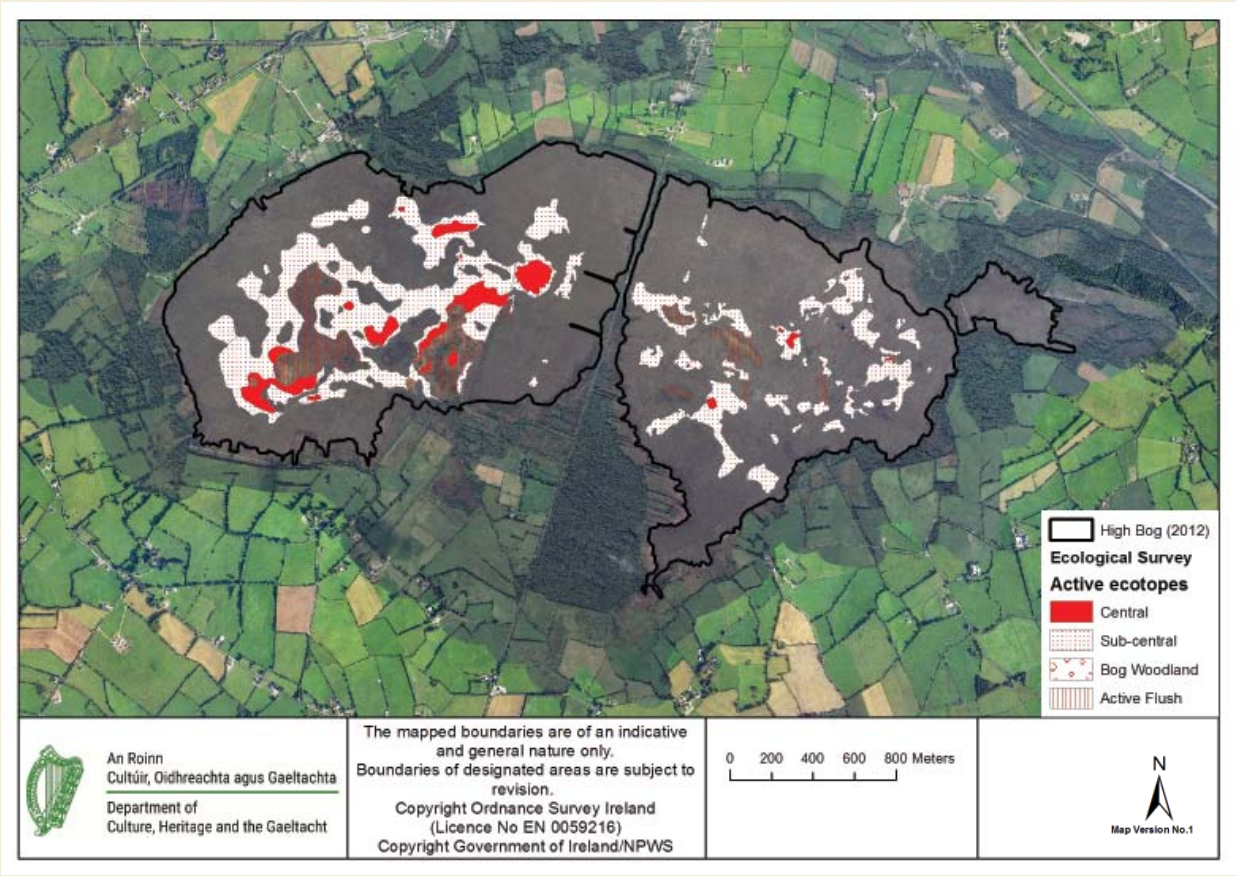


Figure A2.3: Clara Bog SAC, Co. Offaly, Ecological Survey Results 2009

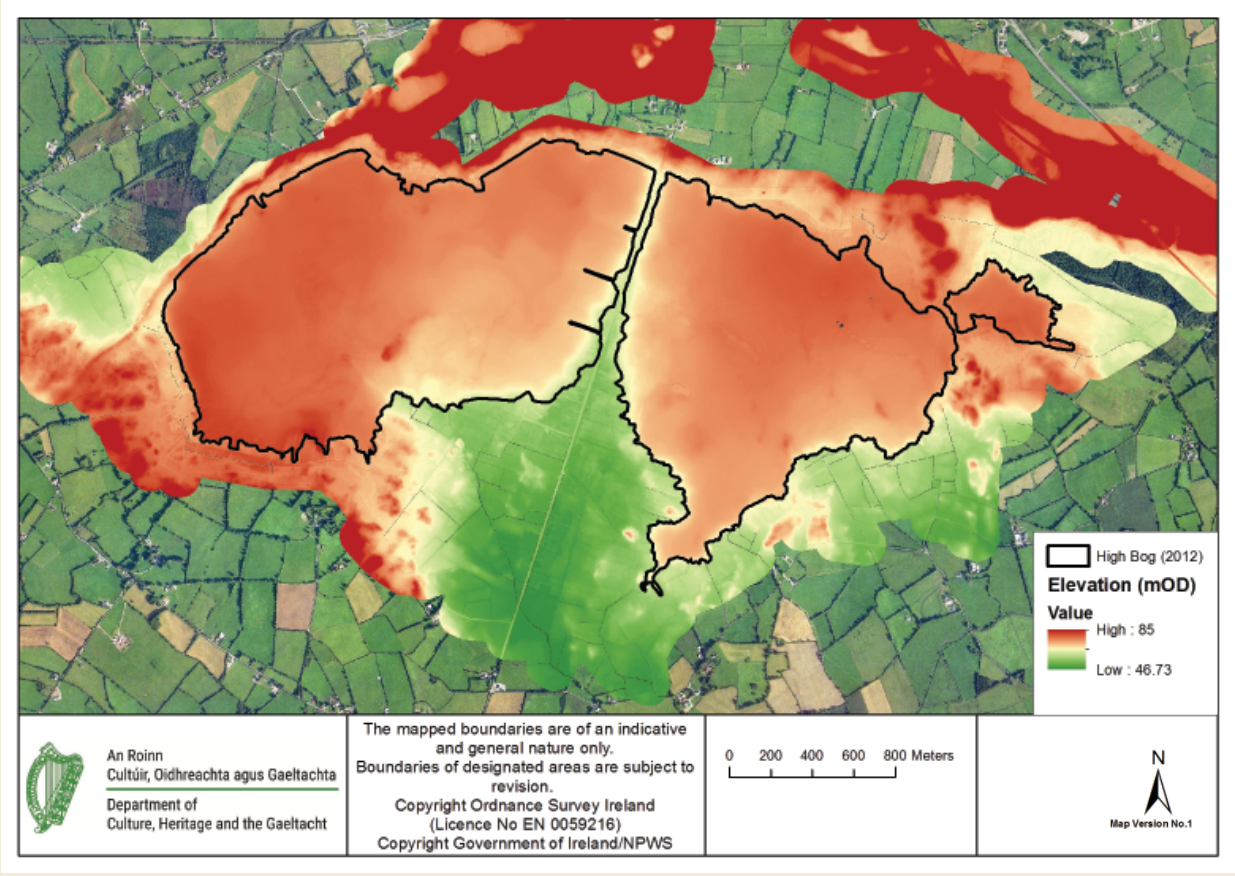


Figure A2.4: Clara Bog SAC, Co. Offaly, LiDAR imagery 2012

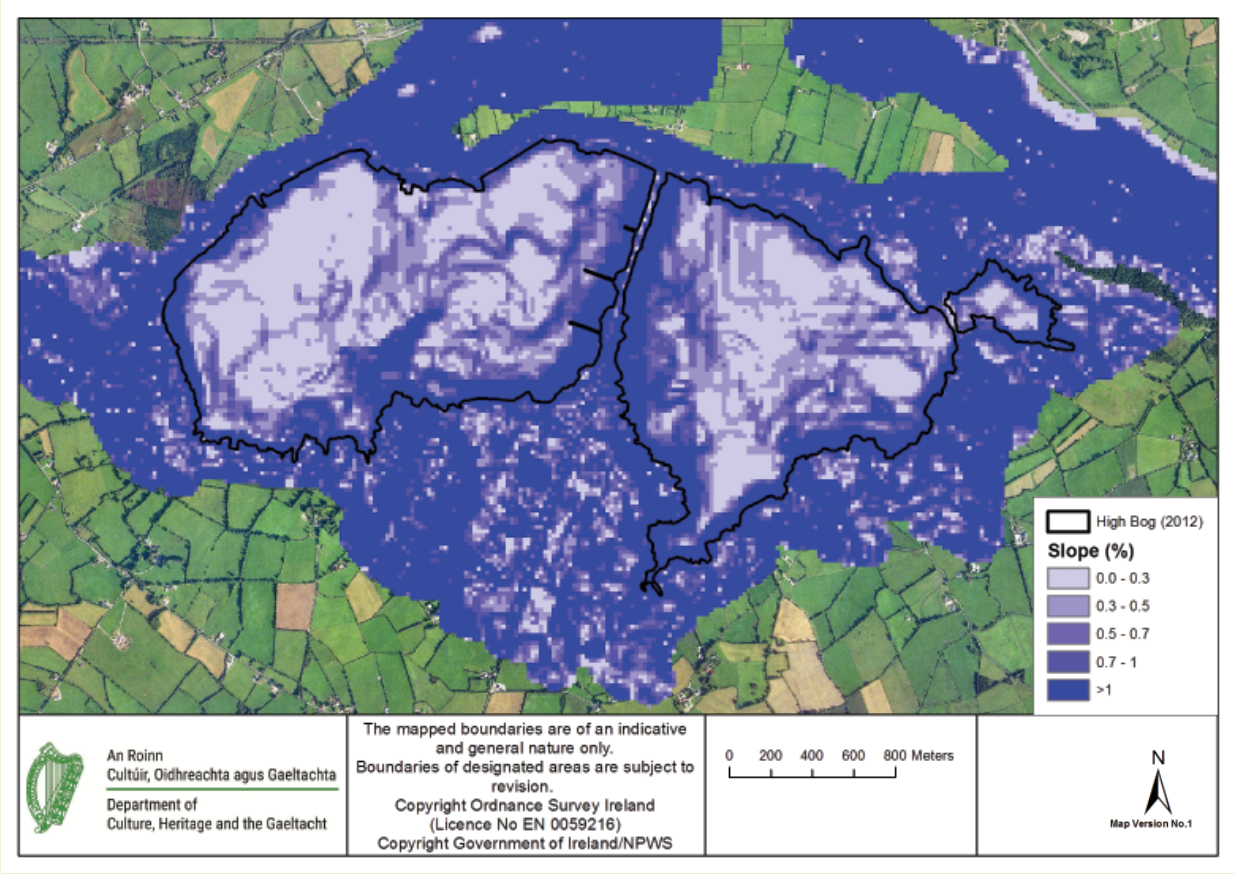


Figure A2.5: Clara Bog SAC, Co. Offaly, slope derived from LiDAR imagery 2012

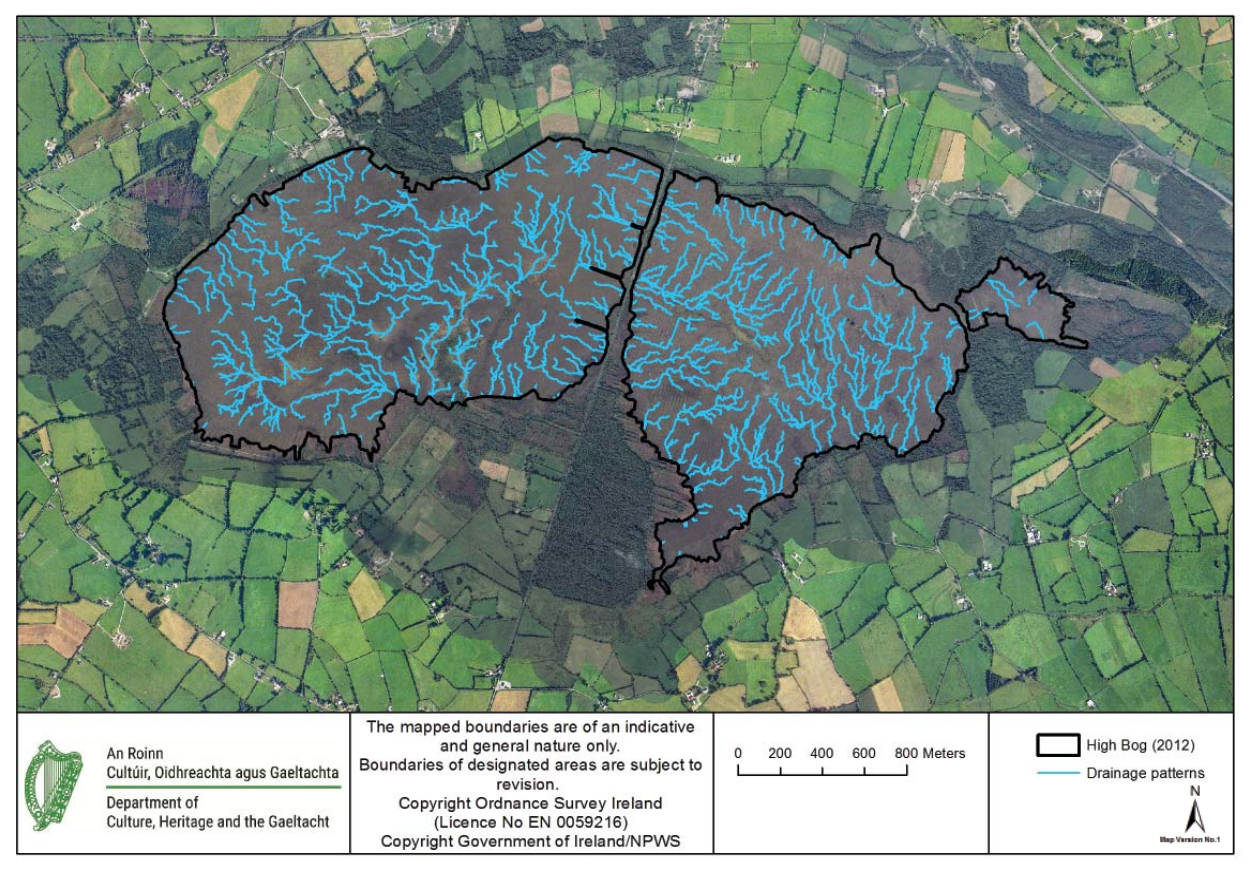


Figure A2.6: Clara Bog SAC, Co. Offaly, drainage paths derived from LiDAR imagery 2012

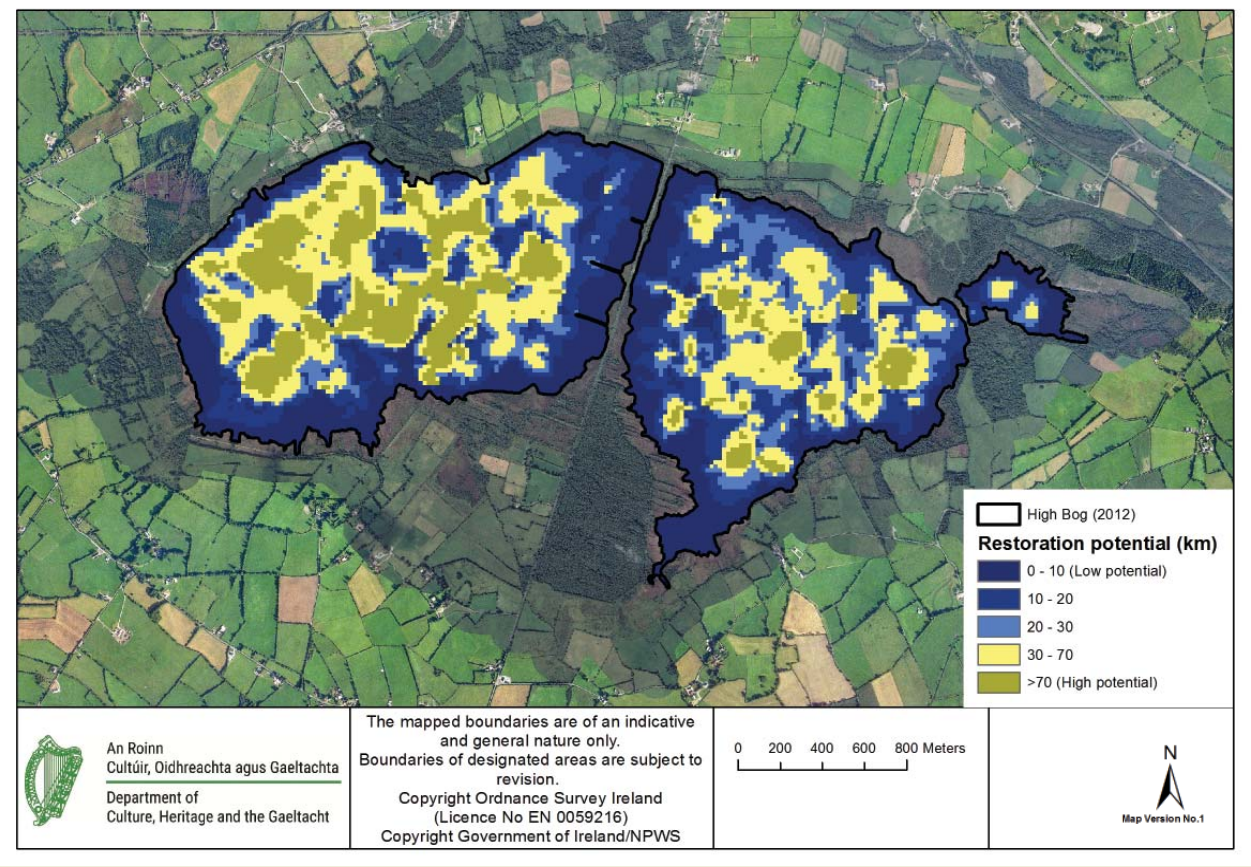


Figure A2.7: Clara Bog SAC, Co. Offaly, restoration potential derived from eco-hydrological model

Modelling the potential for restoration of cutover areas

The National Raised Bog Special Areas of Conservation Management Plan recognises that in order to achieve the national target area for ARB it will be necessary to carry out restoration works on cutover areas as well as on high bog. Such measures aim to establish areas of peat-forming vegetation. However, these will typically lack the vegetation structure and species diversity required to be considered ARB in a short to medium time frame, but may become ARB in the long term (50–100 years). Restoration of peat-forming habitats on cutover areas is typically more expensive than restoration of suitable high bog areas and more complex due to the range of additional factors that are likely to influence success of restoration. These include peat depth, peat permeability, presence of fen peat and mineral-rich groundwater, potential for nutrient rich run-off and the fact that the peat is often much more damaged and exposed to oxidation.

In order to identify areas on cutover bog with the potential to develop into peat-forming vegetation an empirical eco-hydrological model was developed based on similar modelling techniques that were developed for the high bog. The approach involves identifying areas of cutover bog where peat-forming conditions are most likely to occur, based on surveys of a limited number of sites where peat-formation is occurring on cutover bog and the identification of key factors influencing the hydrological conditions in such areas.

Unlike areas of high bog where plant community complexes have been mapped using recognised surveying techniques, no equivalent approach is currently employed for mapping the range of vegetation communities that are likely to occur on restored cutover bog. As a result it has not been possible to carry out a detailed statistical assessment as was possible for high bog using ecotope maps. Therefore, an empirical approach was used which involved identifying the key hydrological factors involved in the development of the vegetation observed on a number of cutover areas. This identified that some of the key factors likely to be responsible for development of peat-forming vegetation on cutover areas were:

- Flow patterns and contributing catchment area;
- Surface slope;
- Presence of enclosed depressions;
- Depth/permeability of remaining peat deposits;
- Presence of naturally elevated groundwater levels.

The first three factors listed can be identified relatively accurately using high resolution LiDAR data, while the depth/permeability of remaining peat deposits and groundwater levels require more detailed site-specific investigations. As a result, contributing catchment area, surface slope and presence of enclosed depressions were used as the basis of the preliminary model to identify areas with greatest potential for maintaining saturated conditions. This assumes that restoration measures are available and that vertical losses of water through the peat to depth are largely inhibited.

Flow patterns across the raised bog surface, including the high bog and cutover areas, are modelled. Local surface slope is calculated to identify areas with very gentle topographic slope and analysis is carried out to identify enclosed depressions that are likely to retain water. The modelling process involves identifying the areas of gentle surface slopes (≤0.3%) and enclosed depressions that have a contributing catchment area of at least 5000m^2.

Habitats that develop on cutover areas following restoration are likely to be more diverse than those typically associated with high bog due much more significant variation in hydrological conditions. However, peat-forming habitats that may develop can be broadly divided into two categories:

- Bog peat-forming habitats
- Lagg peat-forming habitats

Where rainfall and run-off from the high bog is the primary source of water, ombrotrophic dominated bog peat-forming habitats are likely to develop. These areas of bog peat-forming habitats may eventually become ARB in the long term (50–100 years) and therefore are considered to contribute to the long-term targets for the habitat. In contrast, where there is significant influence of mineral-rich water (e.g. through upwelling of mineral-rich groundwater or presence of a fen peat layer), lagg or fen vegetation is more likely to develop. A preliminary assessment of the dominant vegetation type that may develop is made based on available information including surface water patterns and topography which can be used as an indication of where upwelling mineral-rich groundwater may occur. However, in most cases a mosaic of habitats would be anticipated to develop following restoration of cutover areas.

Appendix 3

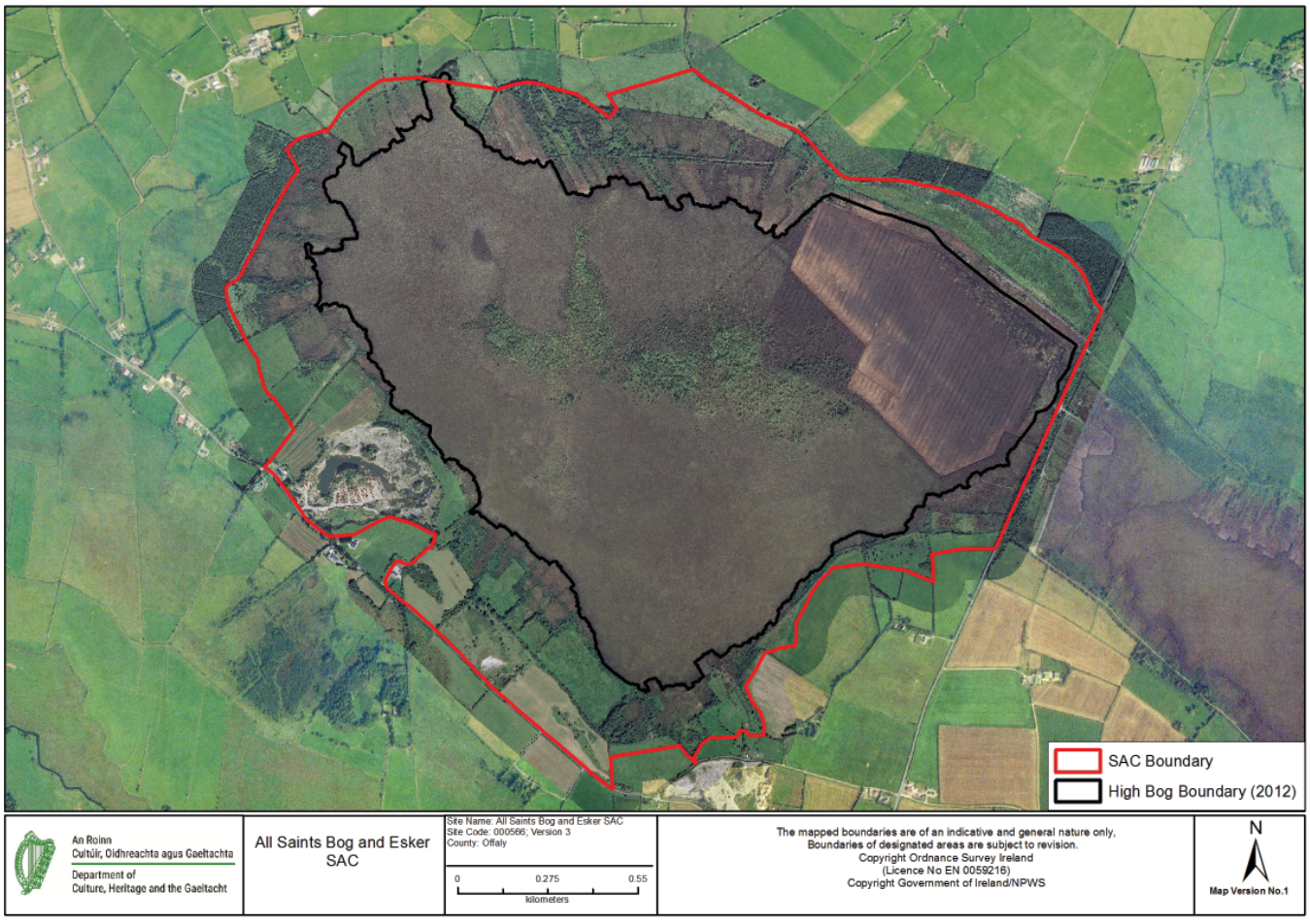
TECHNICAL OVERVIEW OF THE RAISED BOG SAC NETWORK

All Saints Bog and Esker SAC - Summary

Site Name:	All Saints Bog and Esker SAC
Site Code:	000566
Counties:	Offaly
River Basin District:	Shannon
Sub-Catchment:	Shannon[Lower]_SC_040, Shannon[Lower]_SC_060
Further Information:	http://www.npws.ie/protected-sites/sac/000566

Site Summary:

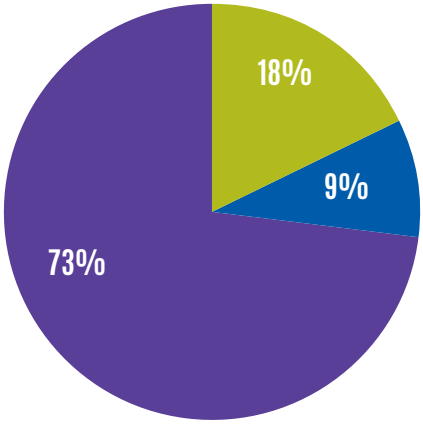
All Saints Bog is a lowland raised bog lying about 5 km north-west of Birr. The bog has a large area of bog woodland occurring in the central part of the site, a rare feature on Irish raised bogs. The north-eastern part of the site has been damaged by commercial peat milling in the past. The bog is bordered by a large esker ridge to the south.



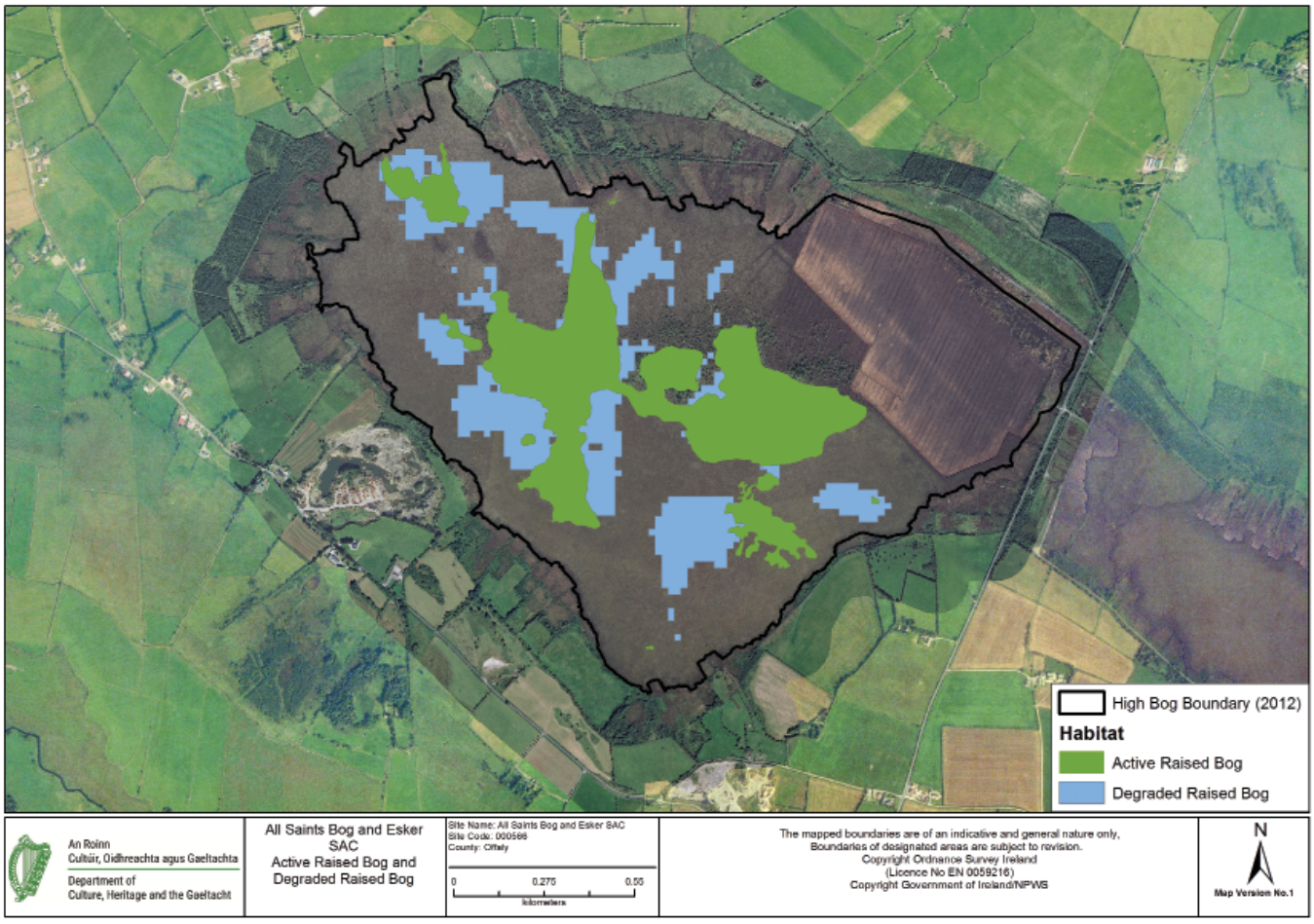
Site Statistics

Area of high bog in 1995 (ha):	228.9
Area of high bog in 2012 (ha):	226.8
Change in high bog (ha):	-2.1
Change in high bog (%):	-0.9%
Area of active raised bog in 1994 (ha) (Kelly et al. 1995)	66.6
Area of active raised bog in 2011 (ha) (Fernandez et al. 2012)	39.8
Change in active raised bog (ha):	-26.8
Change in active raised bog (%):	-40.2%
Area of degraded raised bog (ha):	21.2
Potential area bog peat-forming habitats (ha)	10.7

Composition of High Bog



- Active raised bog
- Degraded raised bog
- Potential supporting high bog habitat



Ardagullion Bog SAC - Summary

Site Name:	Ardagullion Bog SAC
Site Code:	002341
Counties:	Longford
River Basin District:	Shannon
Sub-Catchment:	Inny[Shannon]_SC_020, Inny[Shannon]_SC_050, Camlin_SC_010
Further Information:	http://www.npws.ie/protected-sites/sac/002341

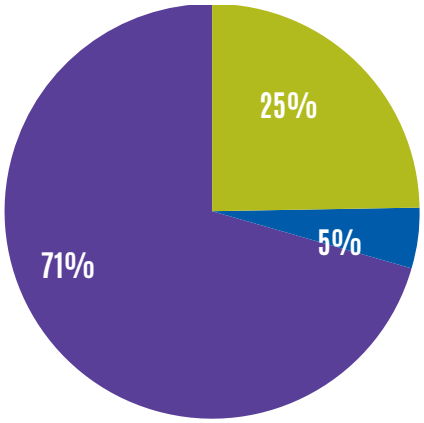
Site Summary:

Ardaguillion Bog is located 5 km north-east of Edgeworthstown, mainly in the townlands of Cloonshannagh and Ardaguillon in Co. Longford. The bog is of high conservation value due to the occurrence of a significant area of active raised bog. Although the site is relatively small and represents a remnant of a much more extensive raised bog, it retains a good example of active raised bog vegetation with hummocks and frequent pools.

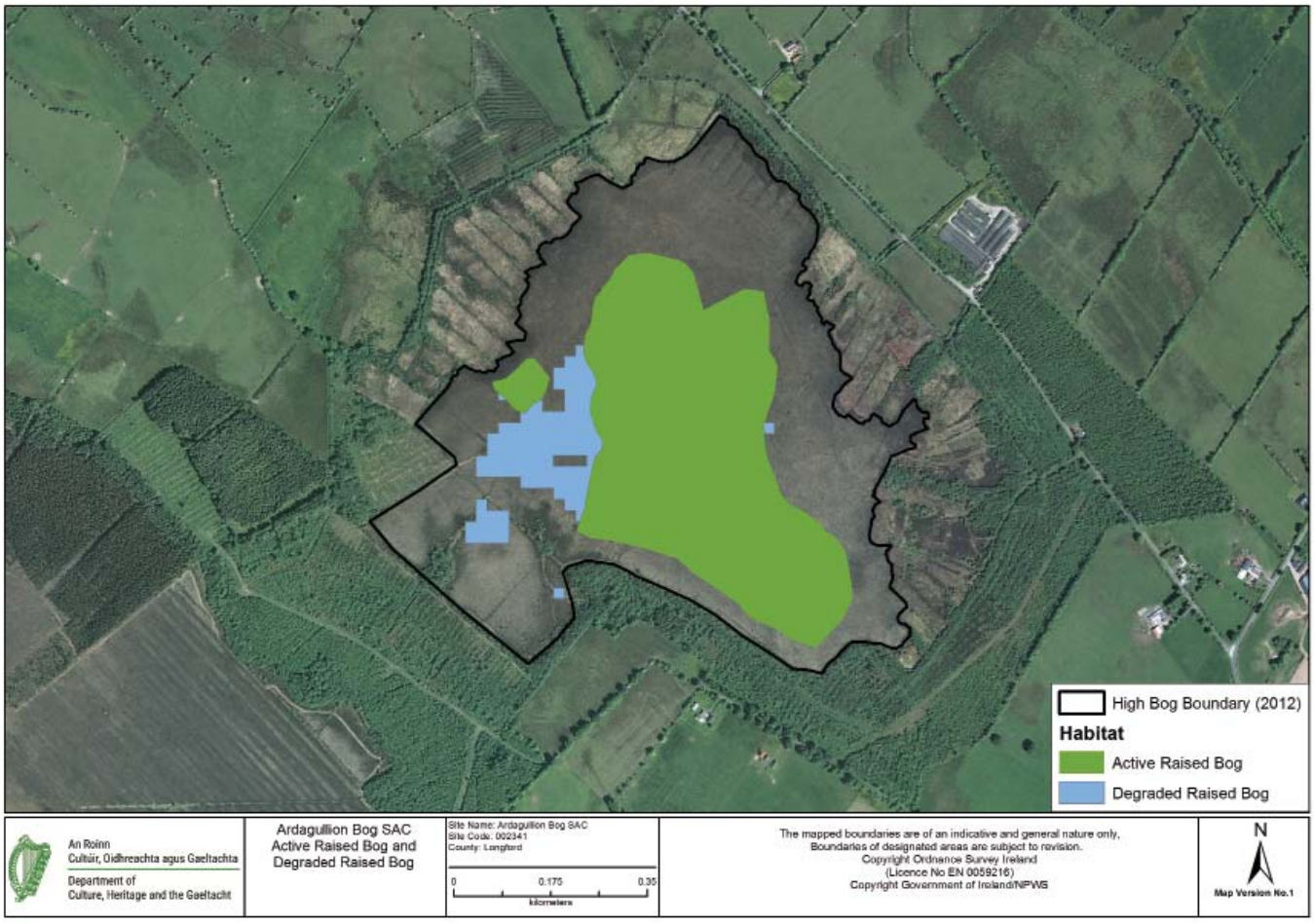
Site Statistics

Area of high bog in 1995 (ha):	57.9
Area of high bog in 2012 (ha):	56.9
Change in high bog (ha):	-1.0
Change in high bog (%):	-1.7%
No earlier survey available	N/A
Area of active raised bog in 1999 (ha) (Derwin & MacGowan, 2000*) (*Revised by NPWS in 2014)	14.0
Change in active raised bog (ha):	N/A
Change in active raised bog (%):	N/A
Area of degraded raised bog (ha):	2.7
Potential area bog peat-forming habitats (ha)	6.3

Composition of High Bog



- Active raised bog
- Degraded raised bog
- Potential supporting high bog habitat

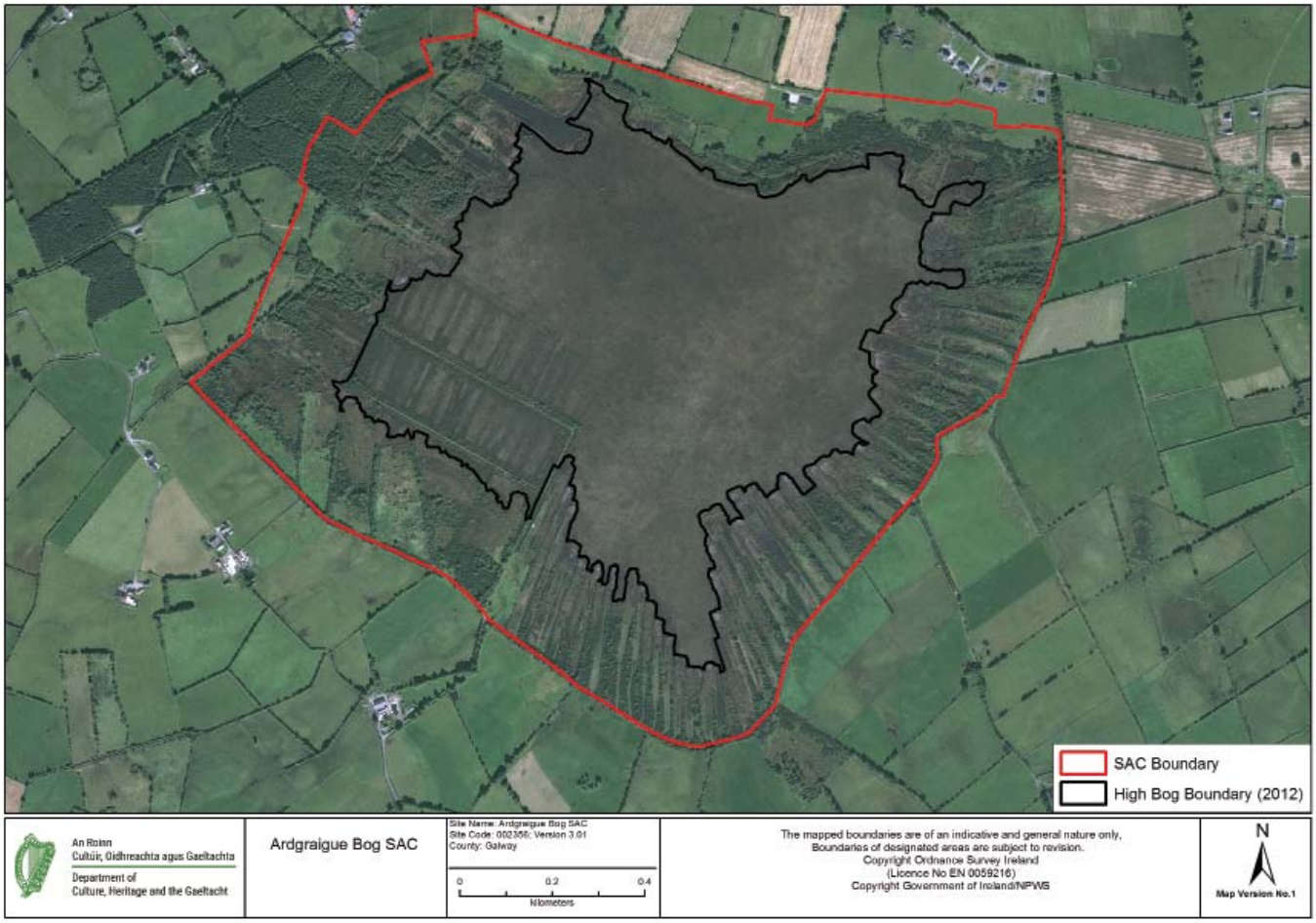


Ardgraigue Bog SAC - Summary

Site Name:	Ardgraigue Bog SAC
Site Code:	002356
Counties:	Galway
River Basin District:	Shannon
Sub-Catchment:	Shannon[Lower]_SC_050, Kilcrow_SC_010
Further Information:	http://www.npws.ie/protected-sites/sac/002356

Site Summary:

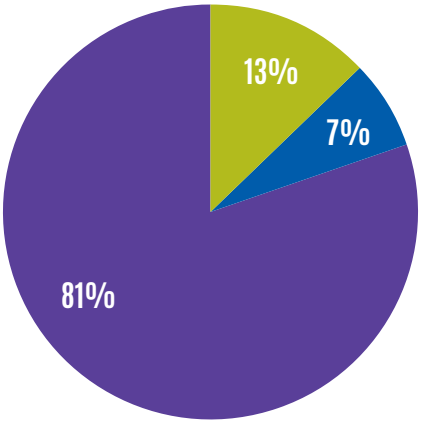
Ardgraigue Bog is situated approximately 3 km north-east of Killimor, Co. Galway. The bog represents a small western raised bog with a good example of active raised bog with good hummock hollow complexes. The presence of a wet flush area on the north-eastern part of the bog adds interest to the site.



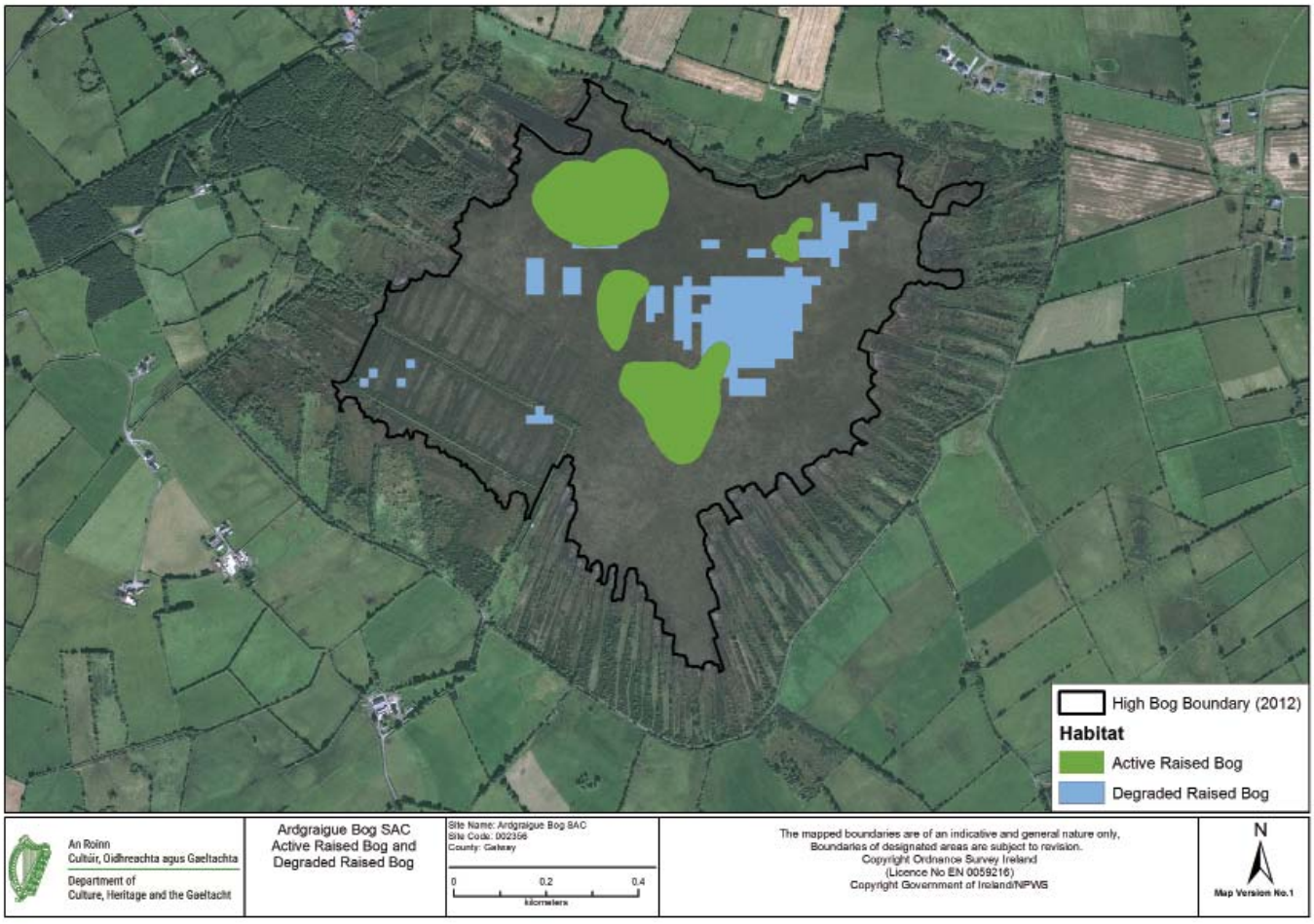
Site Statistics

Area of high bog in 1995 (ha):	89.5
Area of high bog in 2012 (ha):	80.4
Change in high bog (ha):	-9.1
Change in high bog (%):	-10.2%
No earlier survey available	N/A
Area of active raised bog in 2003 (ha) (Fernandez et al.2006)	10.3
Change in active raised bog (ha):	N/A
Change in active raised bog (%):	N/A
Area of degraded raised bog (ha):	5.2
Potential area bog peat-forming habitats (ha)	8.8

Composition of High Bog



- Active raised bog
- Degraded raised bog
- Potential supporting high bog habitat

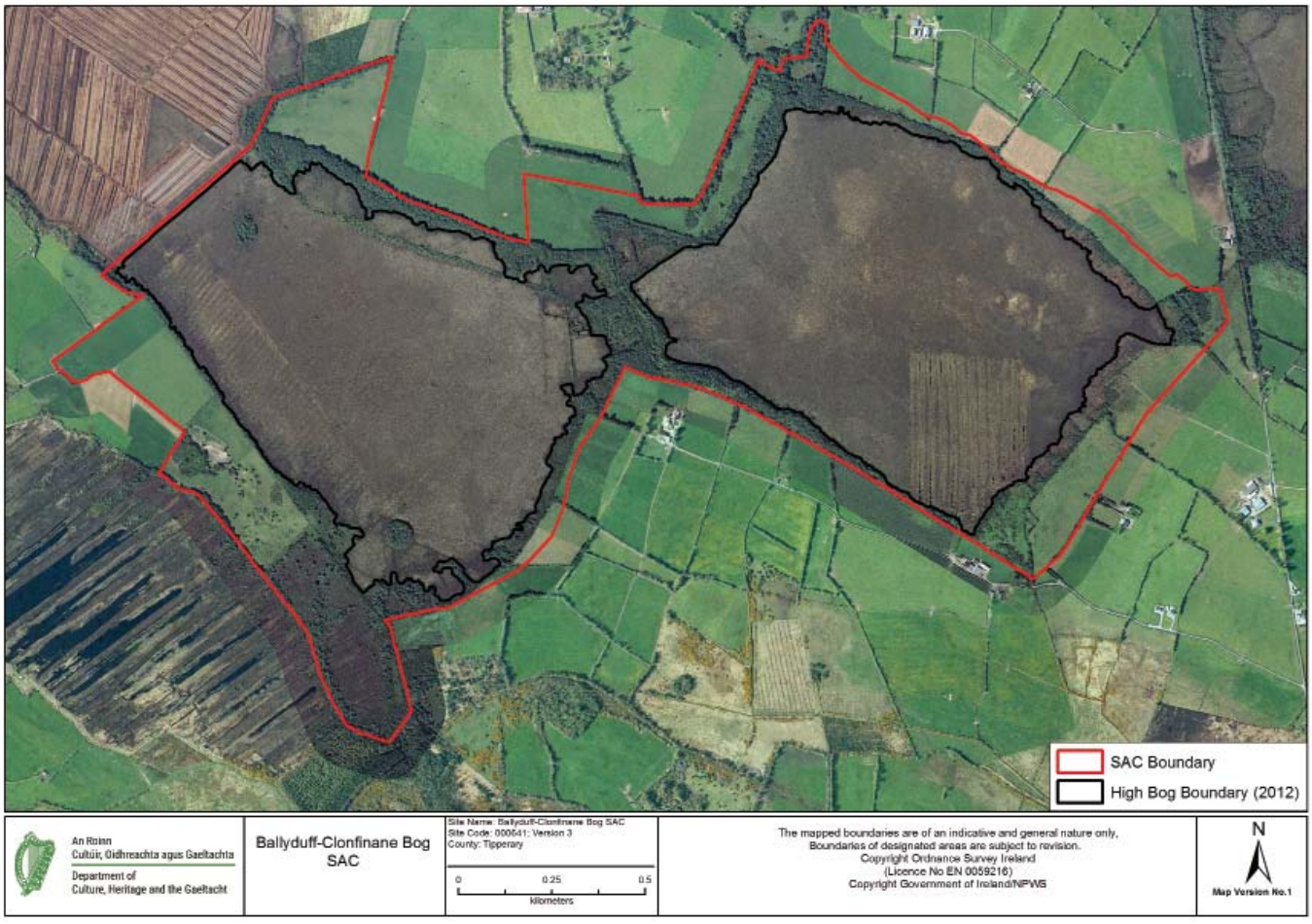


Ballyduff/Clonfinane Bog SAC - Summary

Site Name:	Ballyduff/Clonfinane Bog SAC
Site Code:	000641
Counties:	Tipperary
River Basin District:	Shannon
Sub-Catchment:	LittleBrosna_SC_020, Shannon[Lower]_SC_060
Further Information:	http://www.npws.ie/protected-sites/sac/000641

Site Summary:

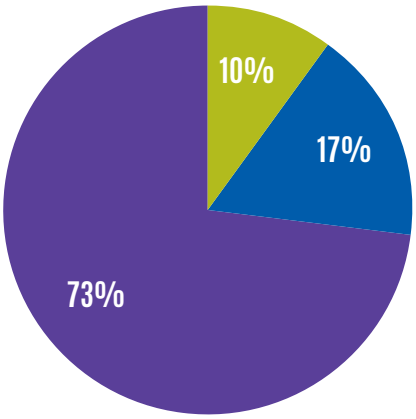
Clonfinane and Ballyduff bogs lie some 6 km to the southwest of Birr, the two bogs are linked and have been combined to form the present site. Clonfinane Bog has been damaged by drainage and commercial cuttting in the past and retains only a small area of active bog. Ballyduff Bog has also been affected by drainage although it retains a good area of active raised bog vegetation. Restoration works in the form of drain blocking has been undertaken by NPWS and is having a beneficial effect.

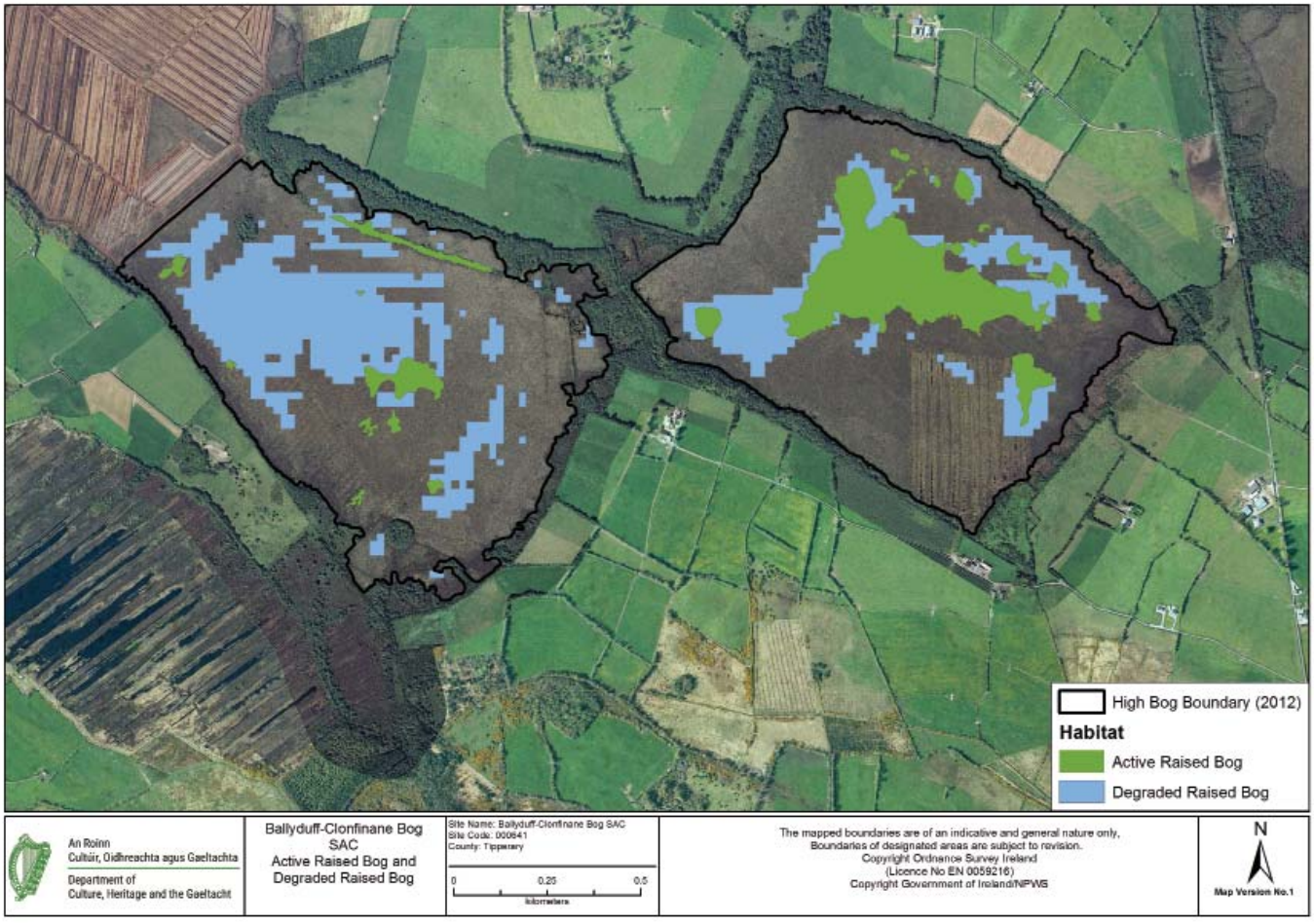


Site Statistics

Area of high bog in 1995 (ha):	175.8
Area of high bog in 2012 (ha):	173.9
Change in high bog (ha):	-1.9
Change in high bog (%):	-1.1%
Area of active raised bog in Ballyduff 1994 (ha) (Kelly et al. 1995) and in Clonfinane 1994 (Kelly et al. 1995*) (*Revised by NPWS in 2014)	36.9
Area of active raised bog in 2011 (ha) (Fernandez et al. 2012)	17.8
Change in active raised bog (ha):	-19.1
Change in active raised bog (%):	-51.8%
Area of degraded raised bog (ha):	30.1
Potential area bog peat-forming habitats (ha)	1.0

Composition of High Bog



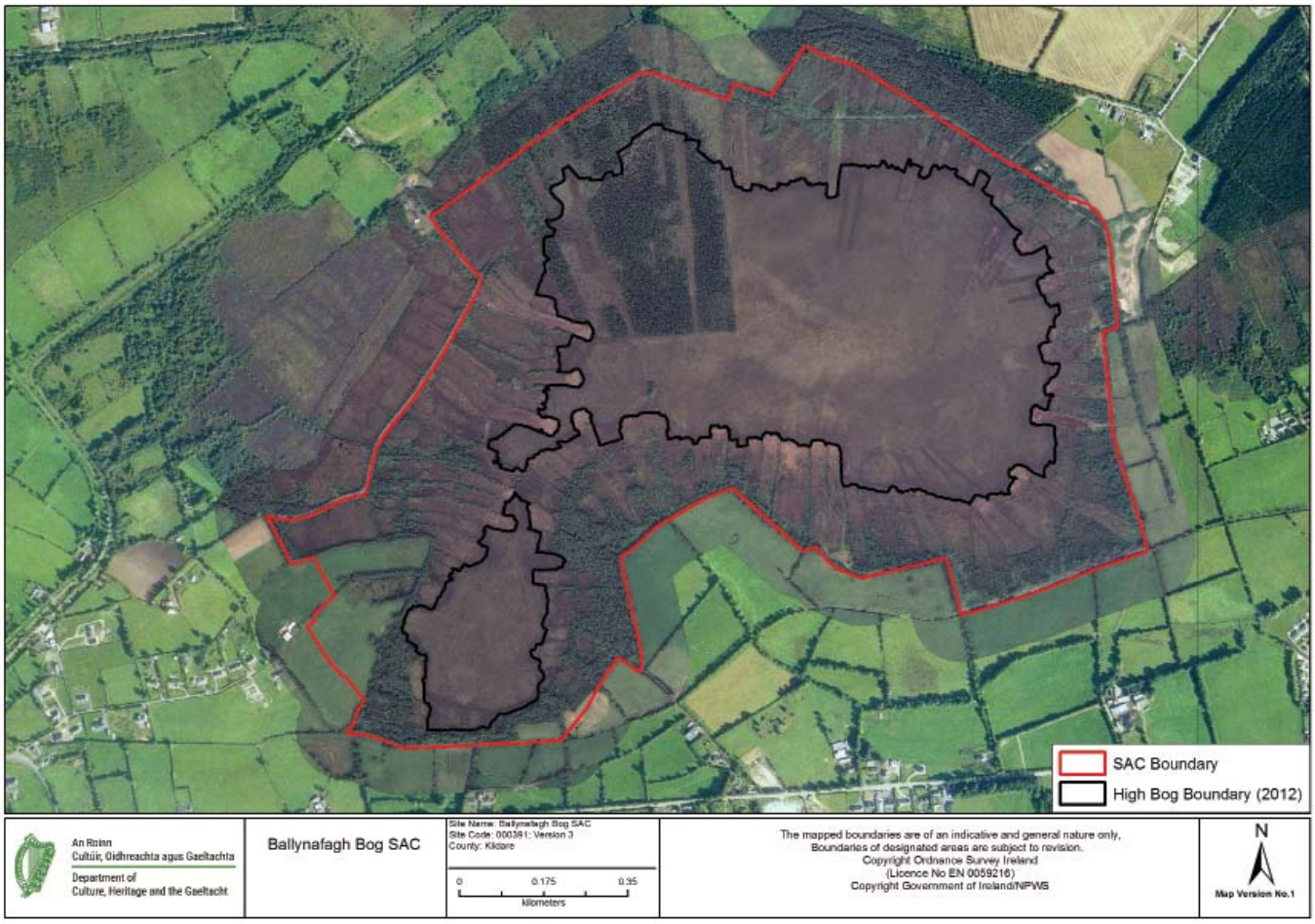


Ballynafagh Bog SAC - Summary

Site Name:	Ballynafagh Bog SAC
Site Code:	000391
Counties:	Kildare
River Basin District:	South Eastern
Sub-Catchment:	Slate_SC_010
Further Information:	http://www.npws.ie/protected-sites/sac/000391

Site Summary:

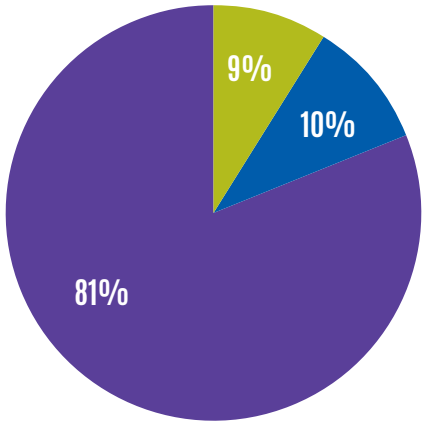
Ballynafagh Bog is situated about 1 km west of Prosperous in Co. Kildare. The bog is of high ecological value due to the occurrence of active raised bog that occupies the central part of the site. The bog is also of importance as it is located at the eastern edge of the range.



Site Statistics

Area of high bog in 1995 (ha):	73.6
Area of high bog in 2012 (ha):	69.7
Change in high bog (ha):	-3.9
Change in high bog (%):	-5.3%
Area of active raised bog in 1994 (ha) (Kelly et al. 1995*) (*Revised by NPWS in 2014)	14
Area of active raised bog in 2011 (ha) (Fernandez et al. 2012)	6.5
Change in active raised bog (ha):	-7.5
Change in active raised bog (%):	-53.6%
Area of degraded raised bog (ha):	6.9
Potential area bog peat-forming habitats (ha)	13.2

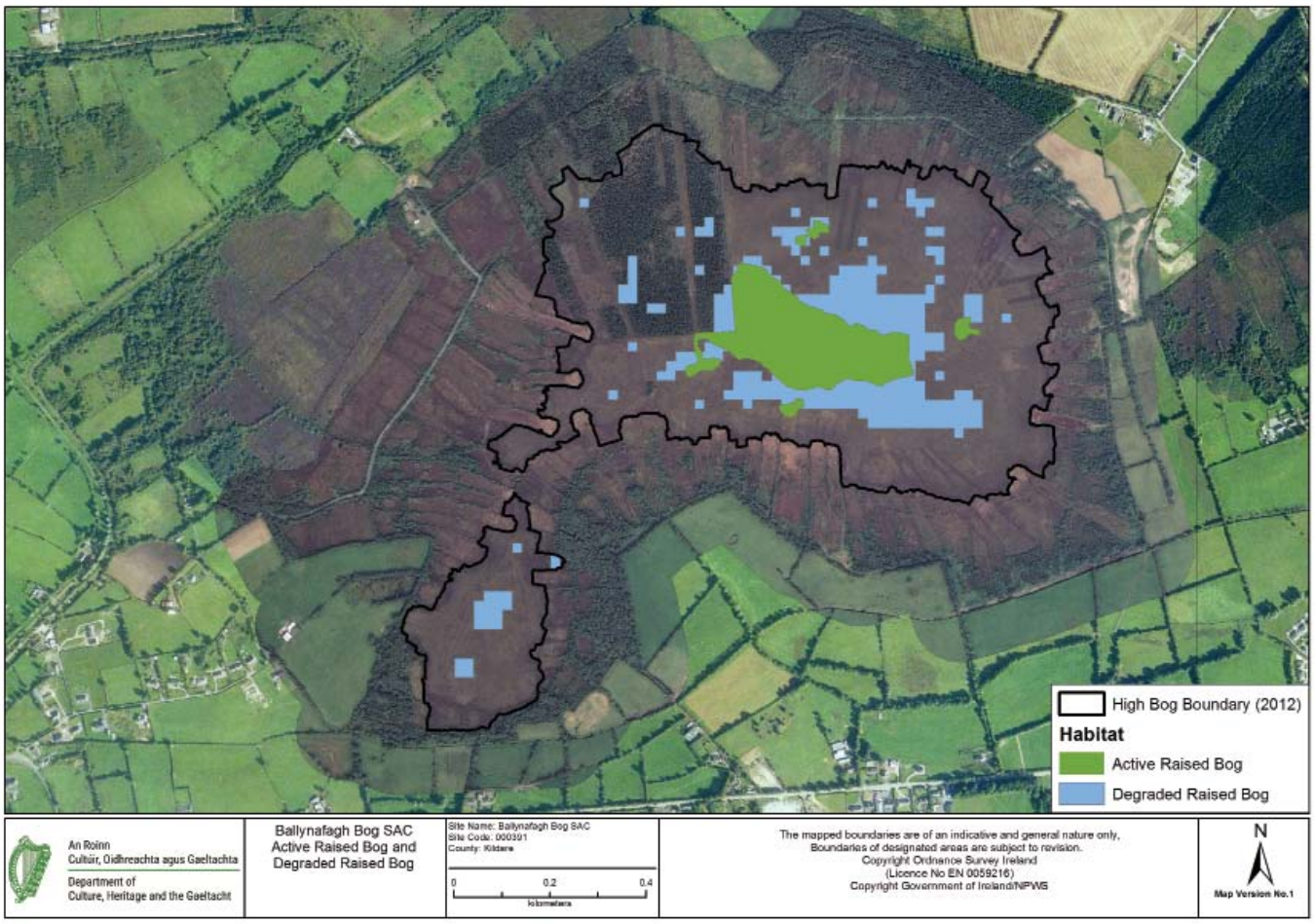
Composition of High Bog



Active raised bog

Degraded raised bog

Potential supporting high bog habitat

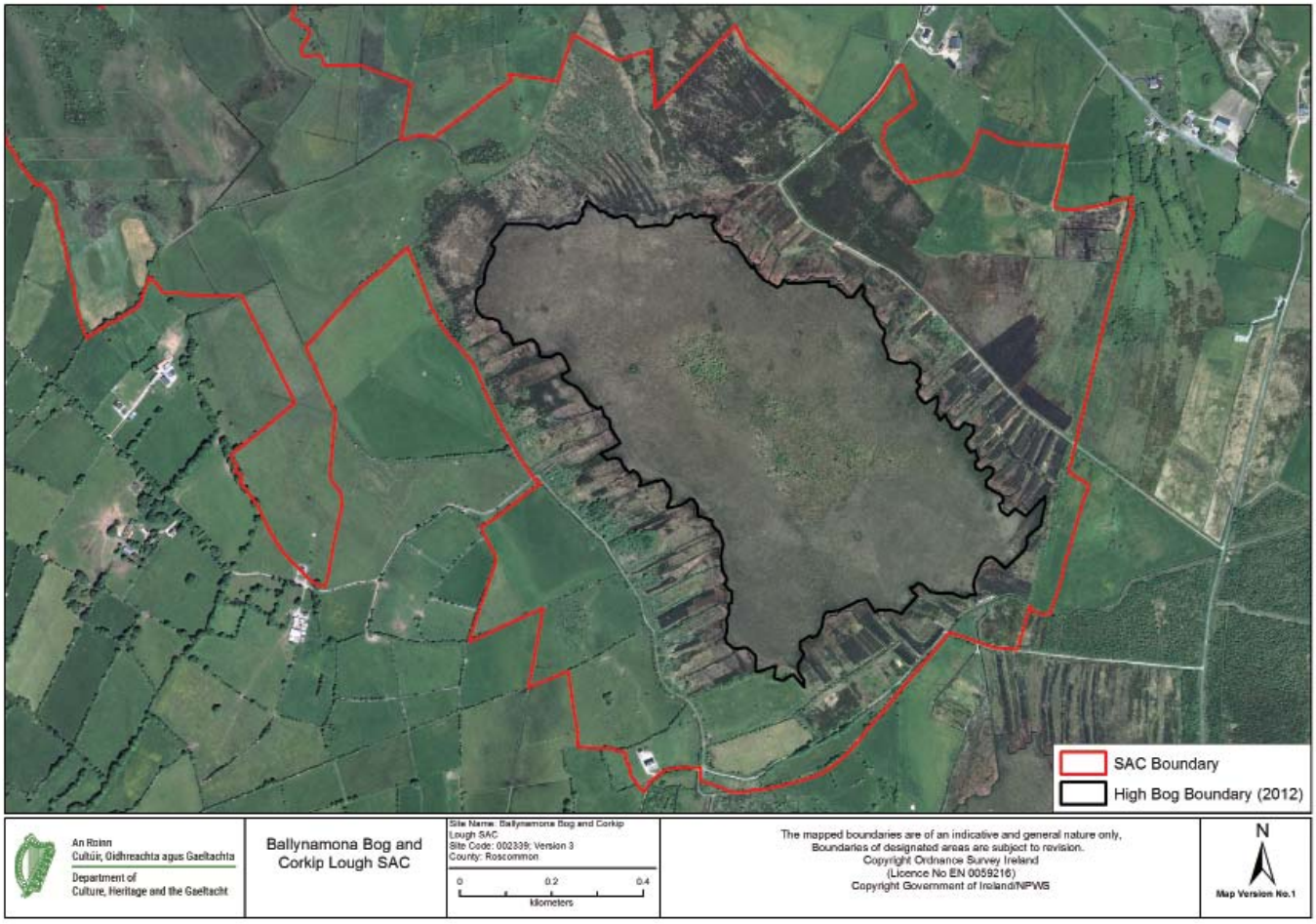


Ballynamona Bog and Corkip Lough SAC - Summary

Site Name:	Ballynamona Bog and Corkip Lough SAC
Site Code:	002339
Counties:	Roscommon
River Basin District:	Shannon
Sub-Catchment:	Shannon[Upper]_SC_100
Further Information:	http://www.npws.ie/protected-sites/sac/002339

Site Summary:

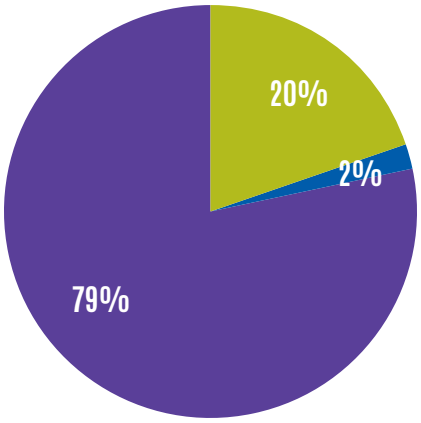
Ballynamona Bog is located approximately 9 km west of Athlone, Co. Roscommon. The bog is of high ecological interest due to the presence of an area of birch woodland (bog woodland) occurring in the central part of the bog, a rare feature of Irish raised bogs. The presence of a turlough adjacent to the bog also adds interest to the site.



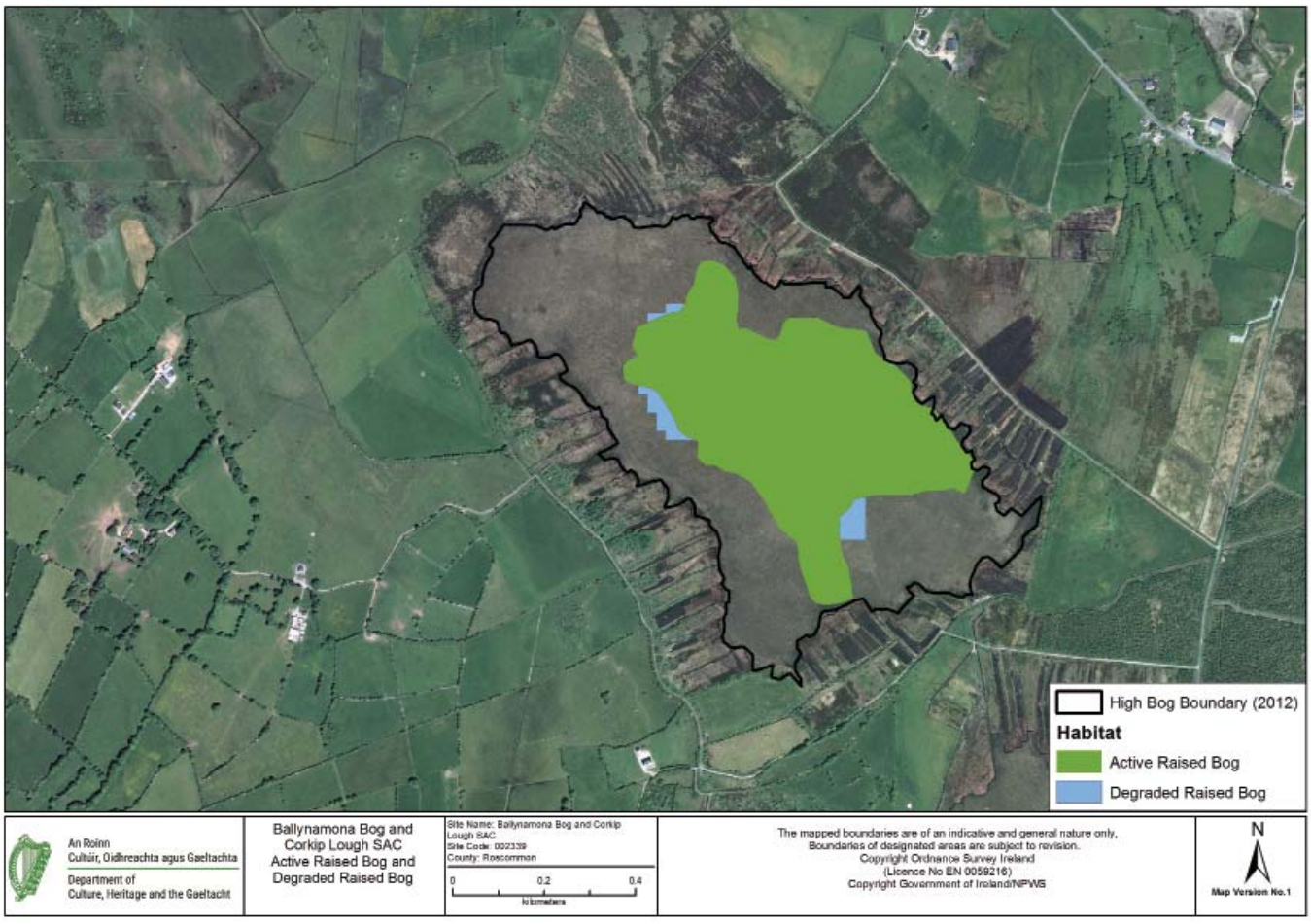
Site Statistics

Area of high bog in 1995 (ha):	66.7
Area of high bog in 2012 (ha):	60.9
Change in high bog (ha):	-5.8
Change in high bog (%):	-8.7%
No earlier survey available	N/A
Area of active raised bog in 2000 (ha) (Derwin & MacGowan, 2000*) (*Revised by NPWS in 2014)	12.0
Change in active raised bog (ha):	N/A
Change in active raised bog (%):	N/A
Area of degraded raised bog (ha):	1.1
Potential area bog peat-forming habitats (ha)	5.8

Composition of High Bog



- Active raised bog
- Degraded raised bog
- Potential supporting high bog habitat

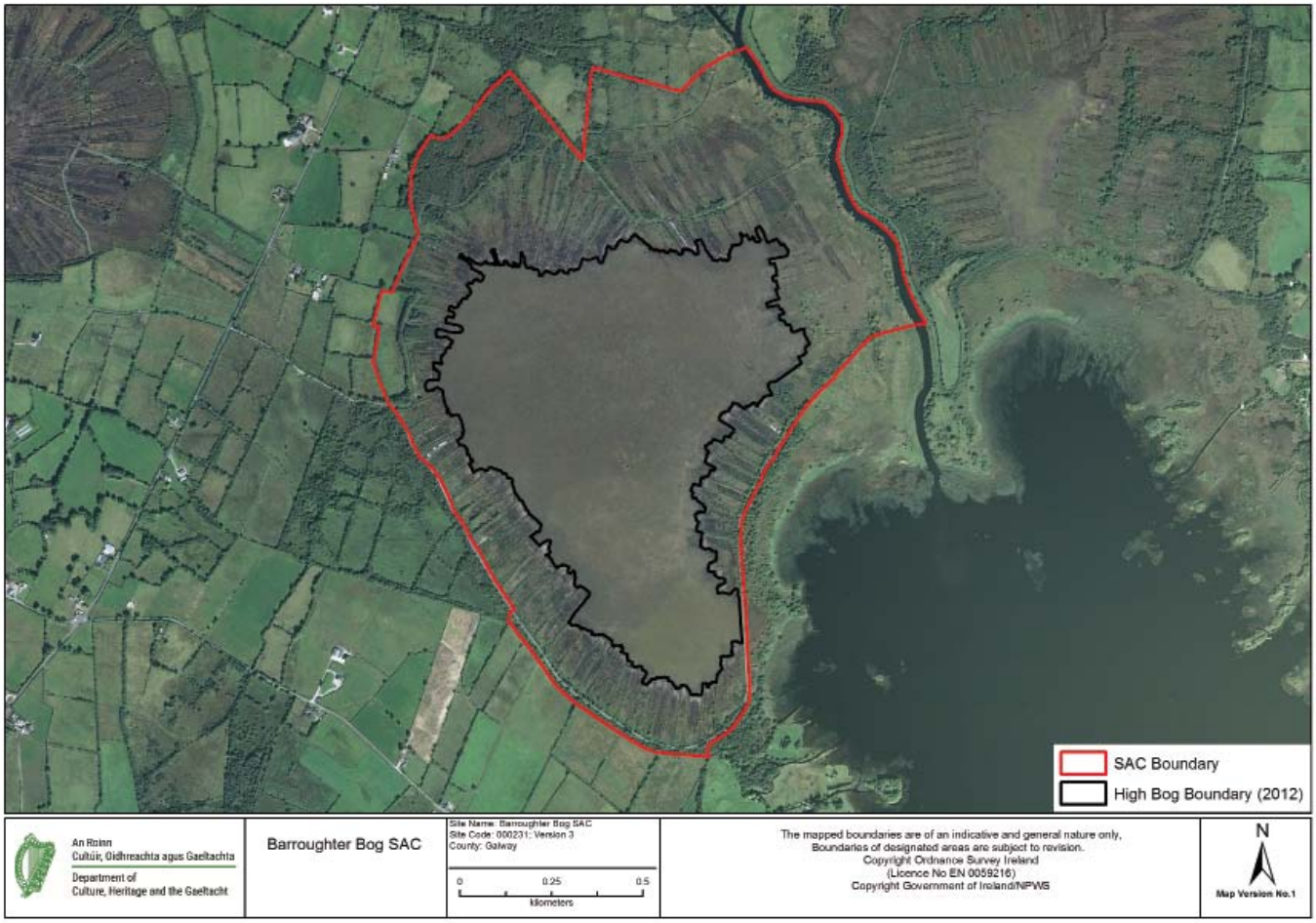


Barroughter Bog SAC - Summary

Site Name:	Barroughter Bog SAC
Site Code:	000231
Counties:	Galway
River Basin District:	Shannon
Sub-Catchment:	Shannon[Lower]_SC_070, Bow_SC_010, Kilcrow_SC_010
Further Information:	http://www.npws.ie/protected-sites/sac/000231

Site Summary:

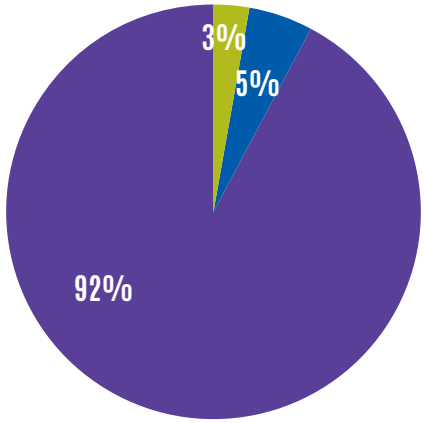
Barroughter Bog is a relatively small raised bog, situated on the shores of Lough Derg, a few kilometres east of Woodford, and bounded in the north by the Cappagh River. The bog now retains only a small area of active raised bog vegetation. The site is of interest being the only raised bog on the shores of Lough Derg and once had a natural transition from the bog to the lake margin. However, continued peat cutting around the perimeter of the bog has caused significant damage to the site.

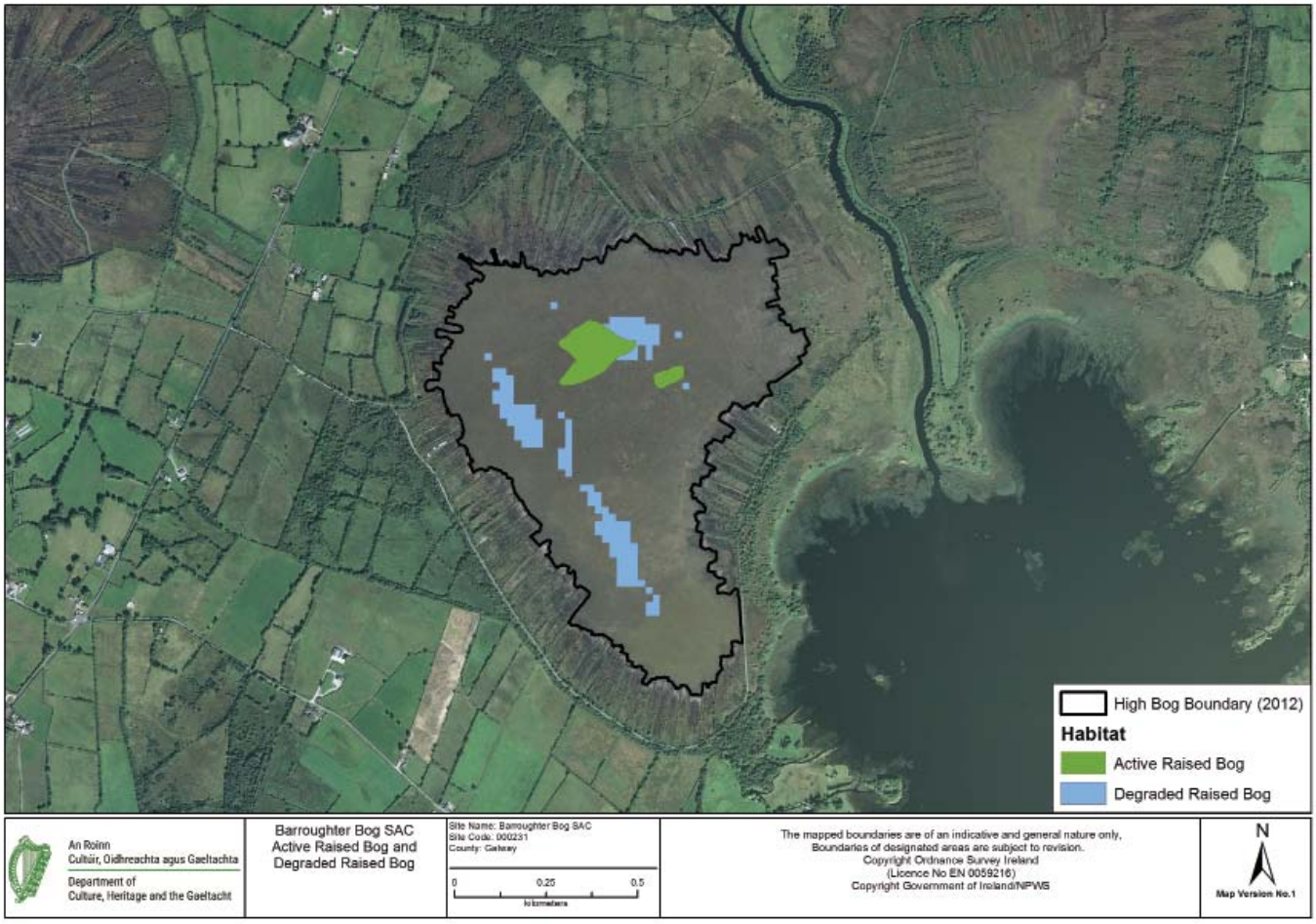


Site Statistics

Area of high bog in 1995 (ha):	84.2
Area of high bog in 2012 (ha):	73.5
Change in high bog (ha):	-10.7
Change in high bog (%):	-12.7%
Area of active raised bog in 1994 (ha) (Kelly et al. 1995*) (*Revised by NPWS in 2014)	21
Area of active raised bog in 2005 (ha) (Fernandez et al. 2005)	2.4
Change in active raised bog (ha):	-18.6
Change in active raised bog (%):	-88.6%
Area of degraded raised bog (ha):	3.7
Potential area bog peat-forming habitats (ha)	8.6

Composition of High Bog



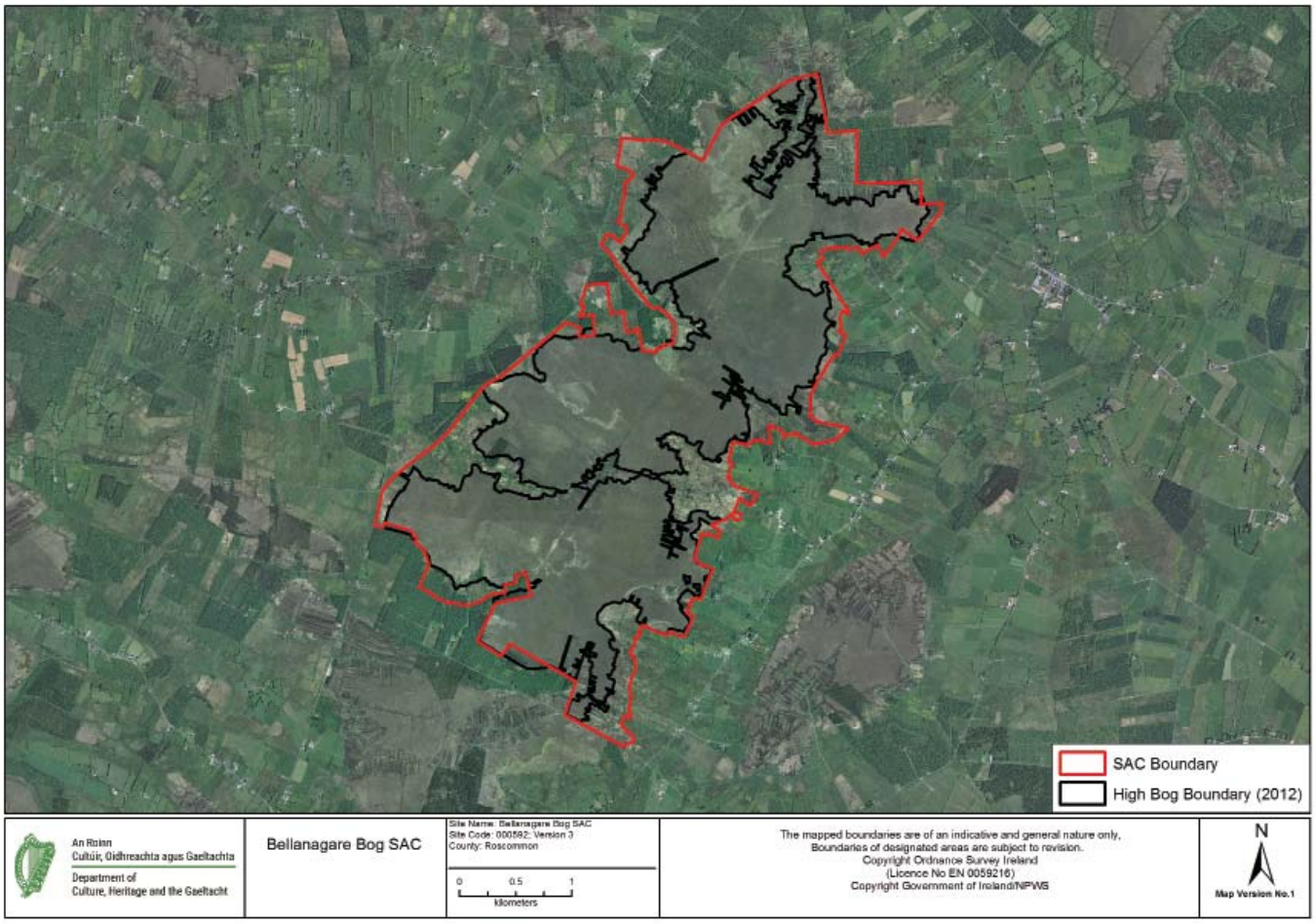


Bellanagare Bog SAC - Summary

Site Name:	Bellanagare Bog SAC
Site Code:	000592
Counties:	Roscommon
River Basin District:	Shannon
Sub-Catchment:	Breedoge_SC_010, Suck_SC_010
Further Information:	http://www.npws.ie/protected-sites/sac/000592

Site Summary:

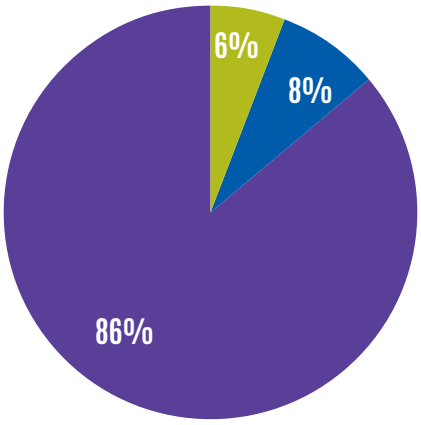
Bellangare Bog is a western, or intermediate, raised bog found 6 km north-north-east of Castlerea. As an intermediate bog it shows characteristics of both raised and blanket bog. A large area of active raised bog vegetation occurs throughout the site. The presence of a series of different flush systems adds further interest to the site.

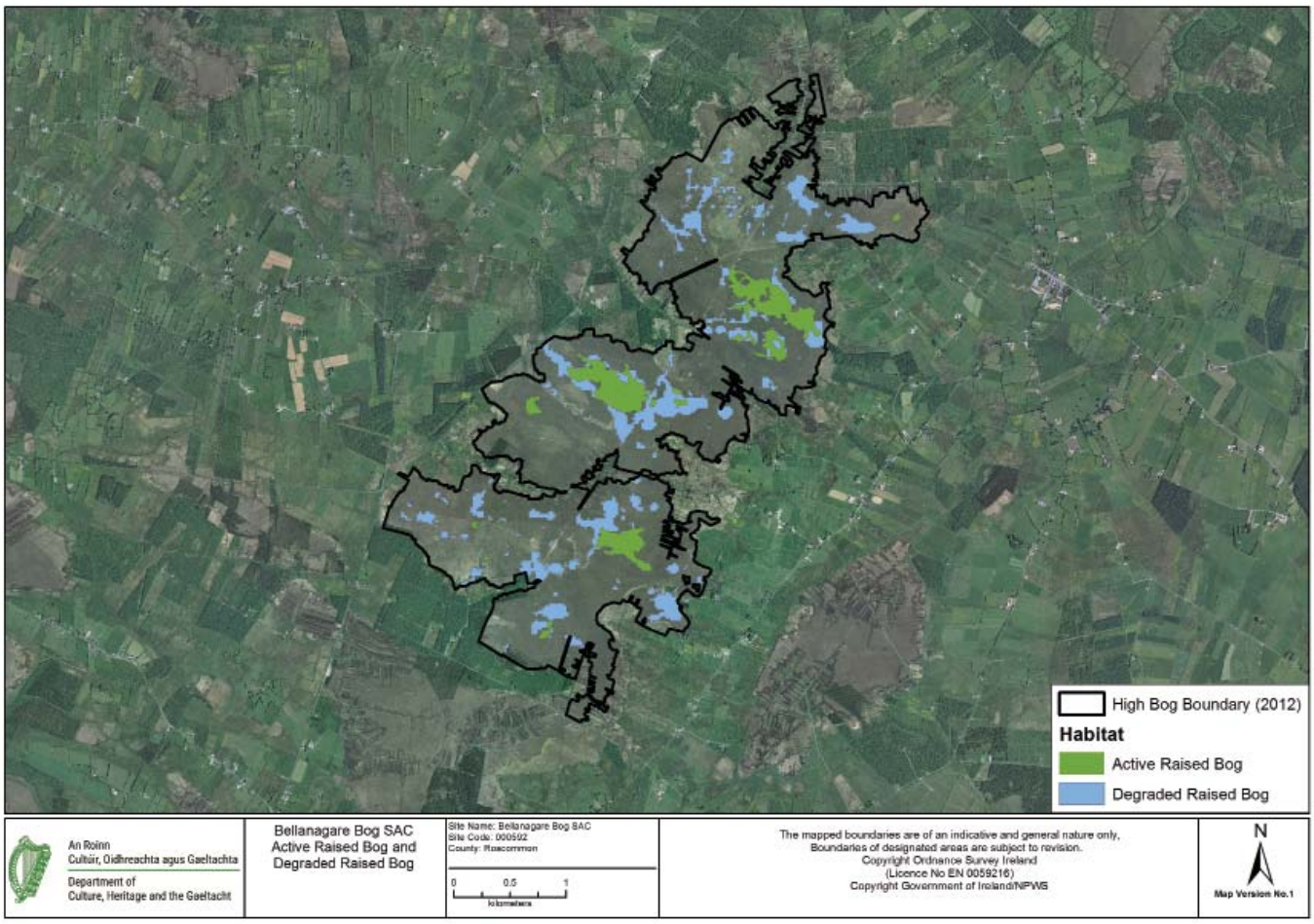


Site Statistics

Area of high bog in 1995 (ha):	889.9
Area of high bog in 2012 (ha):	879.1
Change in high bog (ha):	-10.8
Change in high bog (%):	-1.2%
Area of active raised bog in 1994 (ha) (Kelly et al. 1995*) (*Revised by NPWS in 2014)	84
Area of active raised bog in 2013 (ha) (Fernandez et al. 2014)	49.6
Change in active raised bog (ha):	-34.4
Change in active raised bog (%):	-41%
Area of degraded raised bog (ha):	73.8
Potential area bog peat-forming habitats (ha)	15.7

Composition of High Bog



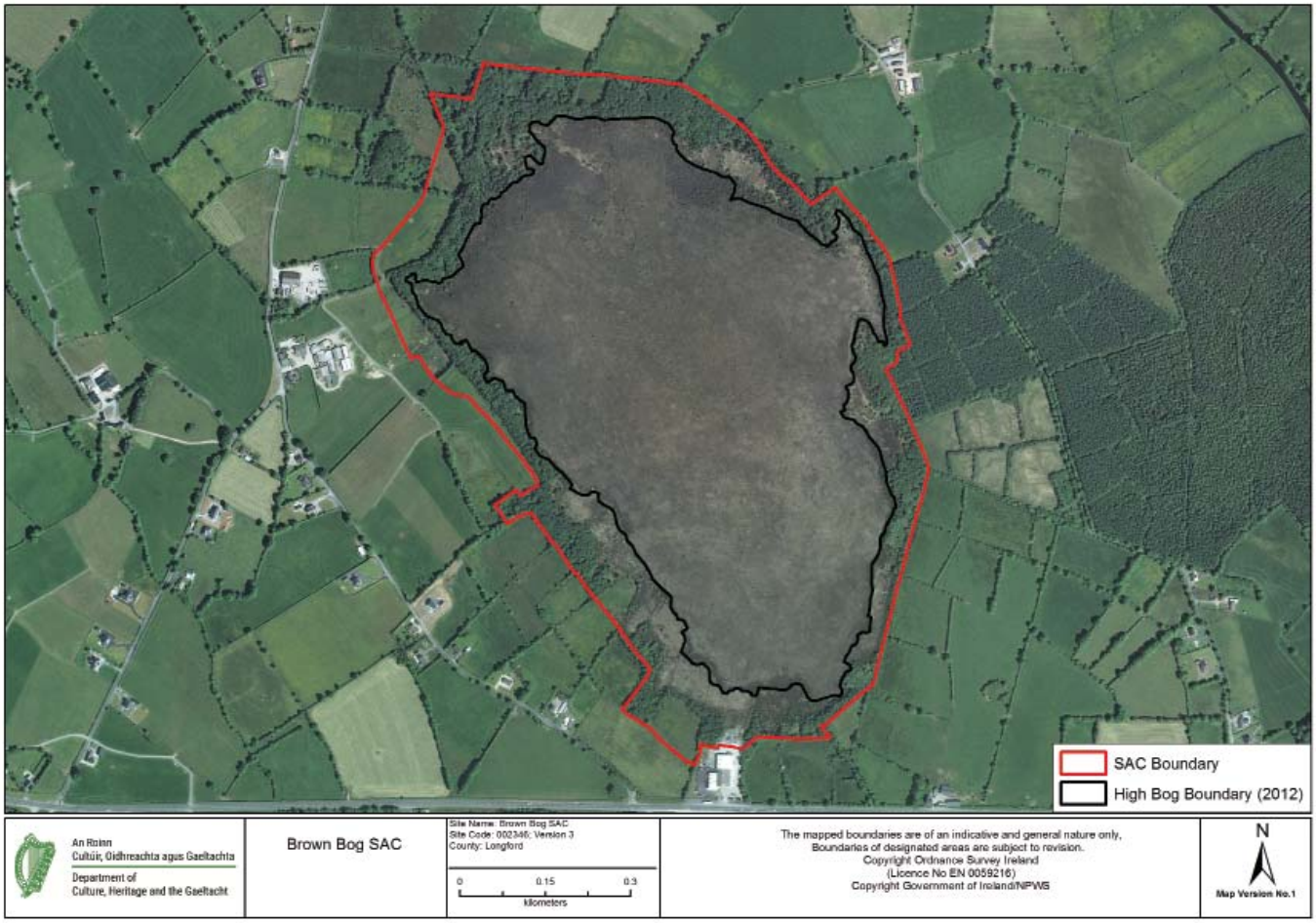


Brown Bog SAC - Summary

Site Name:	Brown Bog SAC
Site Code:	002346
Counties:	Longford
River Basin District:	Shannon
Sub-Catchment:	Shannon[Upper]_SC_060
Further Information:	http://www.npws.ie/protected-sites/sac/002346

Site Summary:

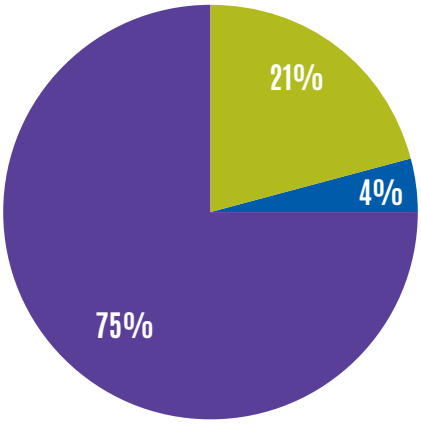
Brown Bog is located 5 km north-west of Longford Town. Brown Bog is of high value due to the presence of good quality active raised bog vegetation throughout the central part. The site also has a relatively intact margin with no recent peat cutting.



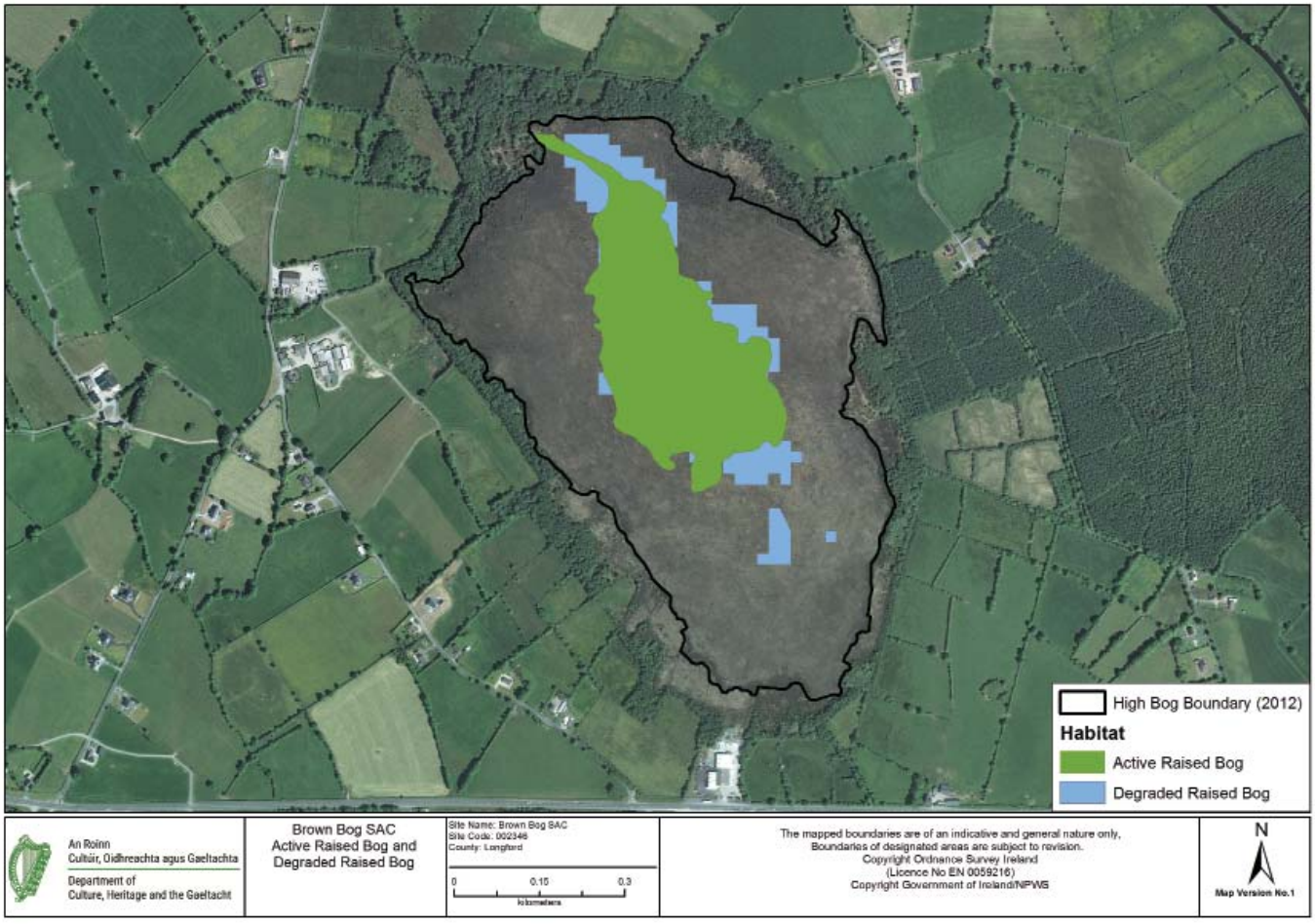
Site Statistics

Area of high bog in 1995 (ha):	50.9
Area of high bog in 2012 (ha):	50.9
Change in high bog (ha):	0.0
Change in high bog (%):	0.0%
Area of active raised bog in 1994 (ha) (Kelly et al. 1995)	10.9
Area of active raised bog in 2012 (ha) (Fernandez et al. 2014)	10.8
Change in active raised bog (ha):	-0.1%
Change in active raised bog (%):	-0.9%
Area of degraded raised bog (ha):	2.2
Potential area bog peat-forming habitats (ha)	0.2

Composition of High Bog



- Active raised bog
- Degraded raised bog
- Potential supporting high bog habitat



Callow Bog SAC - Summary

Site Name:	Callow Bog SAC
Site Code:	000595
Counties:	Roscommon
River Basin District:	Shannon
Sub-Catchment:	Boyle_SC_010, Lung_SC_020
Further Information:	http://www.npws.ie/protected-sites/sac/000595

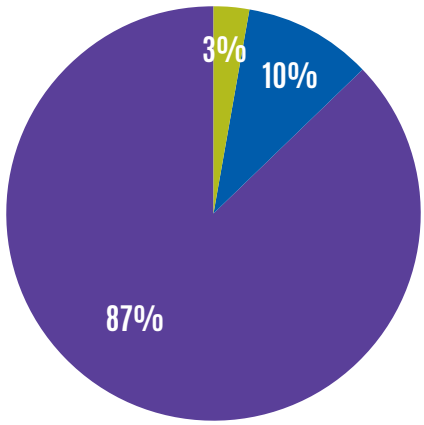
Site Summary:

Callow Bog is located approximately 7 km north-west of Frenchpark, Co. Roscommon. It is a relatively large raised bog that is of value due to the presence of a significant area of active raised bog vegetation. The transition from the bog to Lough Gara to the north adds interest to the site.

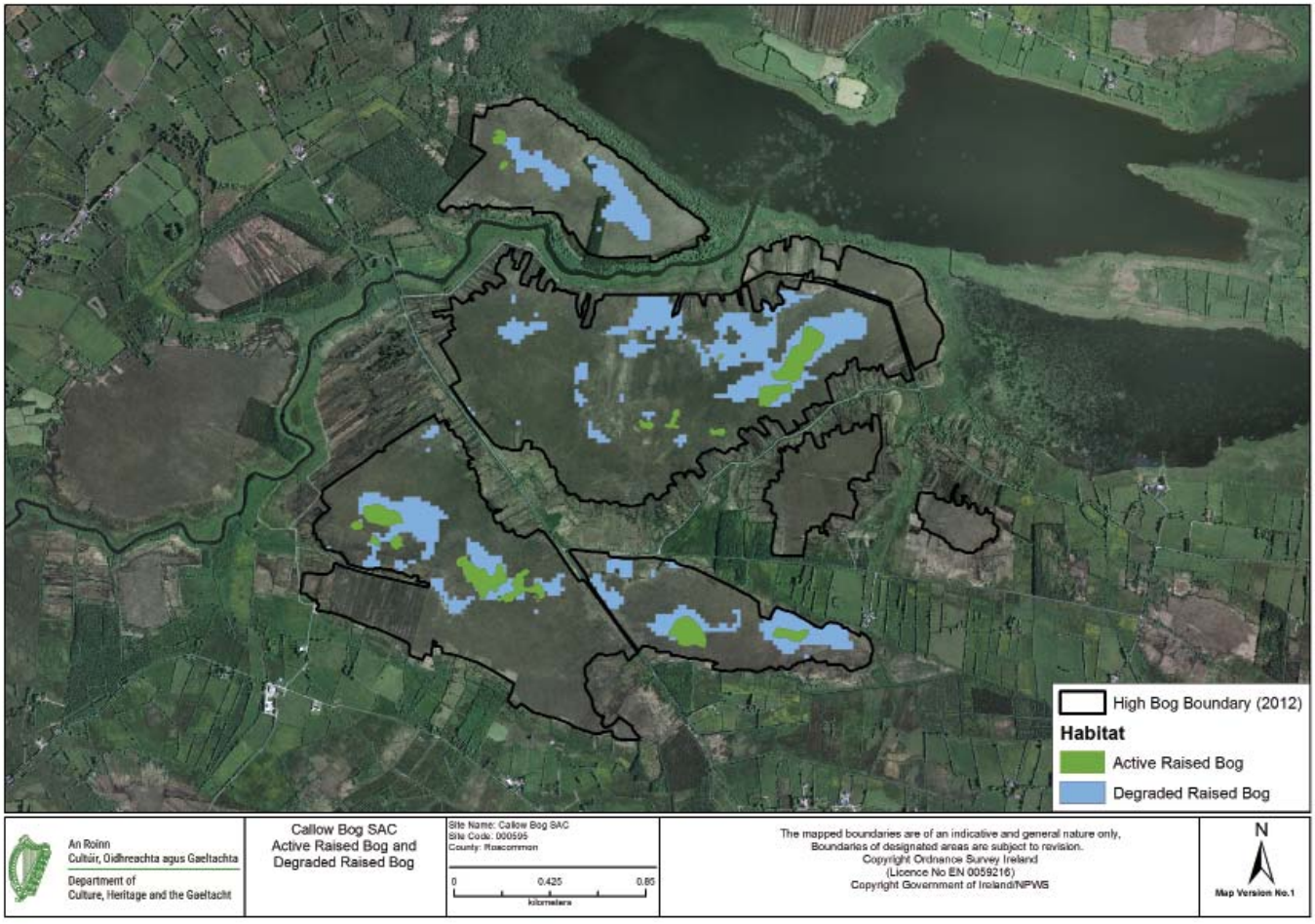
Site Statistics

Area of high bog in 1995 (ha):	358.2
Area of high bog in 2012 (ha):	352.0
Change in high bog (ha):	-6.2
Change in high bog (%):	-1.7%
No earlier survey available that covered the entire site	N/A
Area of active raised bog in 2012 (ha) (Fernandez et al. 2014)	11.4
Change in active raised bog (ha):	N/A
Change in active raised bog (%):	N/A
Area of degraded raised bog (ha):	33.9
Potential area bog peat-forming habitats (ha)	8.1

Composition of High Bog



- Active raised bog
- Degraded raised bog
- Potential supporting high bog habitat

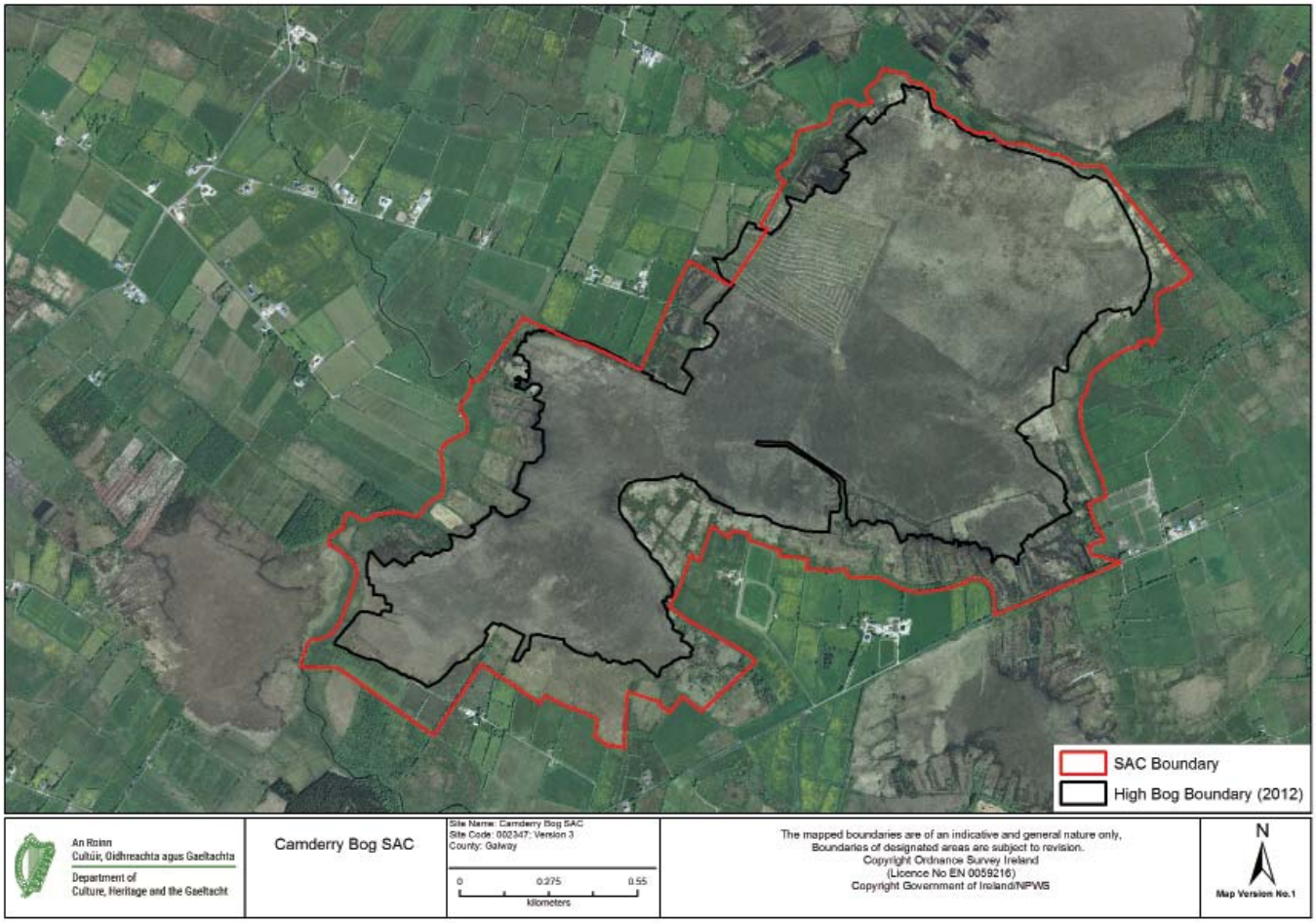


Camderry Bog SAC - Summary

Site Name:	Camderry Bog SAC
Site Code:	002347
Counties:	Galway
River Basin District:	Shannon
Sub-Catchment:	Suck_SC_050
Further Information:	http://www.npws.ie/protected-sites/sac/002347

Site Summary:

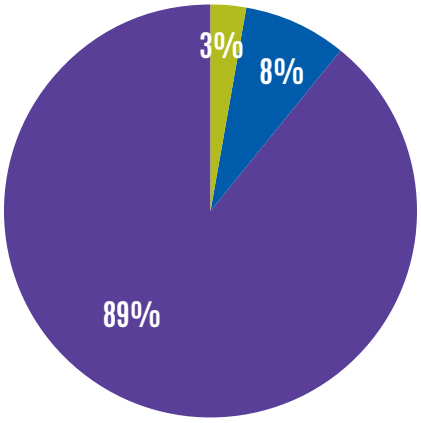
Camderry Bog is part of a cluster of bogs in Co. Galway, approximately 12 km north-east of Mountbellew and 9 km south-east of Glenamaddy. The bog is of interest as a western raised bog comprising two domes separated by a mineral ridge. Restoration works including tree removal and drain blocking have been carried out by Coillte.



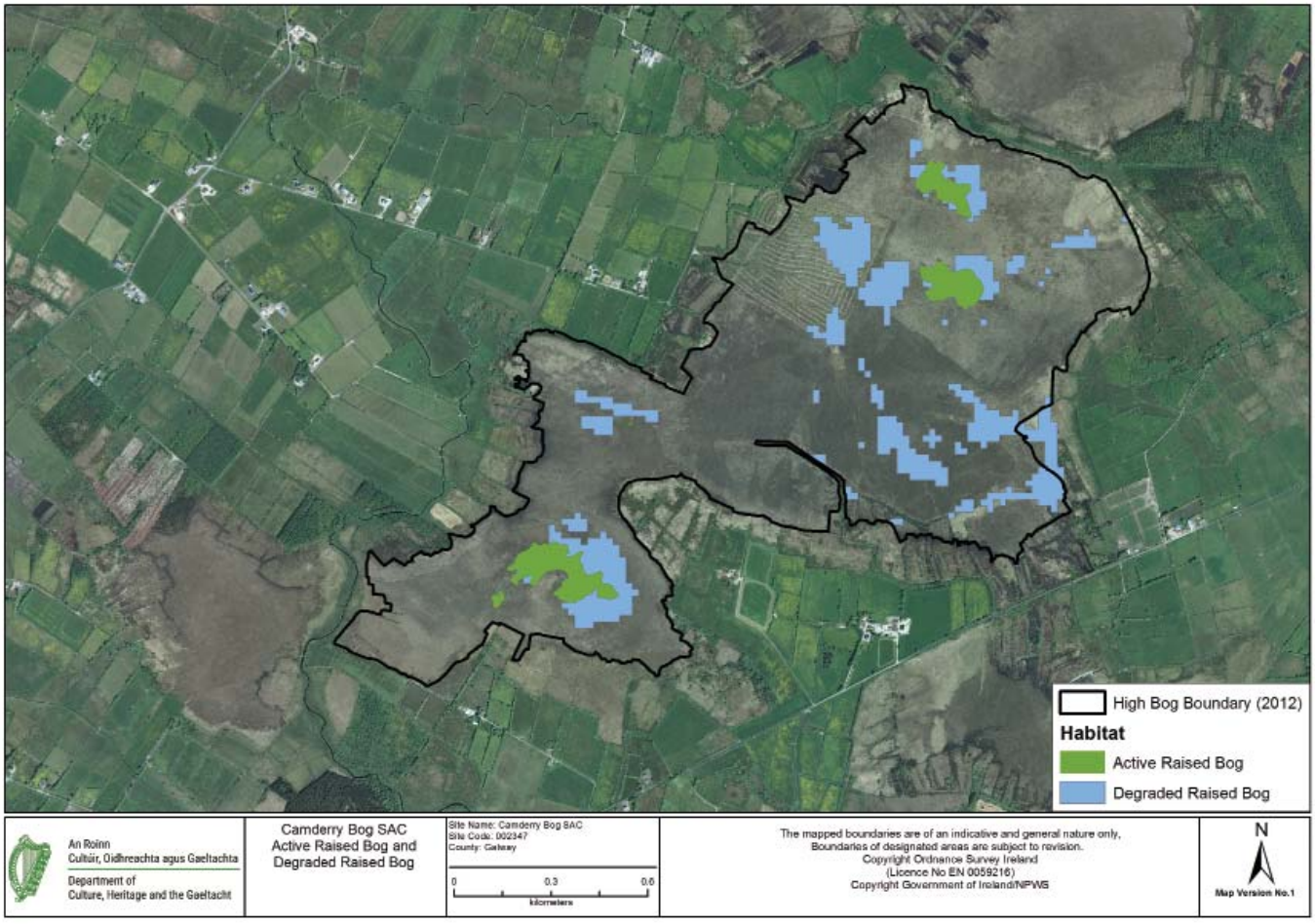
Site Statistics

Area of high bog in 1995 (ha):	195.3
Area of high bog in 2012 (ha):	193.2
Change in high bog (ha):	-2.1
Change in high bog (%):	-1.1%
Area of active raised bog in 1994 (ha) (Kelly et al. 1995)	8.7
Area of active raised bog in 2012 (ha) (Fernandez et al. 2014)	6.2
Change in active raised bog (ha):	-2.5
Change in active raised bog (%):	-28.7%
Area of degraded raised bog (ha):	15.7
Potential area bog peat-forming habitats (ha)	0.7

Composition of High Bog



- Active raised bog
- Degraded raised bog
- Potential supporting high bog habitat

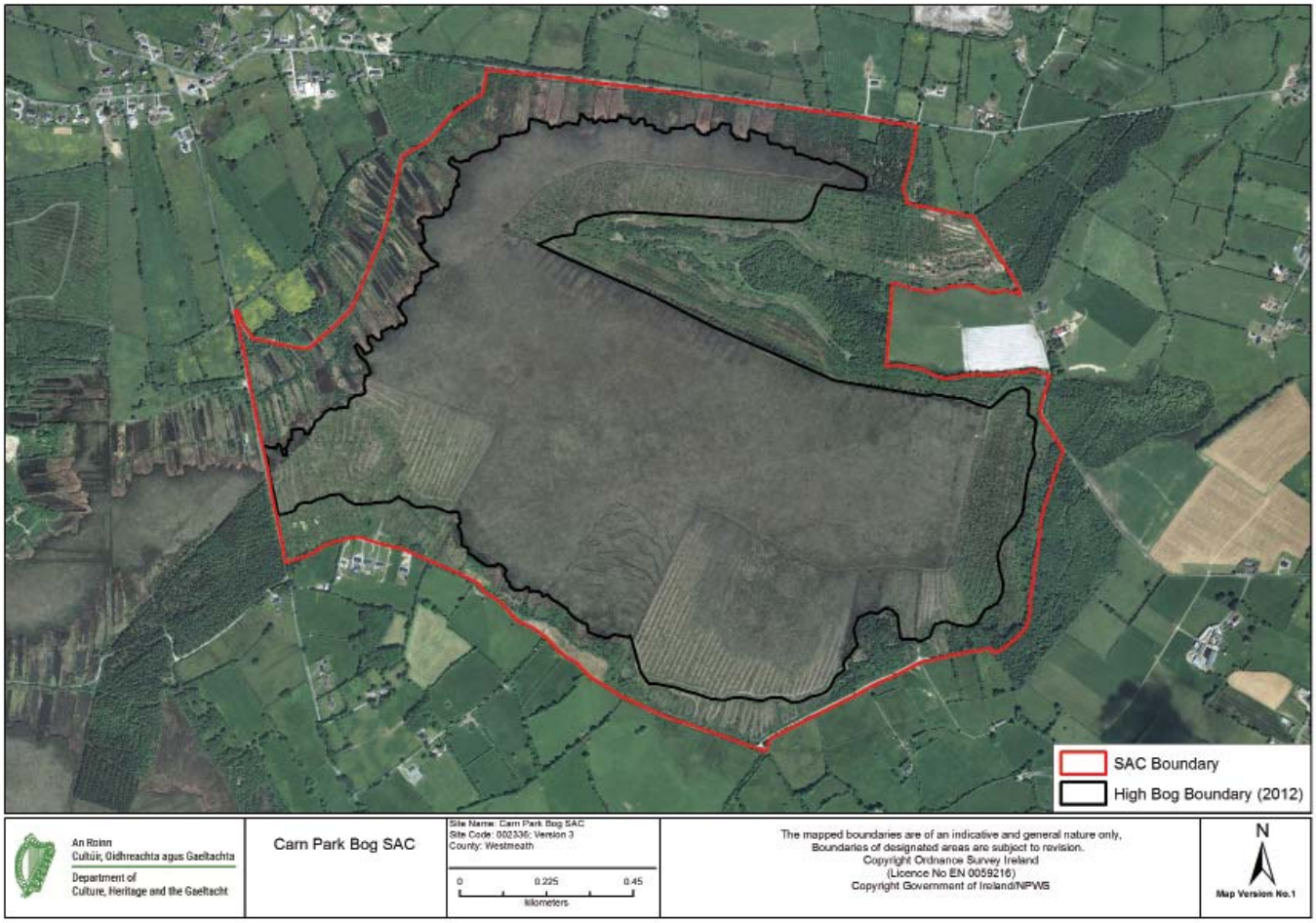


Carn Park Bog SAC - Summary

Site Name:	Carn Park Bog SAC
Site Code:	002336
Counties:	Westmeath
River Basin District:	Shannon
Sub-Catchment:	Breensford_SC_010
Further Information:	http://www.npws.ie/protected-sites/sac/002336

Site Summary:

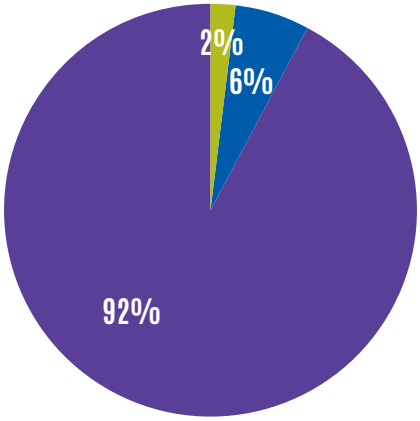
Carn Park Bog is situated 8 km east of Athlone, Co. Westmeath. The bog has a small area of active raised bog vegetation. Much of the bog has been afforested in the past. However, restoration works including tree removal and drain blocking have been carried out by Coillte.

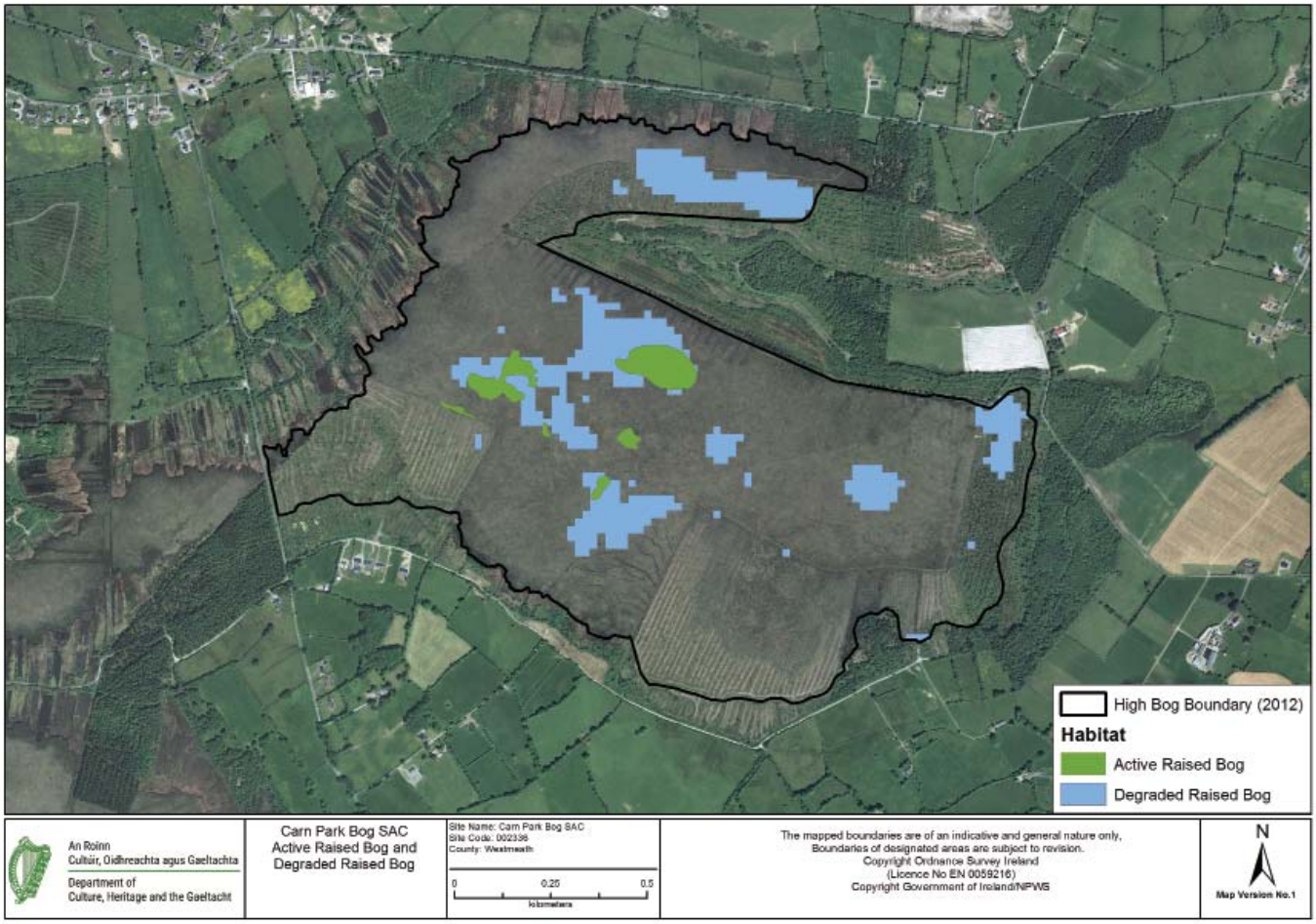


Site Statistics

Area of high bog in 1995 (ha):	164.2
Area of high bog in 2012 (ha):	160.3
Change in high bog (ha):	-3.9
Change in high bog (%):	-2.4%
Area of active raised bog in 2000 (ha) (Derwin & MacGowan, 2000*) (*Revised by NPWS in 2014)	24.4
Area of active raised bog in 2013 (ha) (Fernandez et al. 2014)	3.2
Change in active raised bog (ha):	-21.2
Change in active raised bog (%):	-86.9%
Area of degraded raised bog (ha):	9.4
Potential area bog peat-forming habitats (ha)	1.1

Composition of High Bog



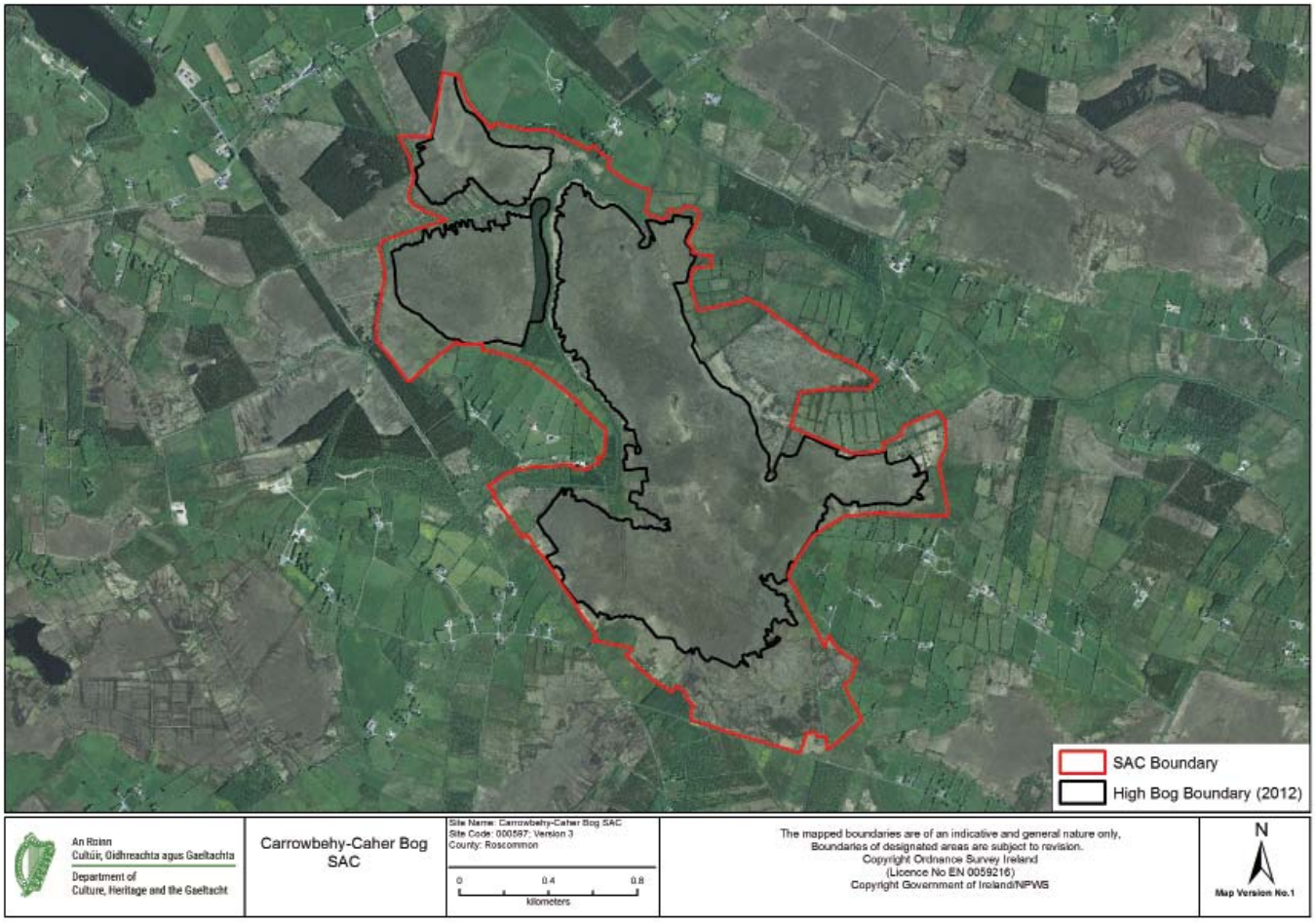


Carrowbehy/Caher Bog SAC - Summary

Site Name:	Carrowbehy/Caher Bog SAC
Site Code:	000597
Counties:	Roscommon
River Basin District:	Shannon
Sub-Catchment:	Suck_SC_010
Further Information:	http://www.npws.ie/protected-sites/sac/000597

Site Summary:

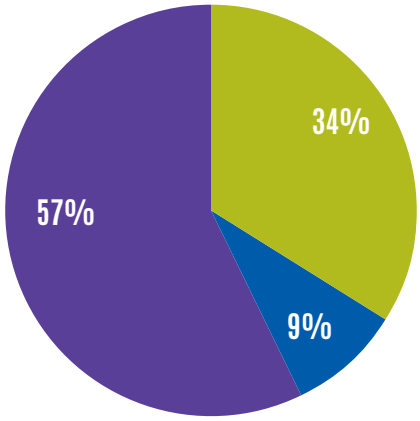
Carrowbehy/Caher Bog is a large floodplain bog developed between low drumlin hills in the headwaters of the River Suck, close to Lough O'Flynn and 8 km north-east of Ballyhaunis, Co. Roscommon. It is of interest as it comprises a large western raised bog with an extensive area of high quality active raised bog vegetation and unusual internal drainage features. The margins are relatively undisturbed with little recent peat cutting.



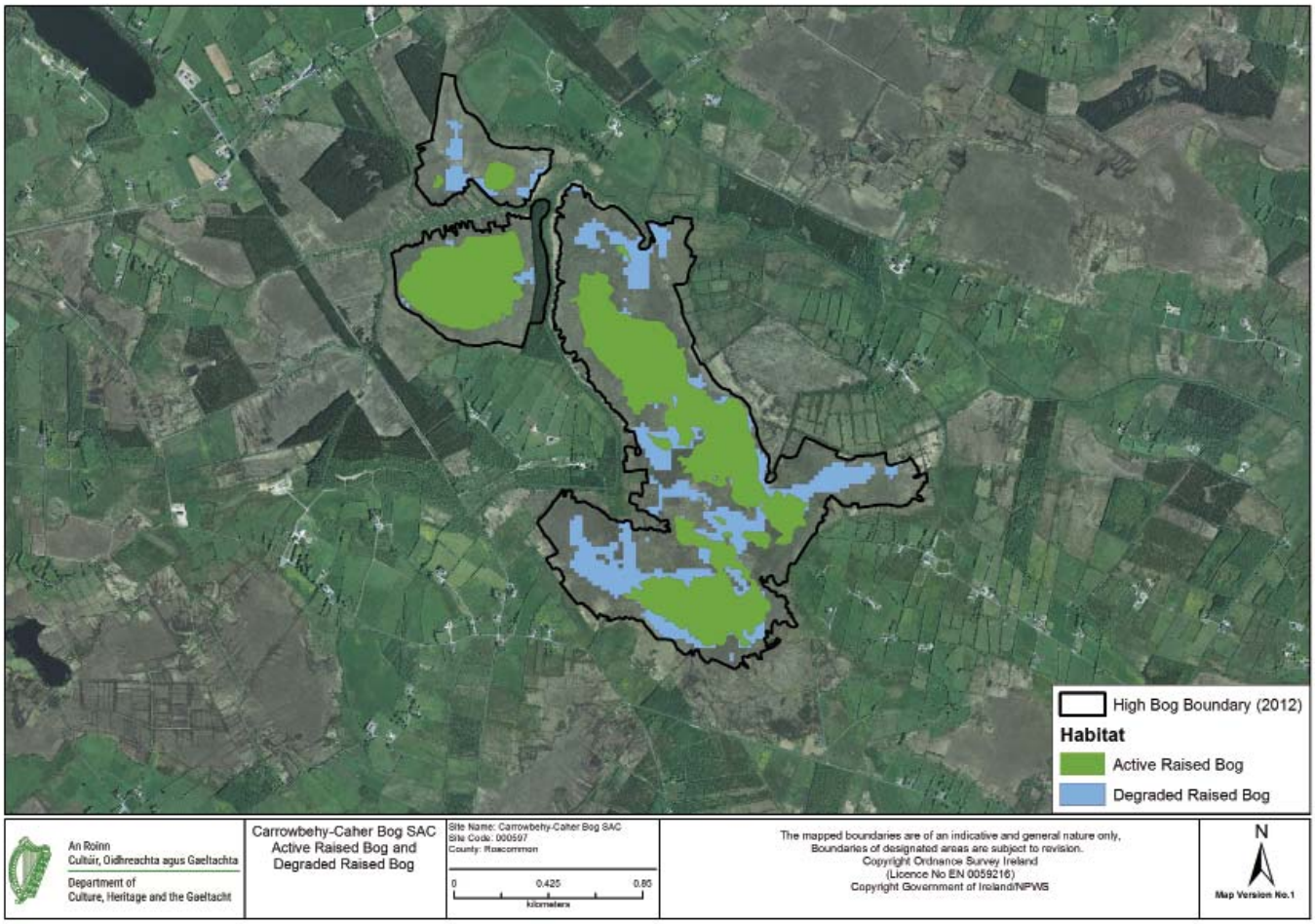
Site Statistics

Area of high bog in 1995 (ha):	204.6
Area of high bog in 2012 (ha):	204.6
Change in high bog (ha):	0.0
Change in high bog (%):	0.0%
Area of active raised bog in 1994 (ha) (Kelly et al. 1995)	67.9
Area of active raised bog in 2012 (ha) (Fernandez et al. 2014)	69.9
Change in active raised bog (ha):	2
Change in active raised bog (%):	2.9%
Area of degraded raised bog (ha):	17.8
Potential area bog peat-forming habitats (ha)	4.6

Composition of High Bog



- Active raised bog
- Degraded raised bog
- Potential supporting high bog habitat

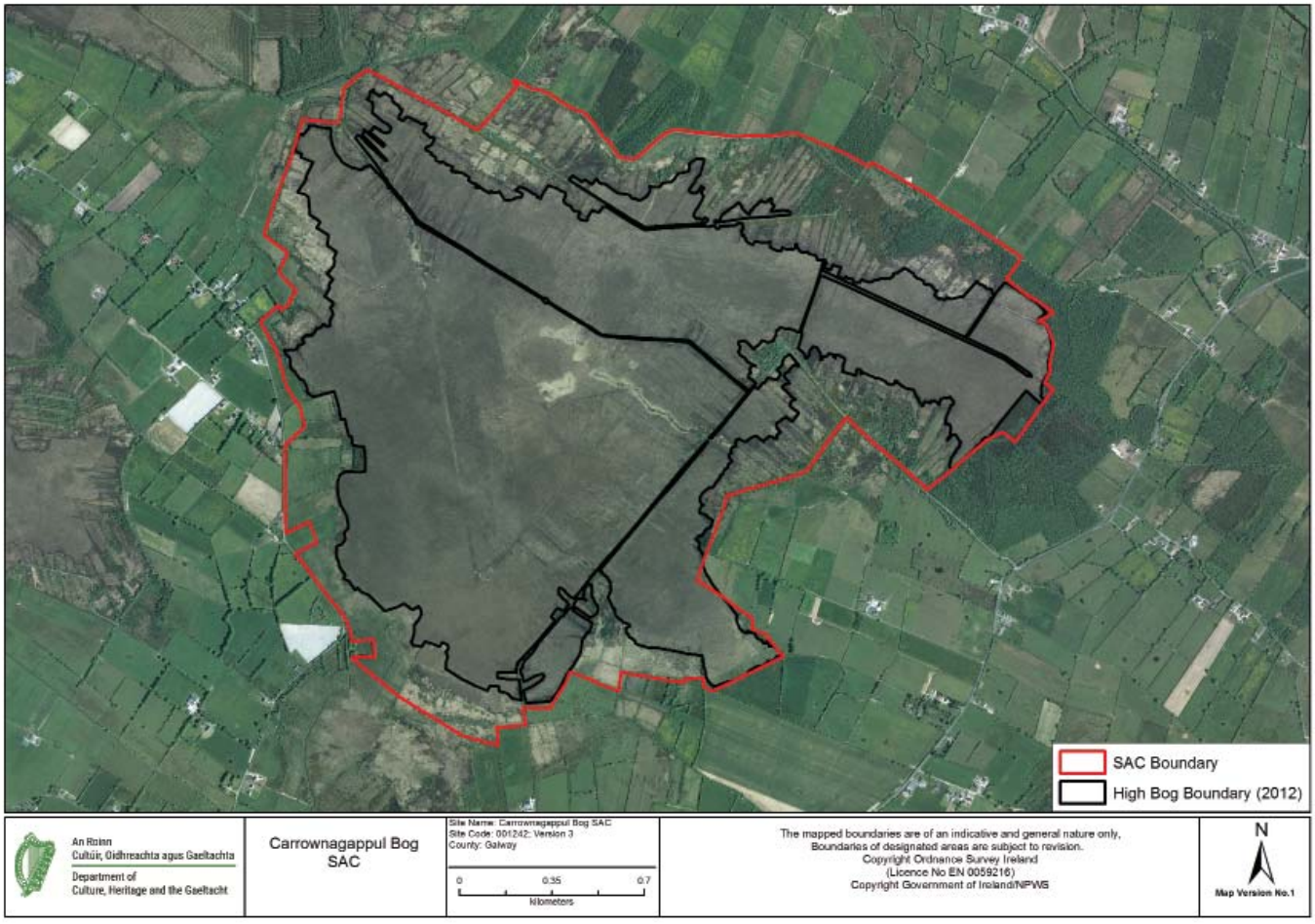


Carrownagappul Bog SAC - Summary

Site Name:	Carrownagappul Bog SAC
Site Code:	001242
Counties:	Galway
River Basin District:	Shannon
Sub-Catchment:	Castlegar_SC_010
Further Information:	http://www.npws.ie/protected-sites/sac/001242

Site Summary:

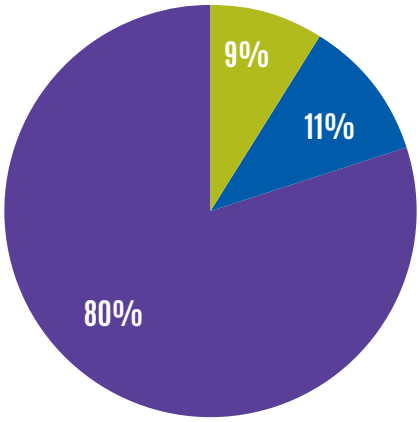
Carrownagappul Bog is a large raised bog situated about 3 km north of Mount Bellew, Co. Galway. Numerous bog roads, tracks and drains extend into the centre of the site. The bog is of high value as it comprises a large western raised bog with an extensive area of active raised bog vegetation. Restoration works in the form of drain blocking have been undertaken by NPWS.



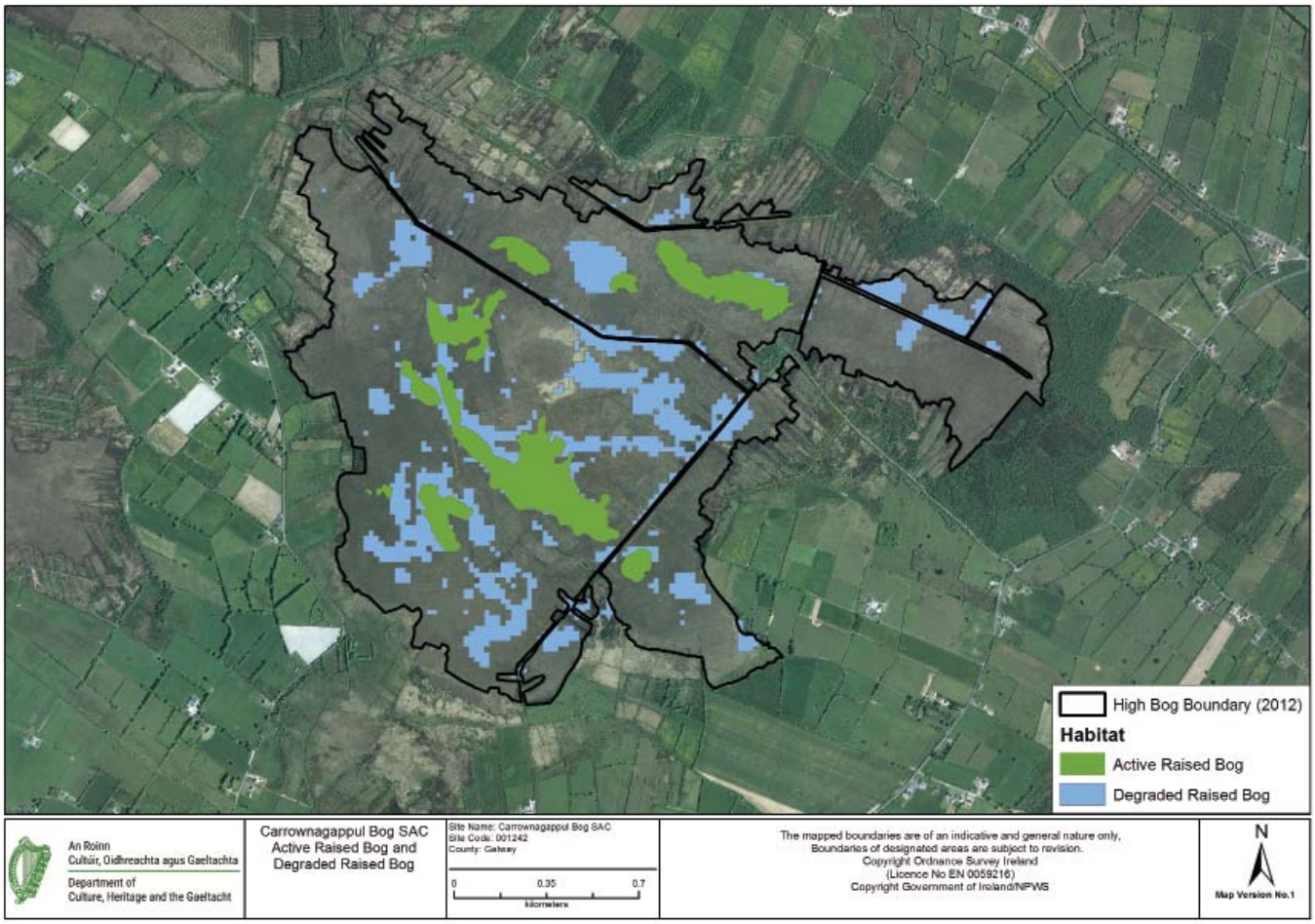
Site Statistics

Area of high bog in 1995 (ha):	330.7
Area of high bog in 2012 (ha):	323.5
Change in high bog (ha):	-7.2
Change in high bog (%):	-2.2%
Area of active raised bog in 1994 (ha) (Kelly et al. 1995)	28
Area of active raised bog in 2012 (ha) (Fernandez et al. 2014)	28.1
Change in active raised bog (ha):	0.1
Change in active raised bog (%):	0.4%
Area of degraded raised bog (ha):	36.5
Potential area bog peat-forming habitats (ha)	5.3

Composition of High Bog



- Active raised bog
- Degraded raised bog
- Potential supporting high bog habitat

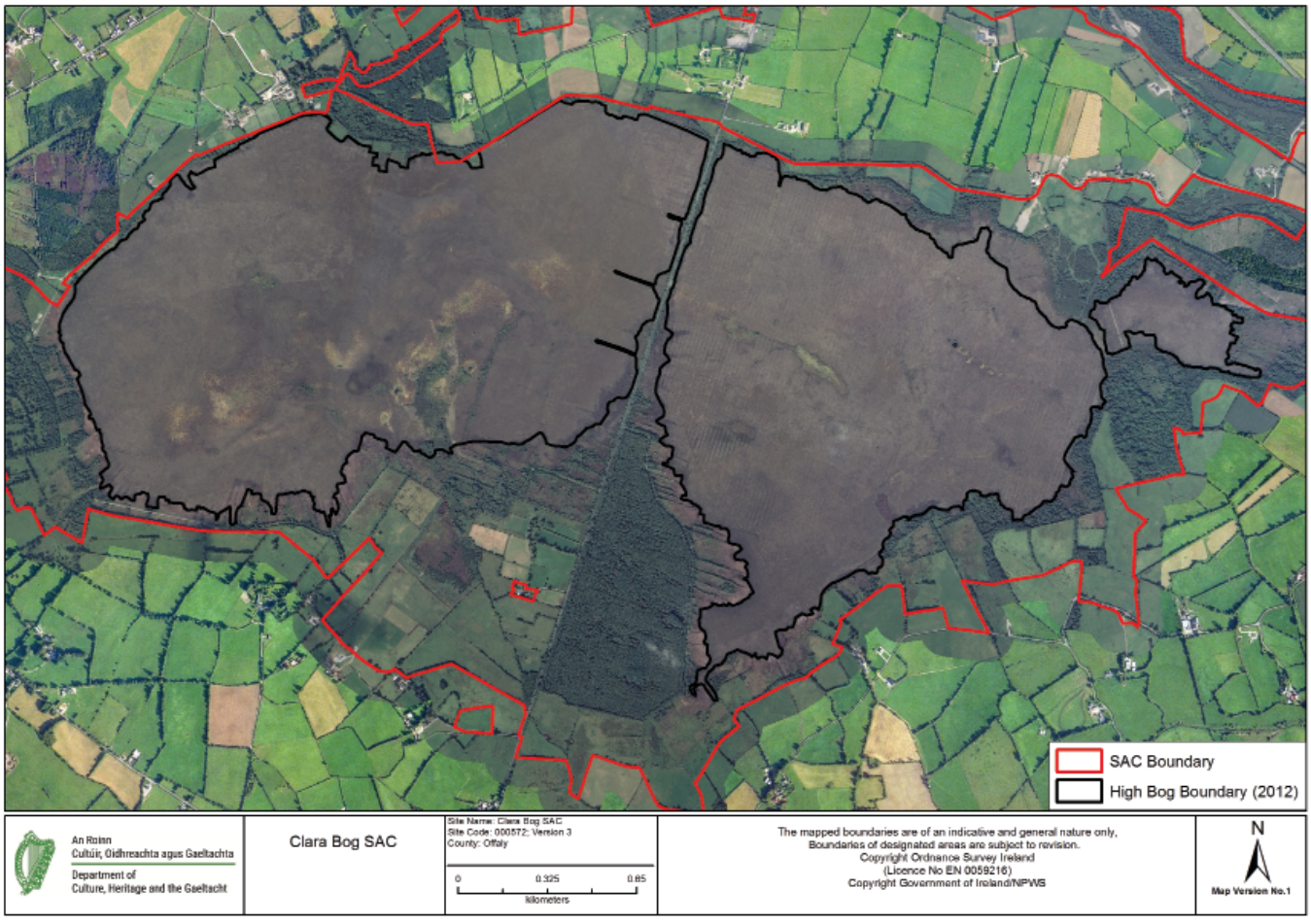


Clara Bog SAC - Summary

Site Name:	Clara Bog SAC
Site Code:	000572
Counties:	Offaly
River Basin District:	Shannon
Sub-Catchment:	Brosna_SC_040, Silver[Tullamore]_SC_010
Further Information:	http://www.npws.ie/protected-sites/sac/000572

Site Summary:

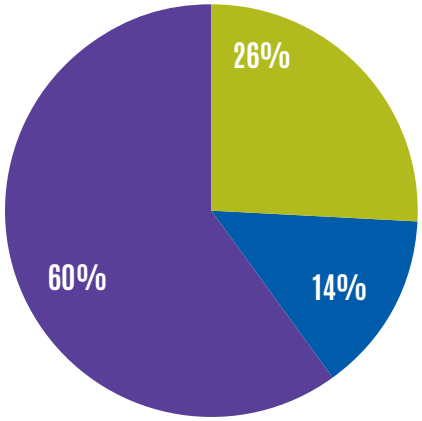
Clara Bog is situated 2 km south of Clara village in Co. Offaly. Much of it is State-owned and designated as a statutory Nature Reserve. It is one of the largest midland raised bogs remaining in Ireland. The bog surface remains wet with an extensive area of active raised bog. The presence of unusual soak systems adds to the overall interest of the site. Restoration works in the form of drain blocking have been undertaken by NPWS on the eastern side.



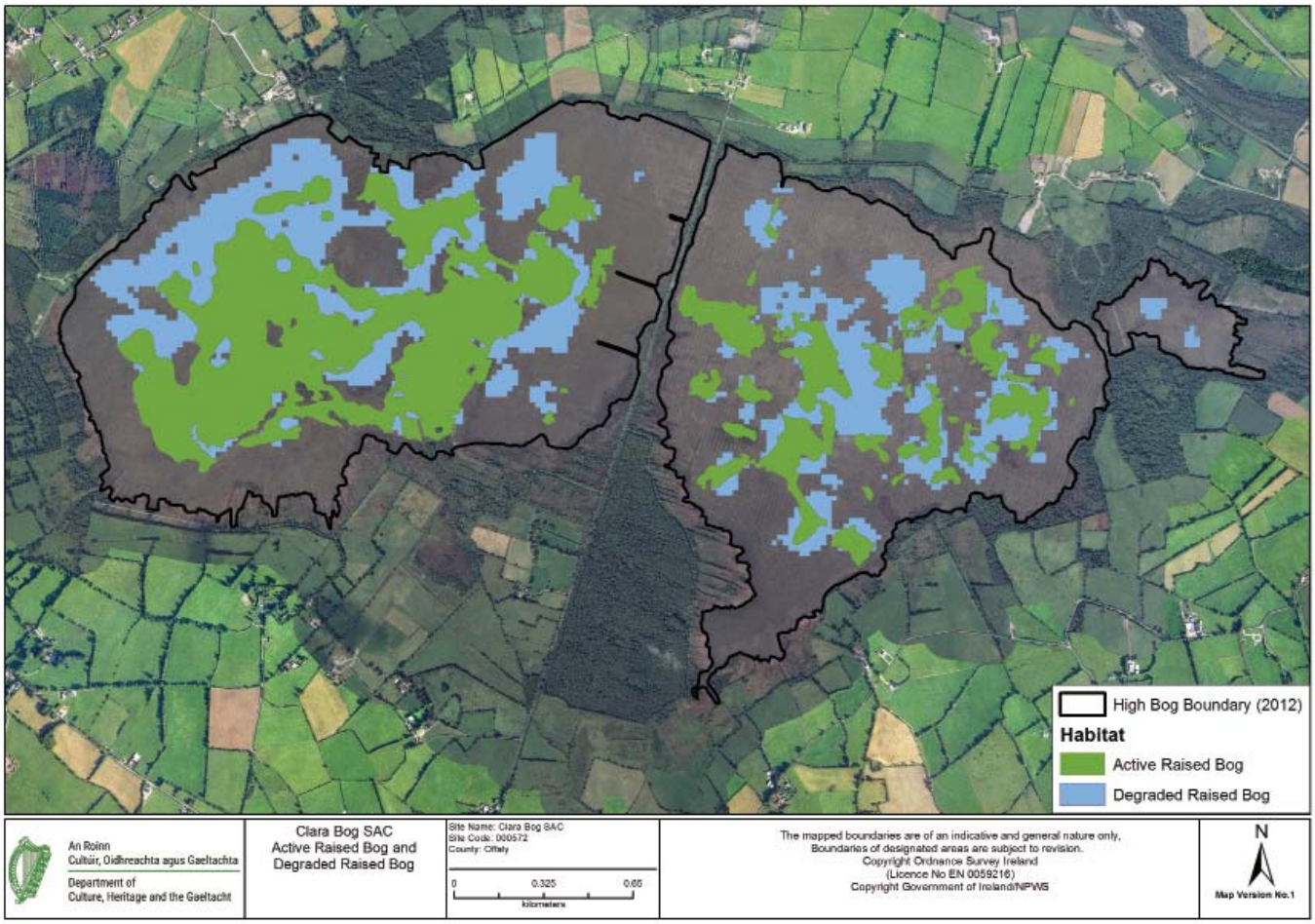
Site Statistics

Area of high bog in 1995 (ha):	445.7
Area of high bog in 2012 (ha):	436.5
Change in high bog (ha):	-9.2
Change in high bog (%):	-2.1%
Area of active raised bog in 1992 (ha) (Kelly et al. 1995)	146.5
Area of active raised bog in 2009 (ha) (Fernandez and Wilson, 2009)	111.5
Change in active raised bog (ha):	-35
Change in active raised bog (%):	-23.9%
Area of degraded raised bog (ha):	61.3
Potential area bog peat-forming habitats (ha)	6.9

Composition of High Bog



- Active raised bog
- Degraded raised bog
- Potential supporting high bog habitat

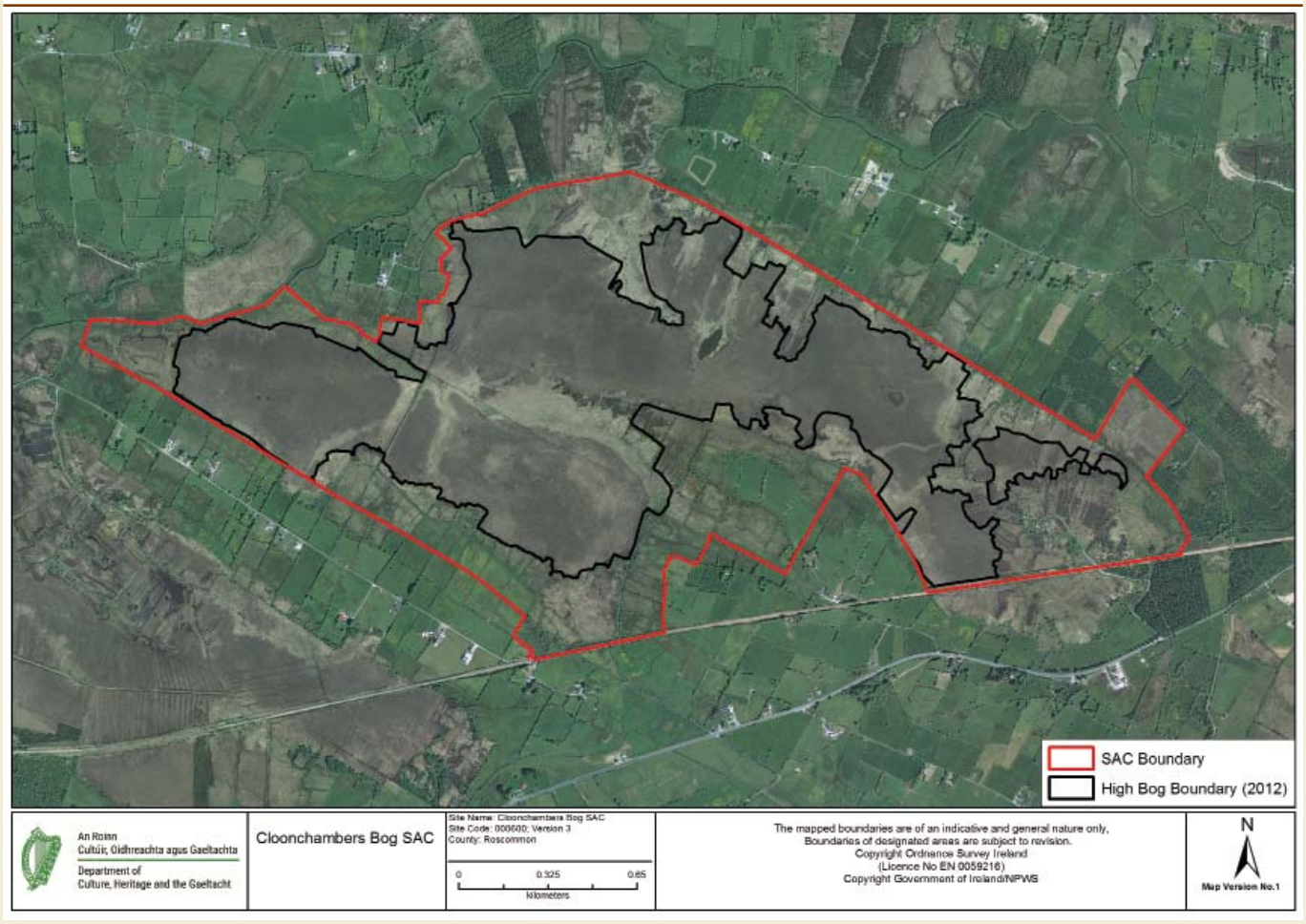


Cloonchambers Bog SAC - Summary

Site Name:	Cloonchambers Bog SAC
Site Code:	000600
Counties:	Roscommon
River Basin District:	Shannon
Sub-Catchment:	Suck_SC_010
Further Information:	http://www.npws.ie/protected-sites/sac/000600

Site Summary:

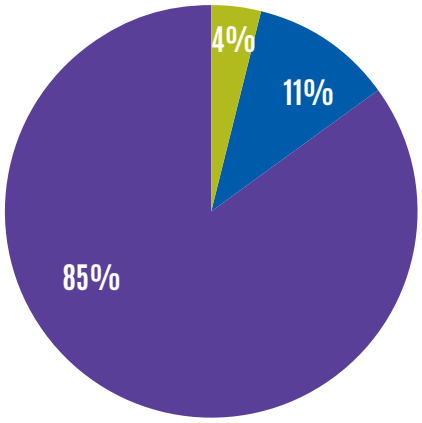
Cloonchambers Bog is a large, relatively intact, undulating bog which lies 6 km west of Castlerea town. It consists of two elongated peat-filled basins, separated by a strip of grassy, fen vegetation, found where thinner peat merges with mineral soil. Cloonchambers Bog is a good example of a western raised bog with a relatively small area of active raised bog. The presence of a large alkaline fen running through the bog is a rare feature and adds interest to the site.

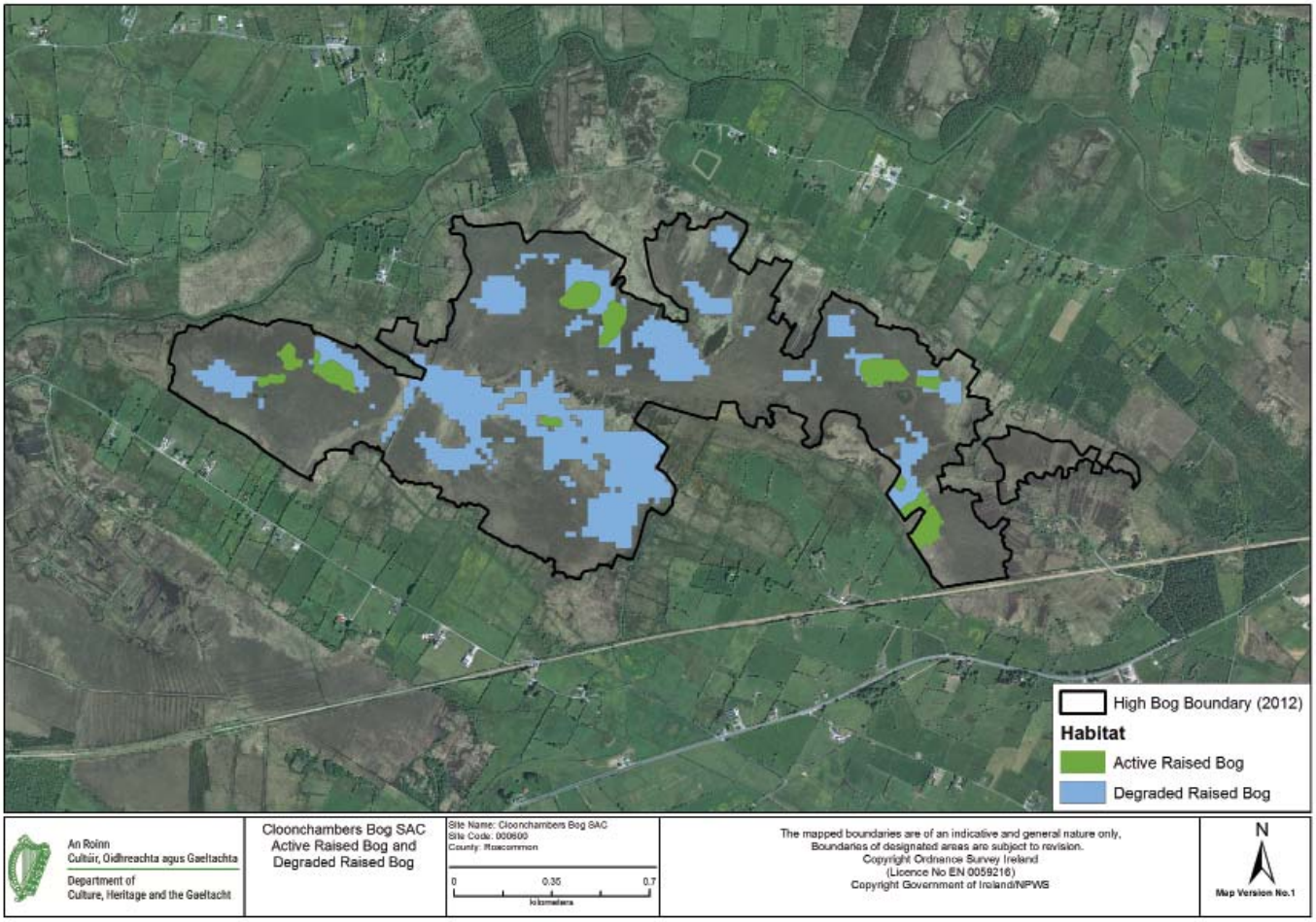


Site Statistics

Area of high bog in 1995 (ha):	198.8
Area of high bog in 2012 (ha):	194.4
Change in high bog (ha):	-4.4
Change in high bog (%):	-2.2%
Area of active raised bog in 1994 (ha) (Kelly et al. 1995*) (*Revised by NPWS in 2014)	7.7
Area of active raised bog in 2012 (ha) (Fernandez et al. 2014)	7.7
Change in active raised bog (ha):	0
Change in active raised bog (%):	0%
Area of degraded raised bog (ha):	21.1
Potential area bog peat-forming habitats (ha)	3.3

Composition of High Bog



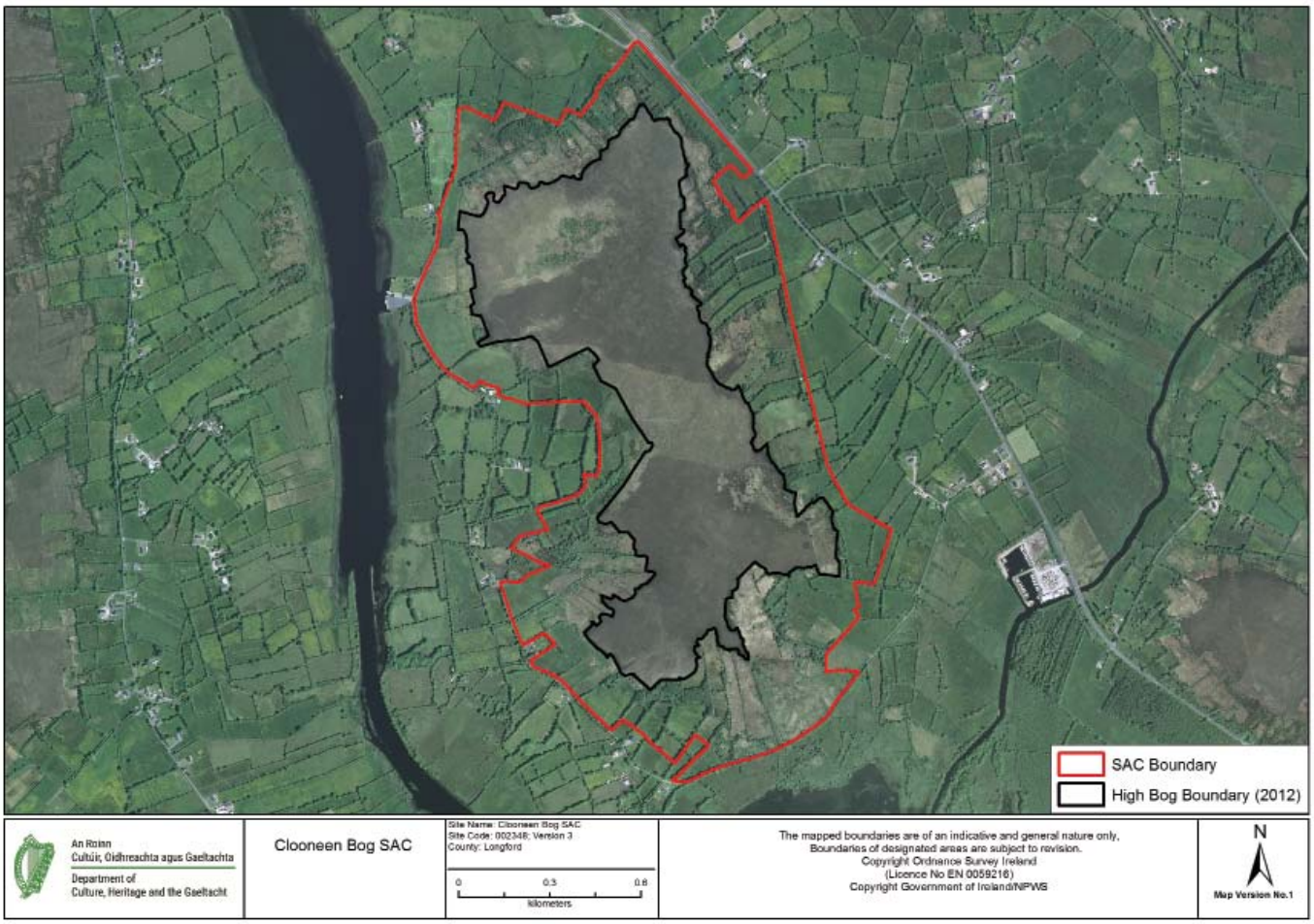


Clooneen Bog SAC - Summary

Site Name:	Clooneen Bog SAC
Site Code:	002348
Counties:	Longford
River Basin District:	Shannon
Sub-Catchment:	Shannon[Upper]_SC_050
Further Information:	http://www.npws.ie/protected-sites/sac/002348

Site Summary:

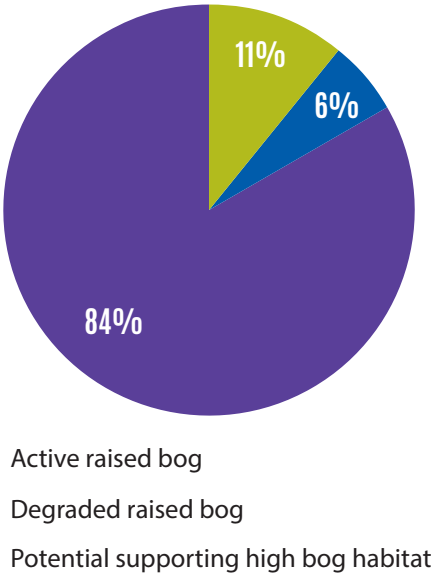
Clooneen Bog lies approximately 3 km south-east of Roosky in Co. Longford on the east bank of the River Shannon, just north of Lough Forbes. The bog is of ecological importance due to the presence of a significant area of active raised bog vegetation. In addition, the occurrence of bog woodland growing on the high bog, a rare feature of Irish raised bogs, adds considerably to the interest of the site.

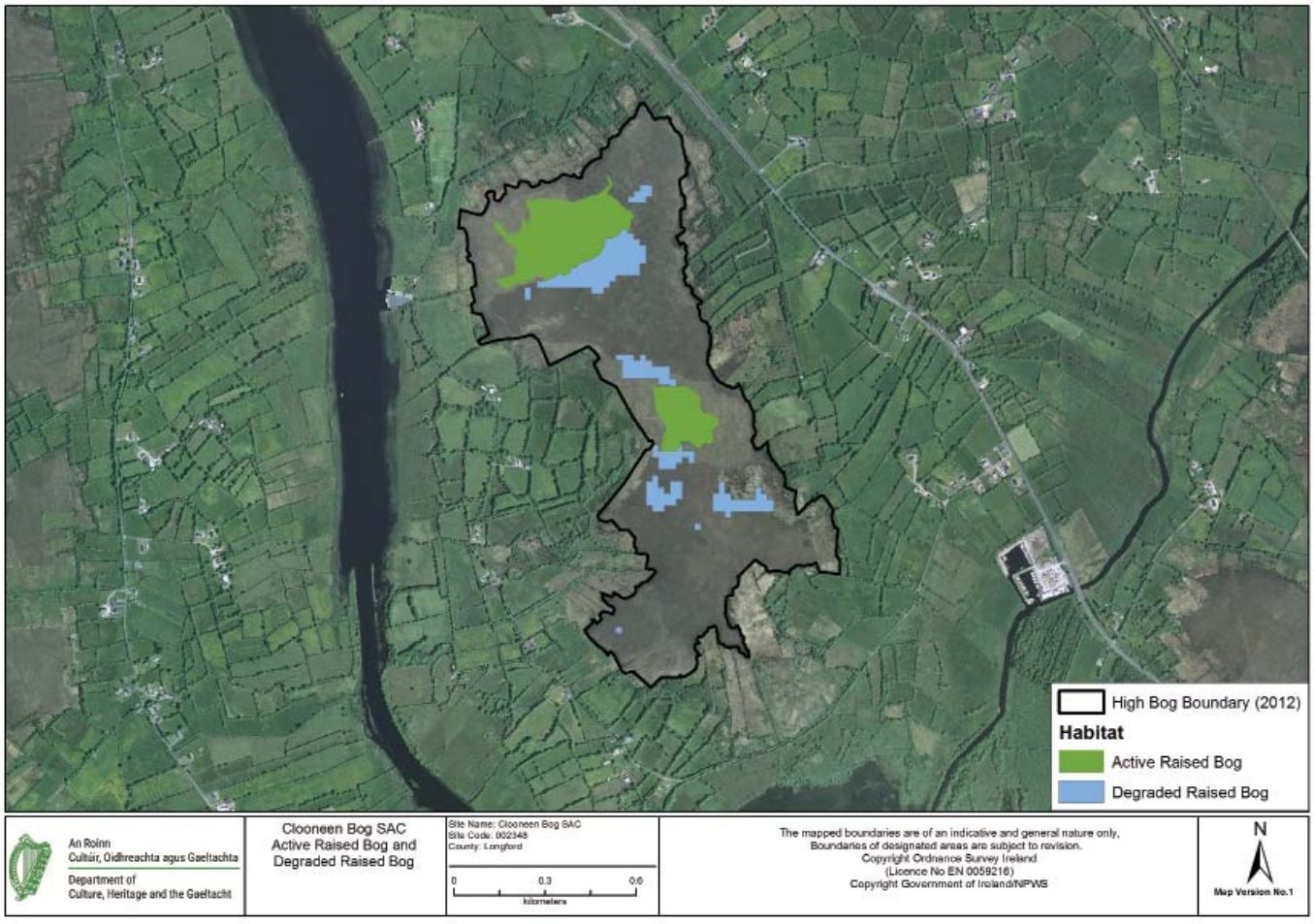


Site Statistics

Area of high bog in 1995 (ha):	94.8
Area of high bog in 2012 (ha):	93.5
Change in high bog (ha):	-1.3
Change in high bog (%):	-1.4%
No earlier survey available	N/A
Area of active raised bog in 1999 (ha) (Derwin & MacGowan, 2000*)(*Revised by NPWS in 2014)	10.0
Change in active raised bog (ha):	N/A
Change in active raised bog (%):	N/A
Area of degraded raised bog (ha):	5.4
Potential area bog peat-forming habitats (ha)	1.2

Composition of High Bog



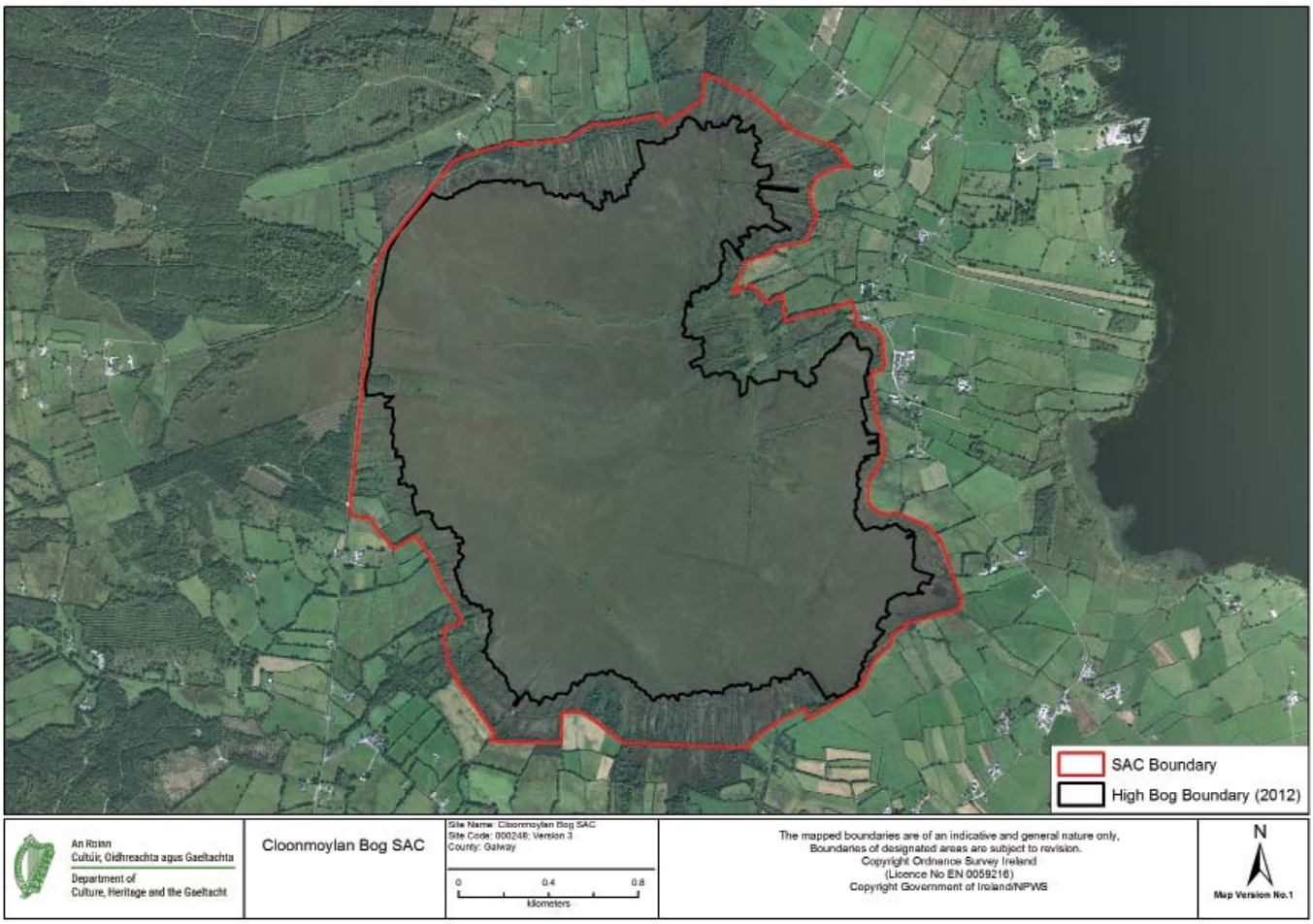


Cloonmoylan Bog SAC - Summary

Site Name:	Cloonmoylan Bog SAC
Site Code:	000248
Counties:	Galway
River Basin District:	Shannon
Sub-Catchment:	Shannon[Lower]_SC_070, Bow_SC_010
Further Information:	http://www.npws.ie/protected-sites/sac/000248

Site Summary:

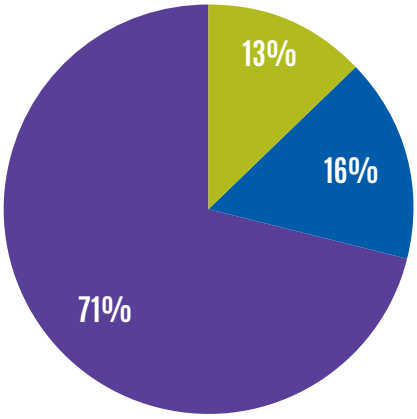
Cloonmoylan Bog is a very large expanse of level raised bog, situated close to the western shore of Lough Derg, near Woodford in County Galway. Cloonmoylan Bog is of high ecological value due to the presence of an extensive area of active raised bog vegetation. The site is also of interest being located at the south-western extent of the national range of the habitat.



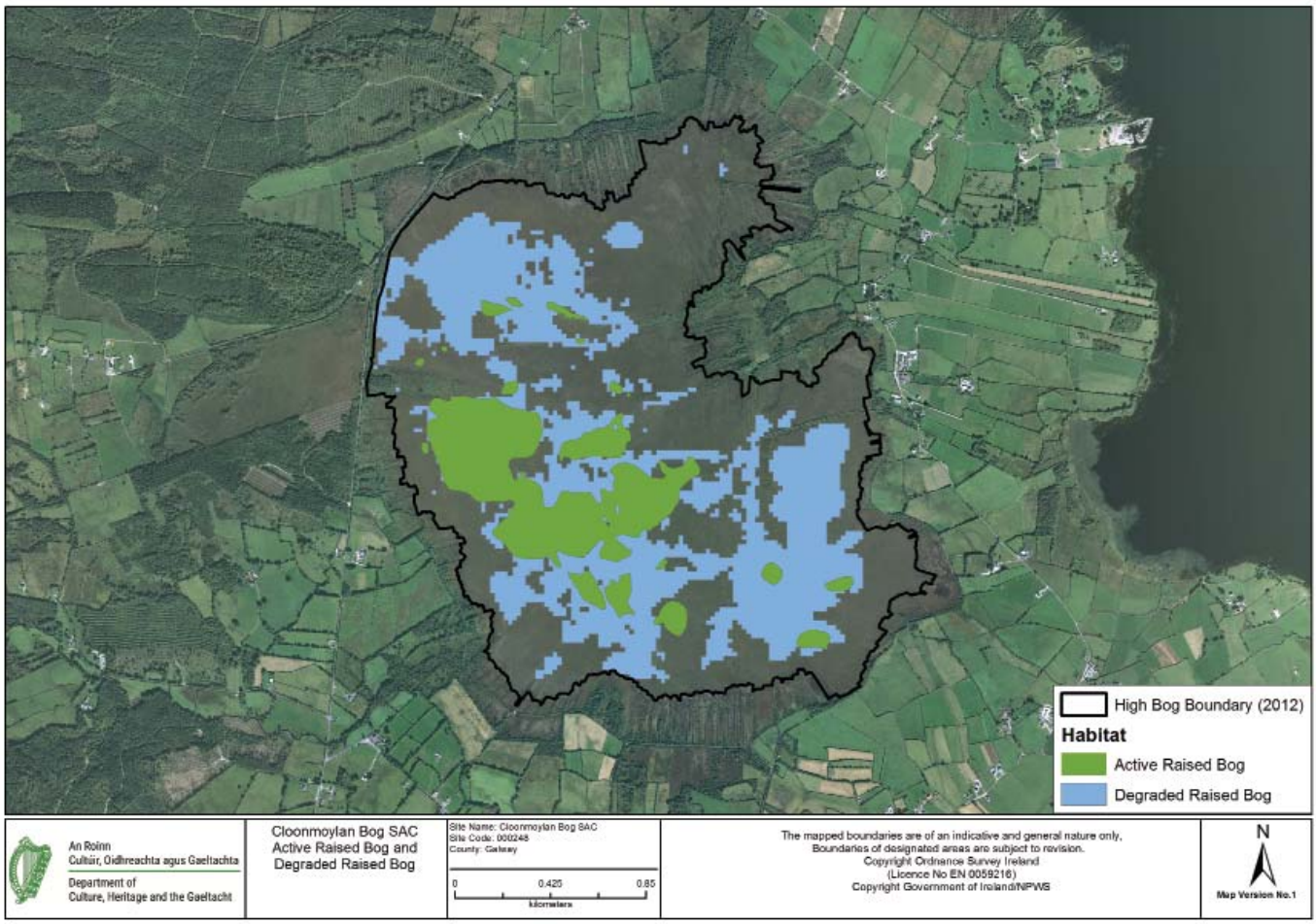
Site Statistics

Area of high bog in 1995 (ha):	423.3
Area of high bog in 2012 (ha):	412.0
Change in high bog (ha):	-11.3
Change in high bog (%):	-2.7%
Area of active raised bog in 1994 (ha) (Kelly et al. 1995*) (*Revised by NPWS in 2014)	125
Area of active raised bog in 2005 (ha) (Fernandez et al. 2005)	52.3
Change in active raised bog (ha):	-72.7
Change in active raised bog (%):	-58.2%
Area of degraded raised bog (ha):	66.6
Potential area bog peat-forming habitats (ha)	18.8

Composition of High Bog



- Active raised bog
- Degraded raised bog
- Potential supporting high bog habitat

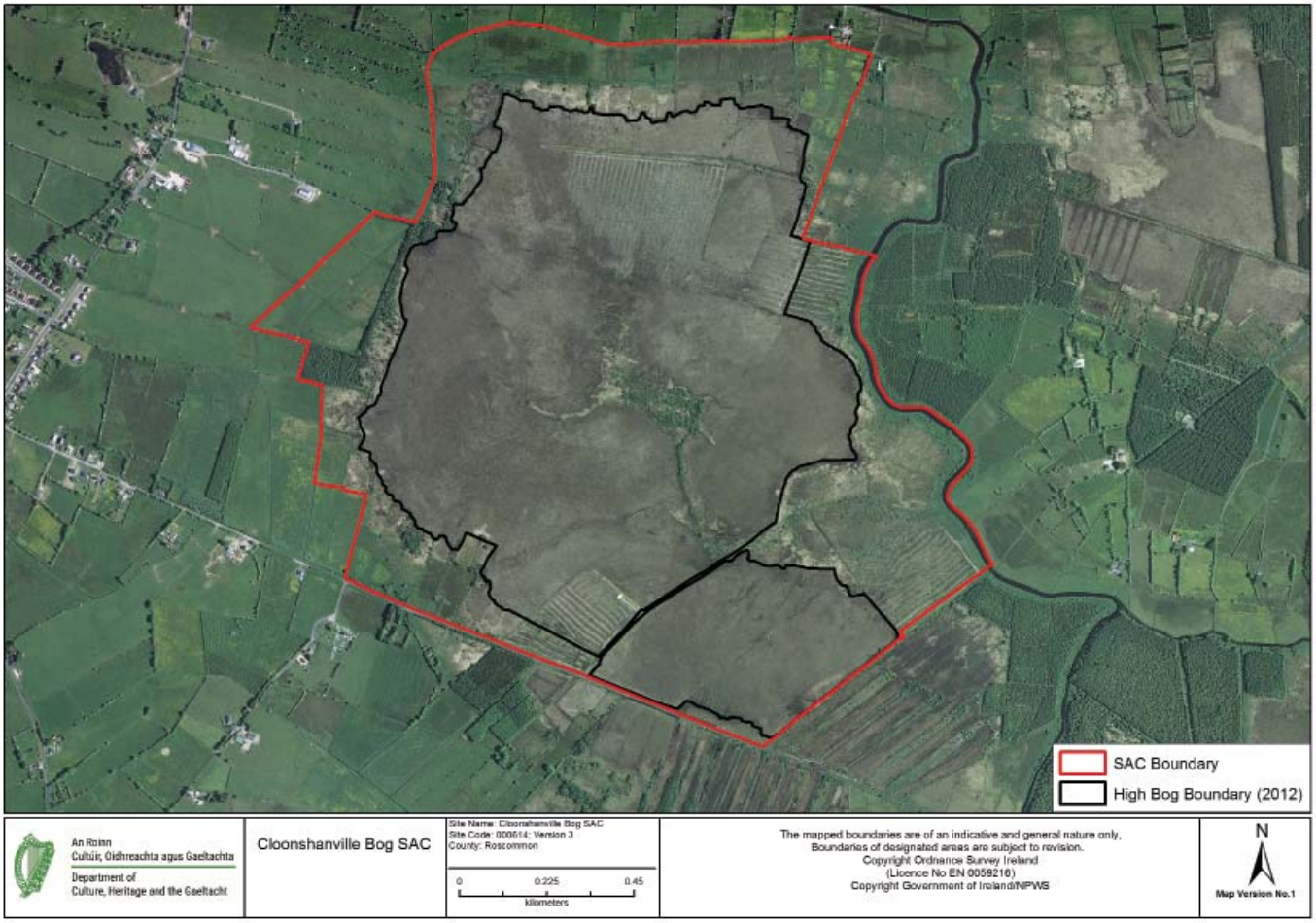


Cloonshanville Bog SAC - Summary

Site Name:	Cloonshanville Bog SAC
Site Code:	000614
Counties:	Roscommon
River Basin District:	Shannon
Sub-Catchment:	Breedoge_SC_010
Further Information:	http://www.npws.ie/protected-sites/sac/000614

Site Summary:

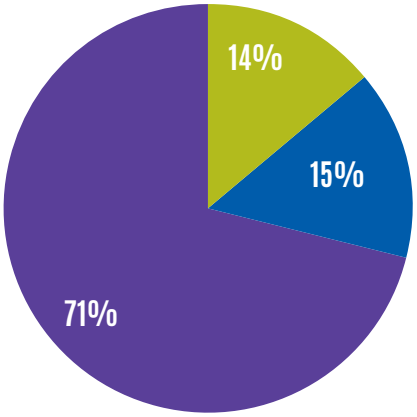
Cloonshanville Bog is located approximately 2 km east of Frenchpark. It is a western raised bog of high interest due to a significant area of active raised bog vegetation. The presence of an area of bog woodland, a rare feature of Irish raised bog, in the central area adds to the interest of the site. Restoration works in the form of tree removal and drain blocking have been undertaken by Coillte.



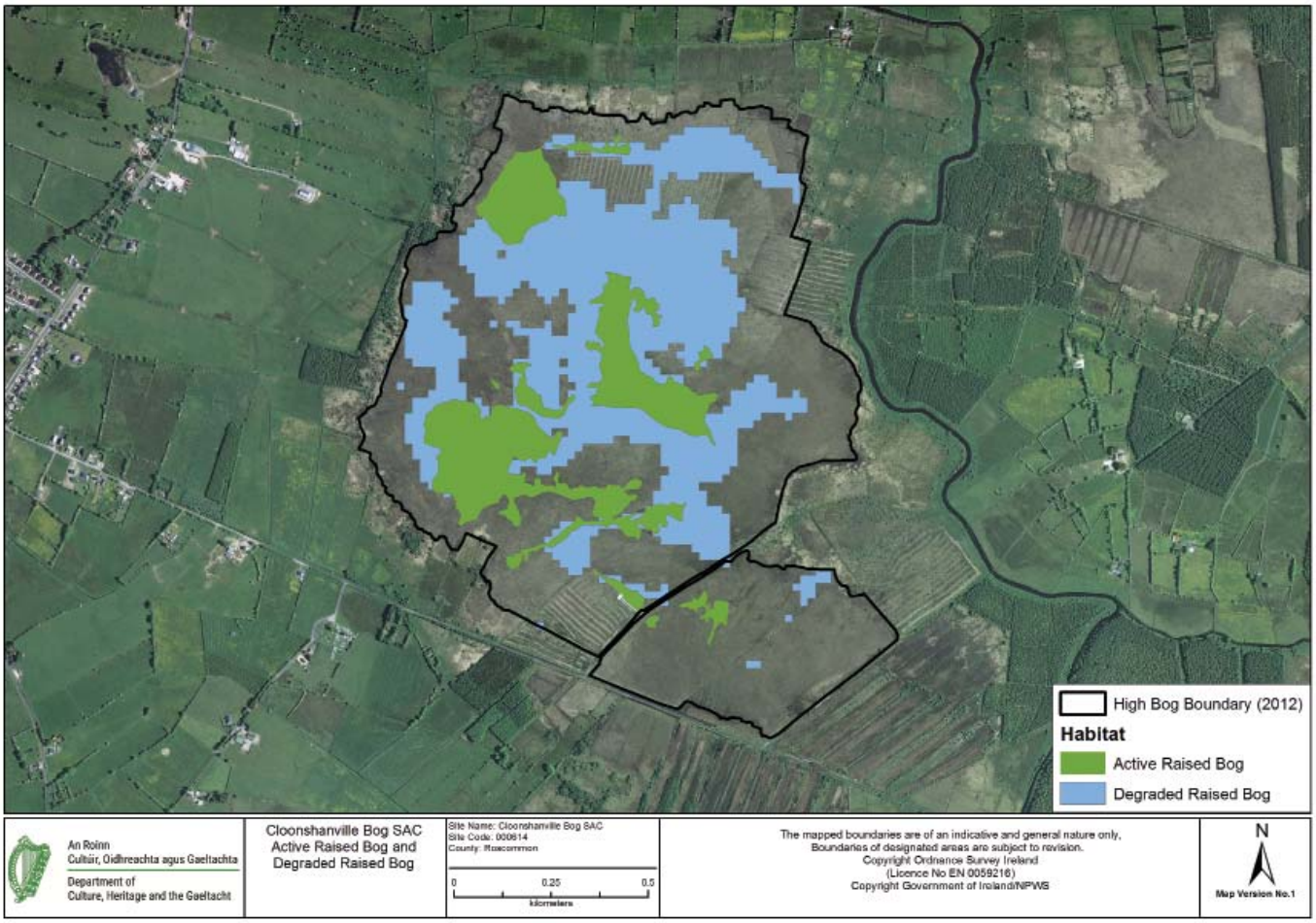
Site Statistics

Area of high bog in 1995 (ha):	146.5
Area of high bog in 2012 (ha):	146.3
Change in high bog (ha):	-0.2
Change in high bog (%):	-0.1%
Area of active raised bog in 1994 (ha) (Kelly et al. 1995)	28.3
Area of active raised bog in 2012 (ha) (Fernandez et al. 2014)	20.1
Change in active raised bog (ha):	-8.2
Change in active raised bog (%):	-29%
Area of degraded raised bog (ha):	22.6
Potential area bog peat-forming habitats (ha)	1.3

Composition of High Bog



- Active raised bog
- Degraded raised bog
- Potential supporting high bog habitat

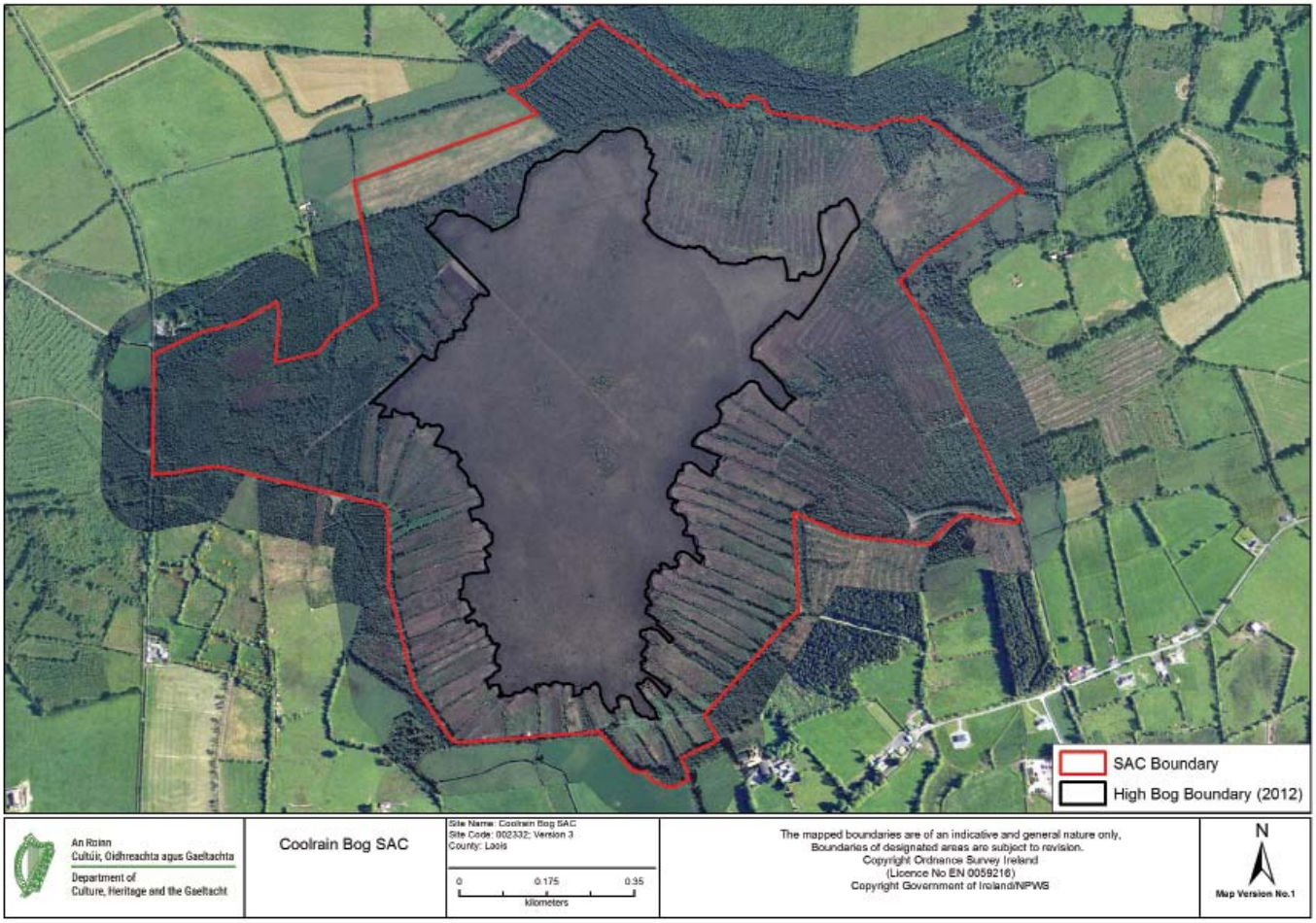


Coolrain Bog SAC - Summary

Site Name:	Coolrain Bog SAC
Site Code:	002332
Counties:	Laois
River Basin District:	South Eastern
Sub-Catchment:	Nore_SC_010, Nore_SC_020
Further Information:	http://www.npws.ie/protected-sites/sac/002332

Site Summary:

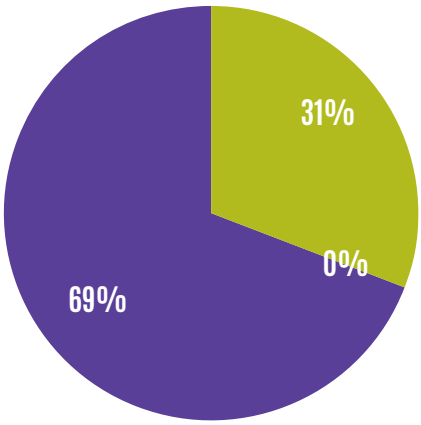
Coolrain Bog is situated in Co. Laois approximately 4 km north-east of Borris-in-Ossory. Coolrain Bog is of high ecological interest due to the presence of an extensive area of active raised bog. The site's south-eastern location within a sandstone area adds further interest to the site. Recent peat cutting around the southern margin of bog is likely to have caused significant damage.



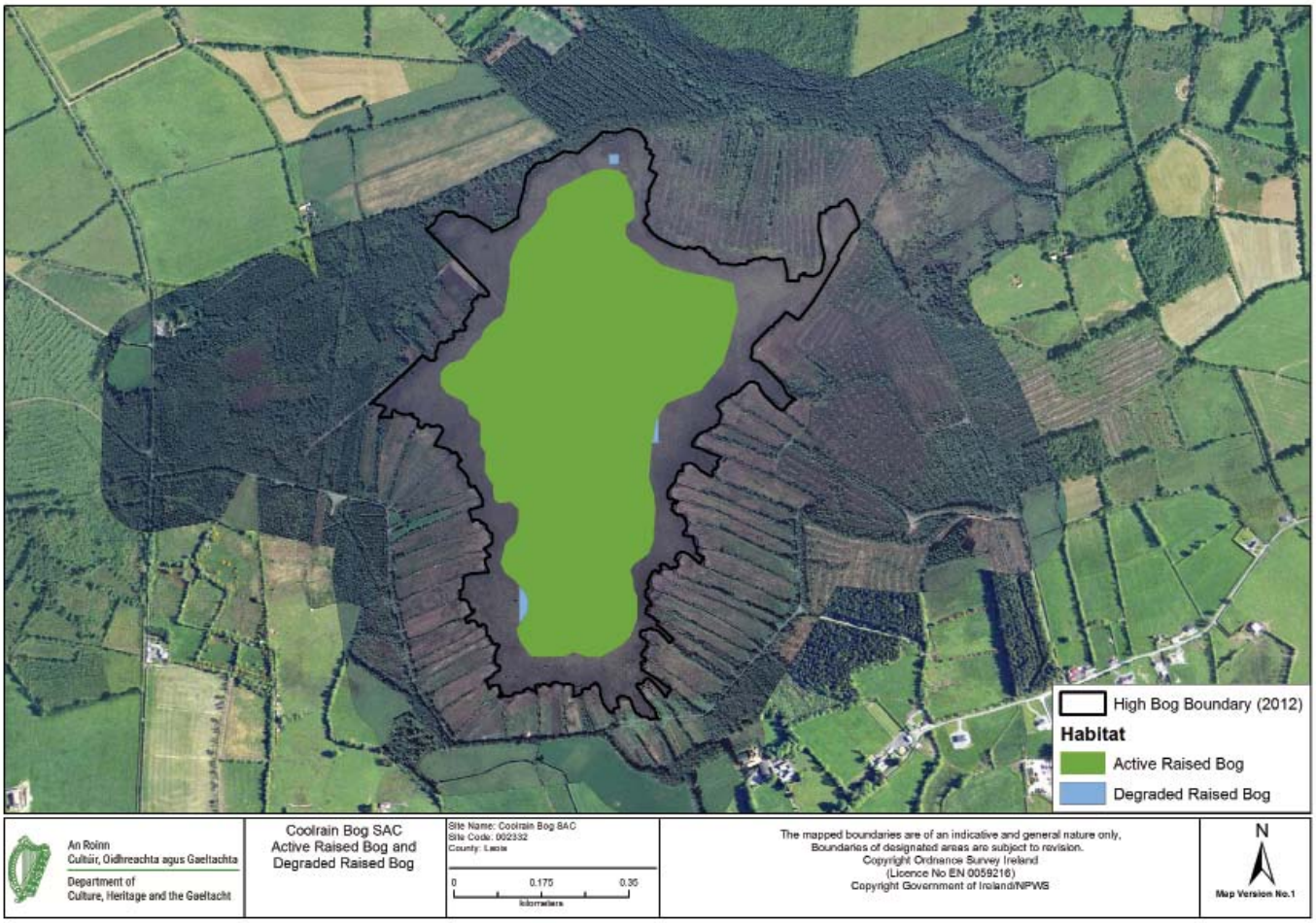
Site Statistics

Area of high bog in 1995 (ha):	57.0
Area of high bog in 2012 (ha):	51.6
Change in high bog (ha):	-5.4
Change in high bog (%):	-9.5%
No earlier survey available	N/A
Area of active raised bog in 1999 (ha) (Derwin & MacGowan, 2000*) (*Revised by NPWS in 2014)	16.0
Change in active raised bog (ha):	N/A
Change in active raised bog (%):	N/A
Area of degraded raised bog (ha):	0.0
Potential area bog peat-forming habitats (ha)	4.6

Composition of High Bog



- Active raised bog
- Degraded raised bog
- Potential supporting high bog habitat

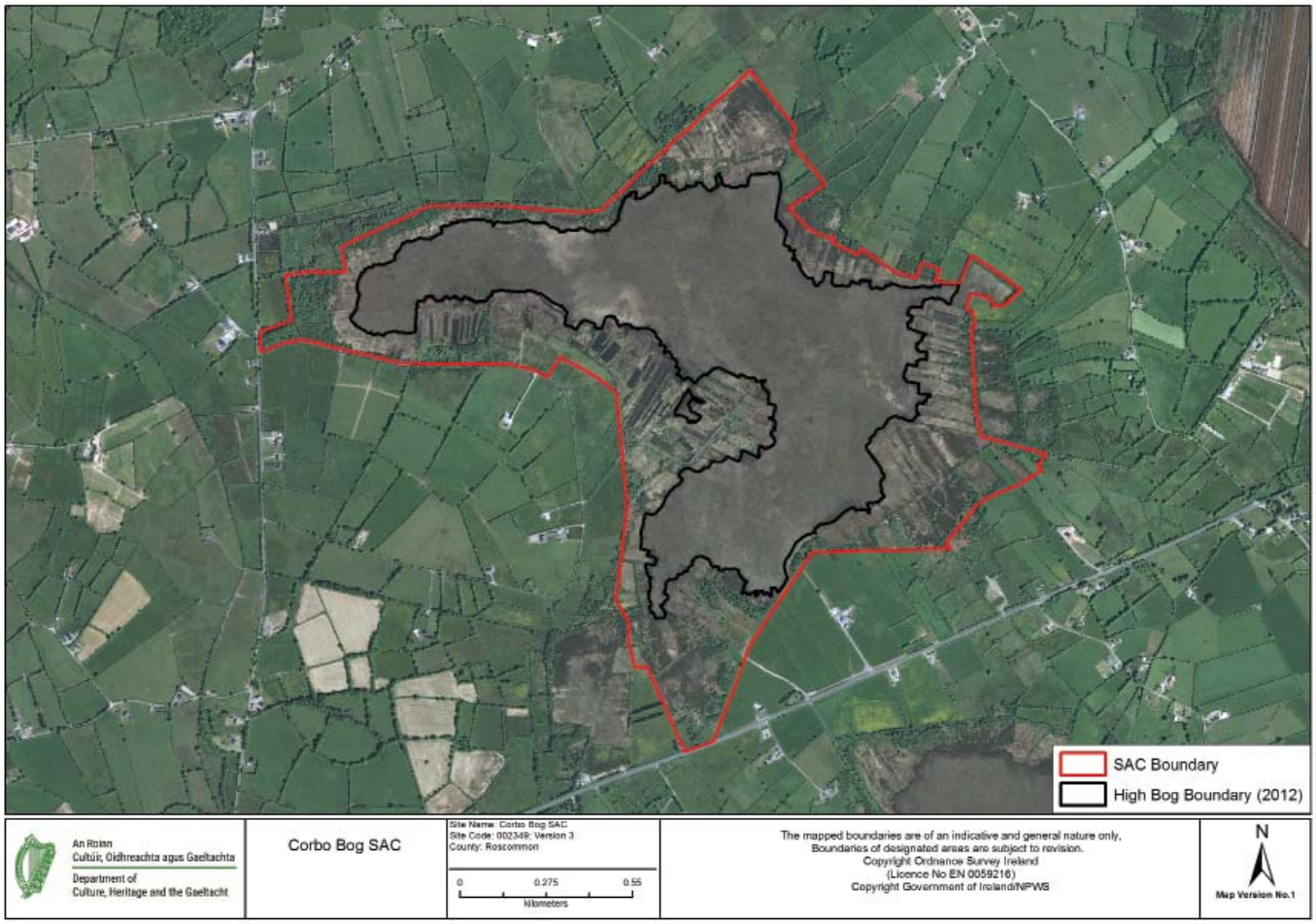


Corbo Bog SAC - Summary

Site Name:	Corbo Bog SAC
Site Code:	002349
Counties:	Roscommon
River Basin District:	Shannon
Sub-Catchment:	Clooneigh_SC_010
Further Information:	http://www.npws.ie/protected-sites/sac/002349

Site Summary:

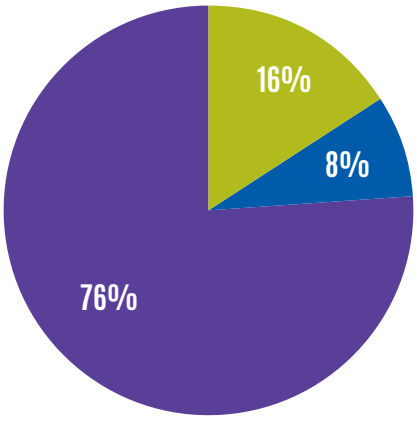
Corbo Bog is located 7 km west of Lanesborough, Co. Roscommon. Corbo Bog is of high importance due to the presence of active raised bog vegetation. The site supports a good diversity of raised bog microhabitats, including hummock/hollow complexes, pools and flushes.



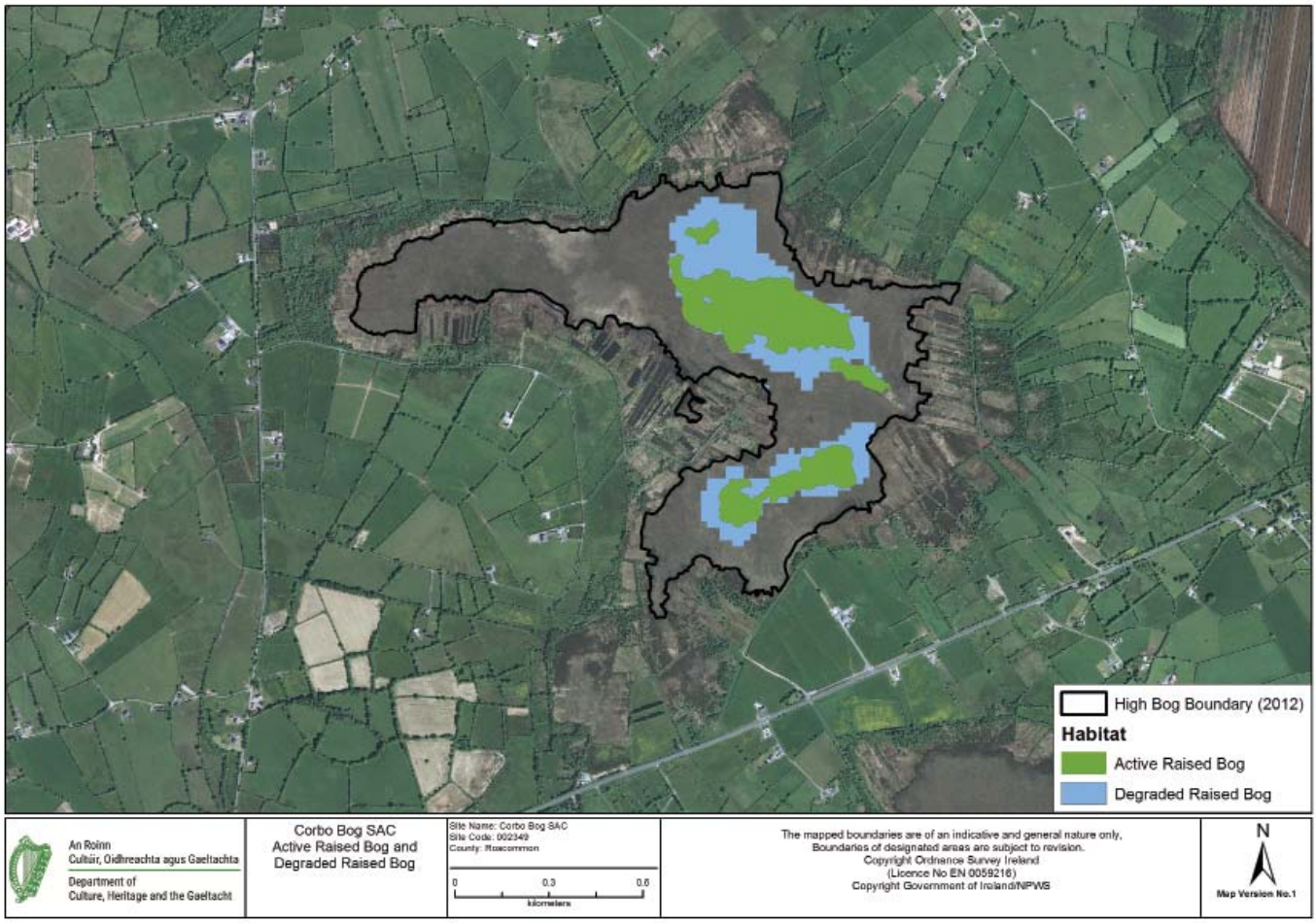
Site Statistics

Area of high bog in 1995 (ha):	105.7
Area of high bog in 2012 (ha):	96.5
Change in high bog (ha):	-9.2
Change in high bog (%):	-8.7%
Area of active raised bog in 1994 (ha) (Kelly et al. 1995)	27.6
Area of active raised bog in 2012 (ha) (Fernandez et al. 2014)	15.5
Change in active raised bog (ha):	-12.1
Change in active raised bog (%):	-43.8%
Area of degraded raised bog (ha):	7.7
Potential area bog peat-forming habitats (ha)	7.7

Composition of High Bog



- Active raised bog
- Degraded raised bog
- Potential supporting high bog habitat

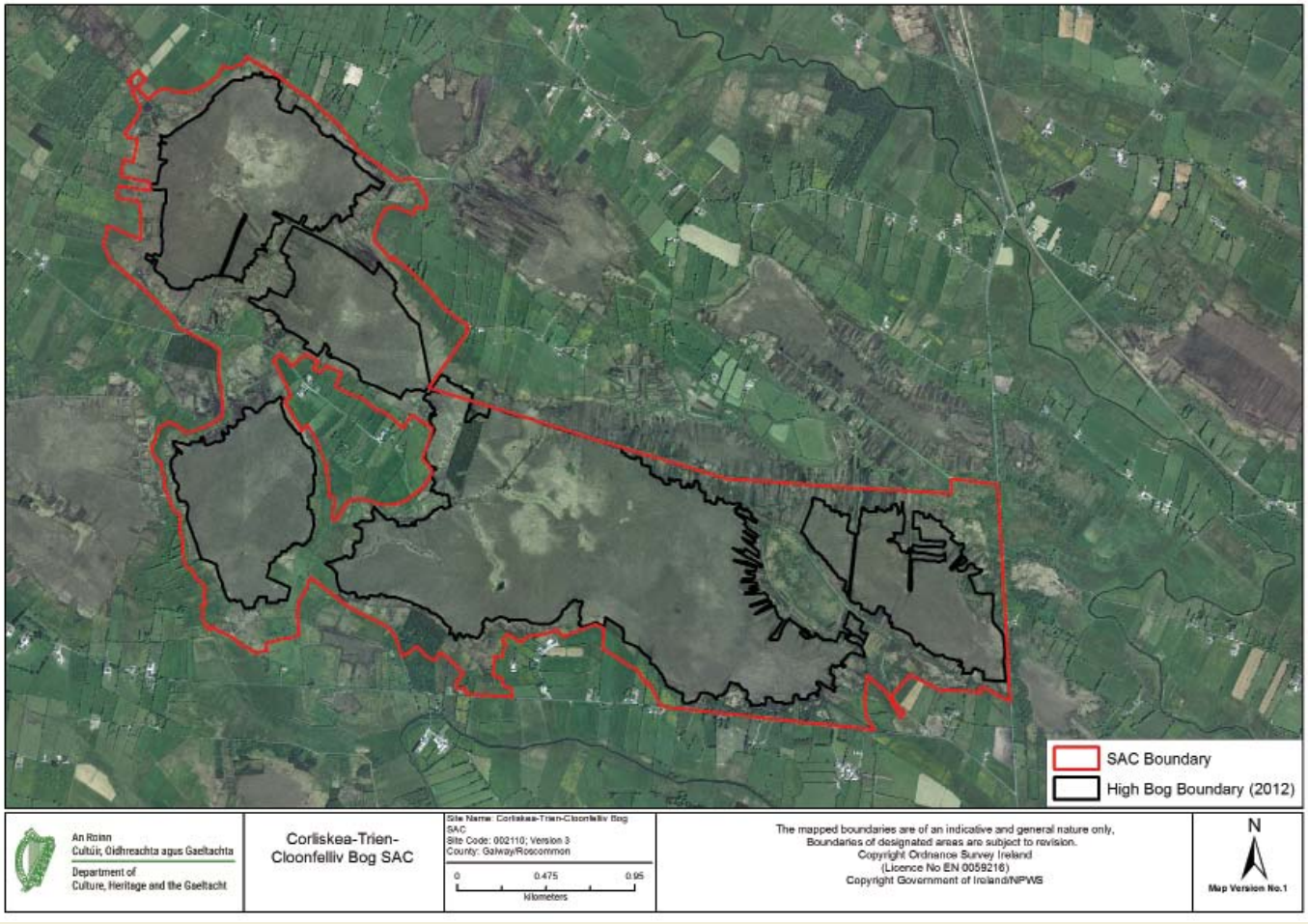


Corliskea/Trien/Cloonfelliv Bog SAC - Summary

Site Name:	Corliskea/Trien/Cloonfelliv Bog SAC
Site Code:	002110
Counties:	Galway / Roscommon
River Basin District:	Shannon
Sub-Catchment:	Suck_SC_020, Suck_SC_010
Further Information:	http://www.npws.ie/protected-sites/sac/002110

Site Summary:

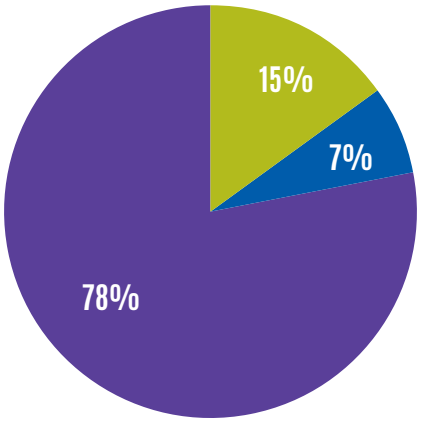
Corliskea/Trien/Cloonfelliv Bog, located 5km south of Castlerea and straddling the Roscommon/Galway county border, comprises a complex of three raised bogs. These are western raised bogs that are of high ecological importance due partly to extensive areas of high quality active raised bog vegetation. The presence of bog woodland and unusual internal drainage features adds to the interest of the site.



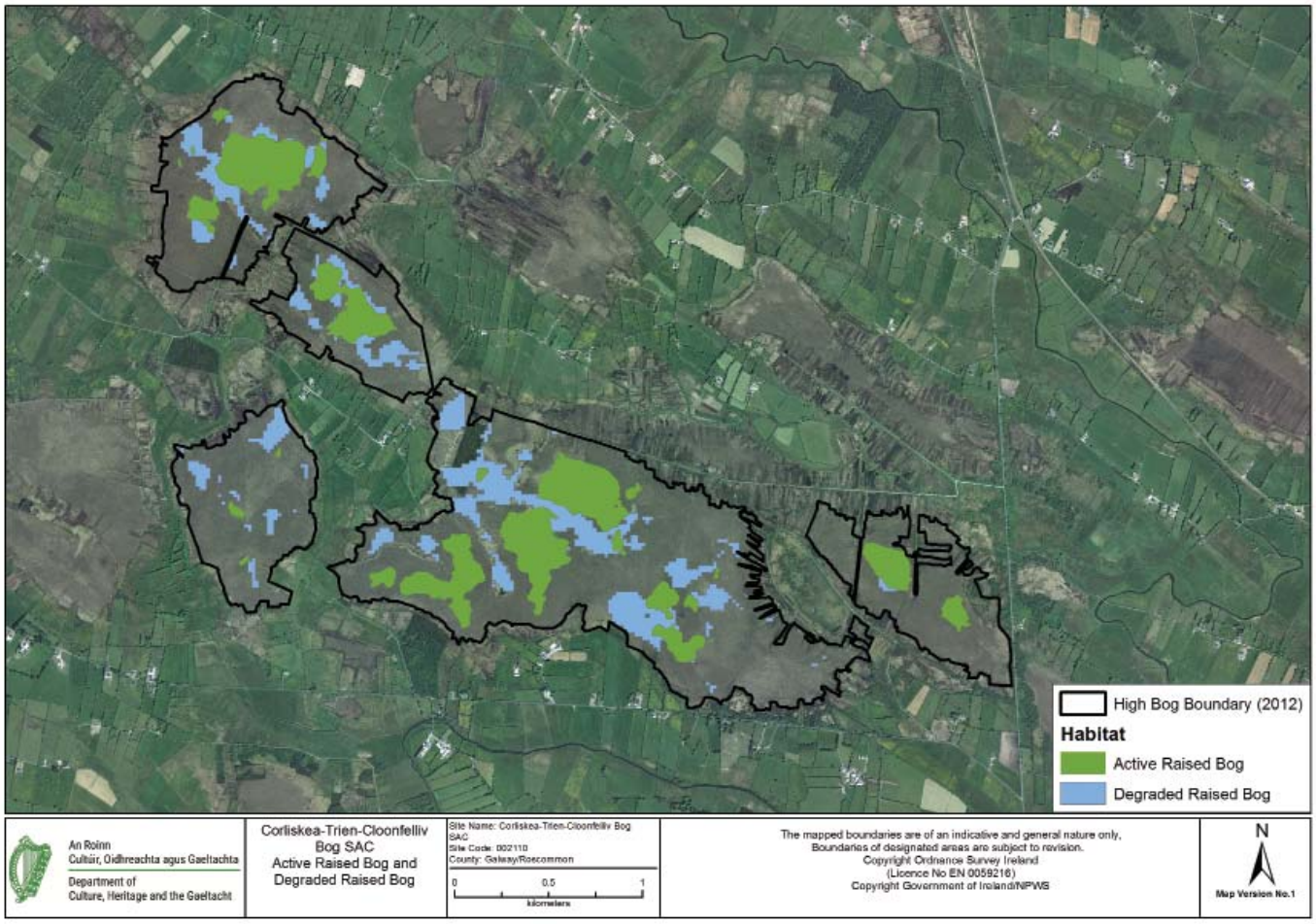
Site Statistics

Area of high bog in 1995 (ha):	457.8
Area of high bog in 2012 (ha):	452.4
Change in high bog (ha):	-5.4
Change in high bog (%):	-1.2%
No earlier survey available that covered the entire site	N/A
Area of active raised bog in 2013 (ha) (Fernandez et al. 2014)	69.2
Change in active raised bog (ha):	N/A
Change in active raised bog (%):	N/A
Area of degraded raised bog (ha):	31.8
Potential area bog peat-forming habitats (ha)	6.5

Composition of High Bog



- Active raised bog
- Degraded raised bog
- Potential supporting high bog habitat

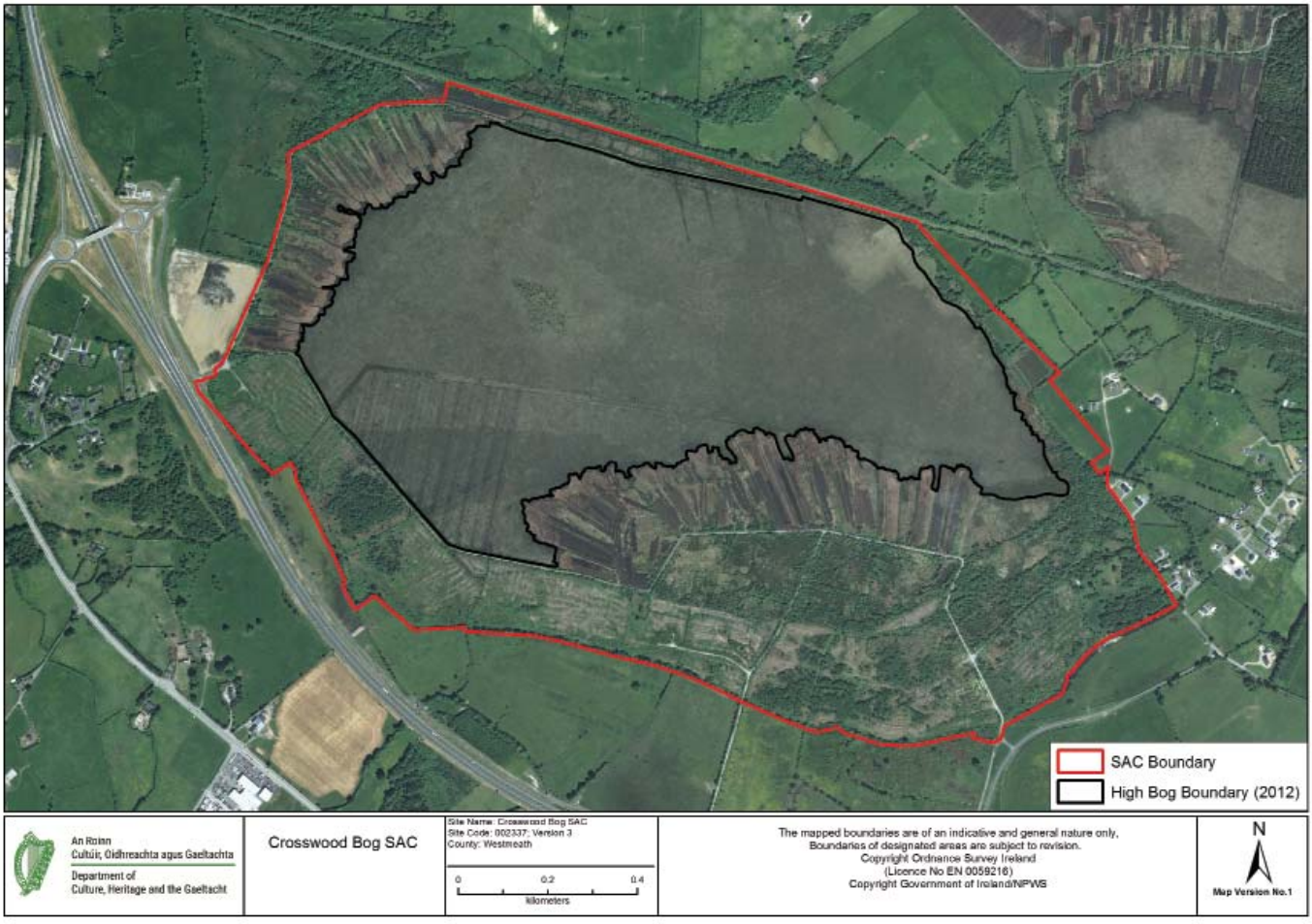


Crosswood Bog SAC - Summary

Site Name:	Crosswood Bog SAC
Site Code:	002337
Counties:	Westmeath
River Basin District:	Shannon
Sub-Catchment:	Shannon[Lower]_SC_010
Further Information:	http://www.npws.ie/protected-sites/sac/002337

Site Summary:

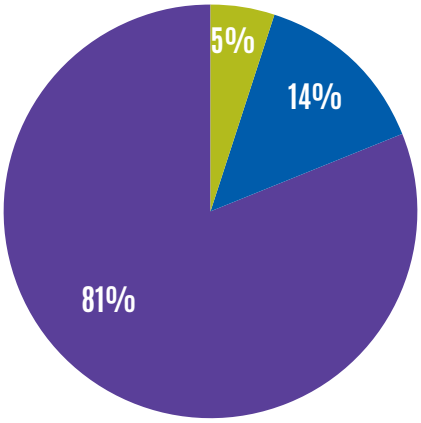
Crosswood Bog is situated approximately 5 km east of Athlone, Co. Westmeath. Crosswood Bog is of conservation value due to the occurrence of a moderate area of active raised bog vegetation. Restoration works in the form of tree removal and drain blocking have been undertaken by Coillte.



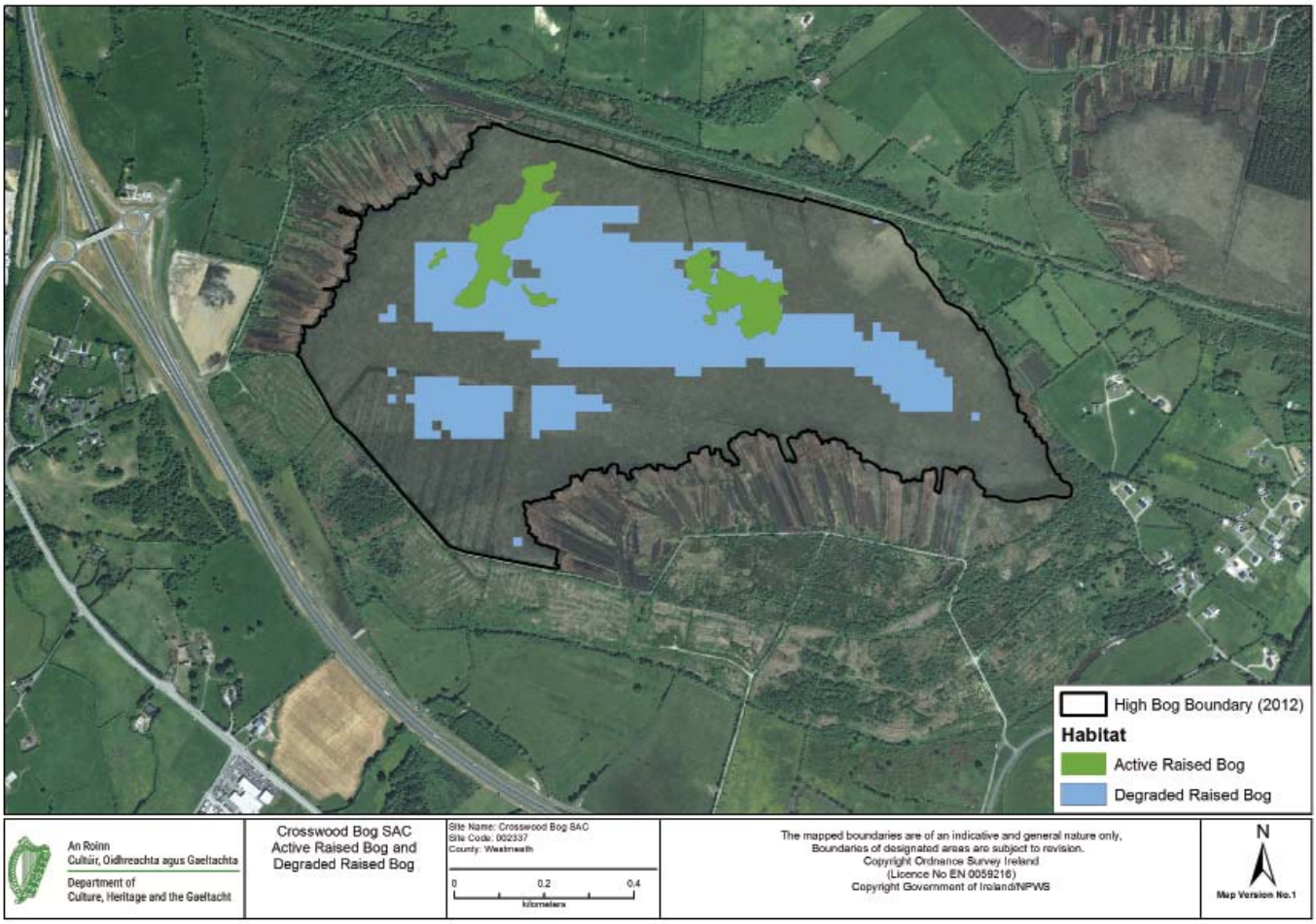
Site Statistics

Area of high bog in 1995 (ha):	103.3
Area of high bog in 2012 (ha):	96.3
Change in high bog (ha):	-7.0
Change in high bog (%):	-6.8%
Area of active raised bog in 1994 (ha) (Kelly et al. 1995)	25.7
Area of active raised bog in 2012 (ha) (Fernandez et al. 2014)	4.6
Change in active raised bog (ha):	-21.1
Change in active raised bog (%):	-82.1%
Area of degraded raised bog (ha):	13.9
Potential area bog peat-forming habitats (ha)	2.9

Composition of High Bog



- Active raised bog
- Degraded raised bog
- Potential supporting high bog habitat

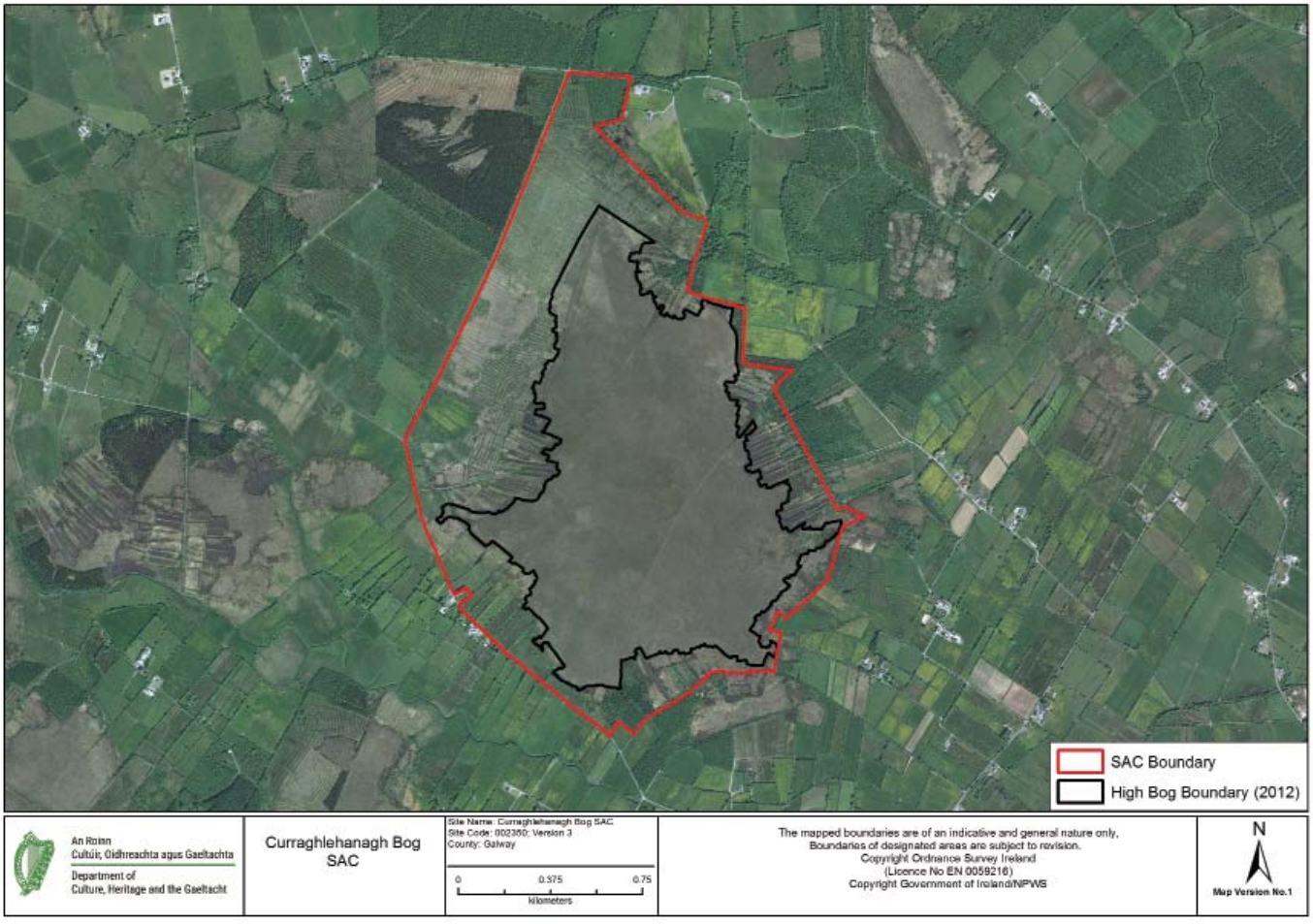


Curraghlehanagh Bog SAC - Summary

Site Name:	Curraghlehanagh Bog SAC
Site Code:	002350
Counties:	Galway
River Basin District:	Shannon
Sub-Catchment:	Suck_SC_050, Castlegar_SC_010
Further Information:	http://www.npws.ie/protected-sites/sac/002350

Site Summary:

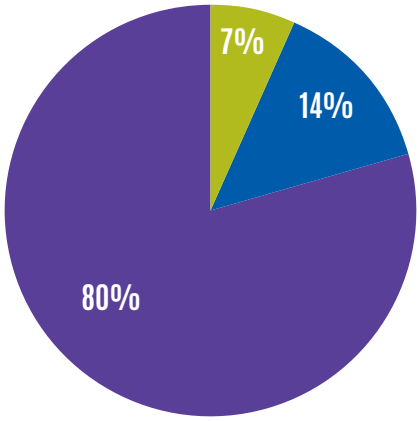
Curraghlehenagh Bog is part of a bog cluster situated approximately 6 km north of Mountbellew Co. Galway. The bog is of conservation value due to the occurrence of a moderate area of active raised bog vegetation. Restoration works in the form of tree removal and drain blocking have been undertaken by Coillte.



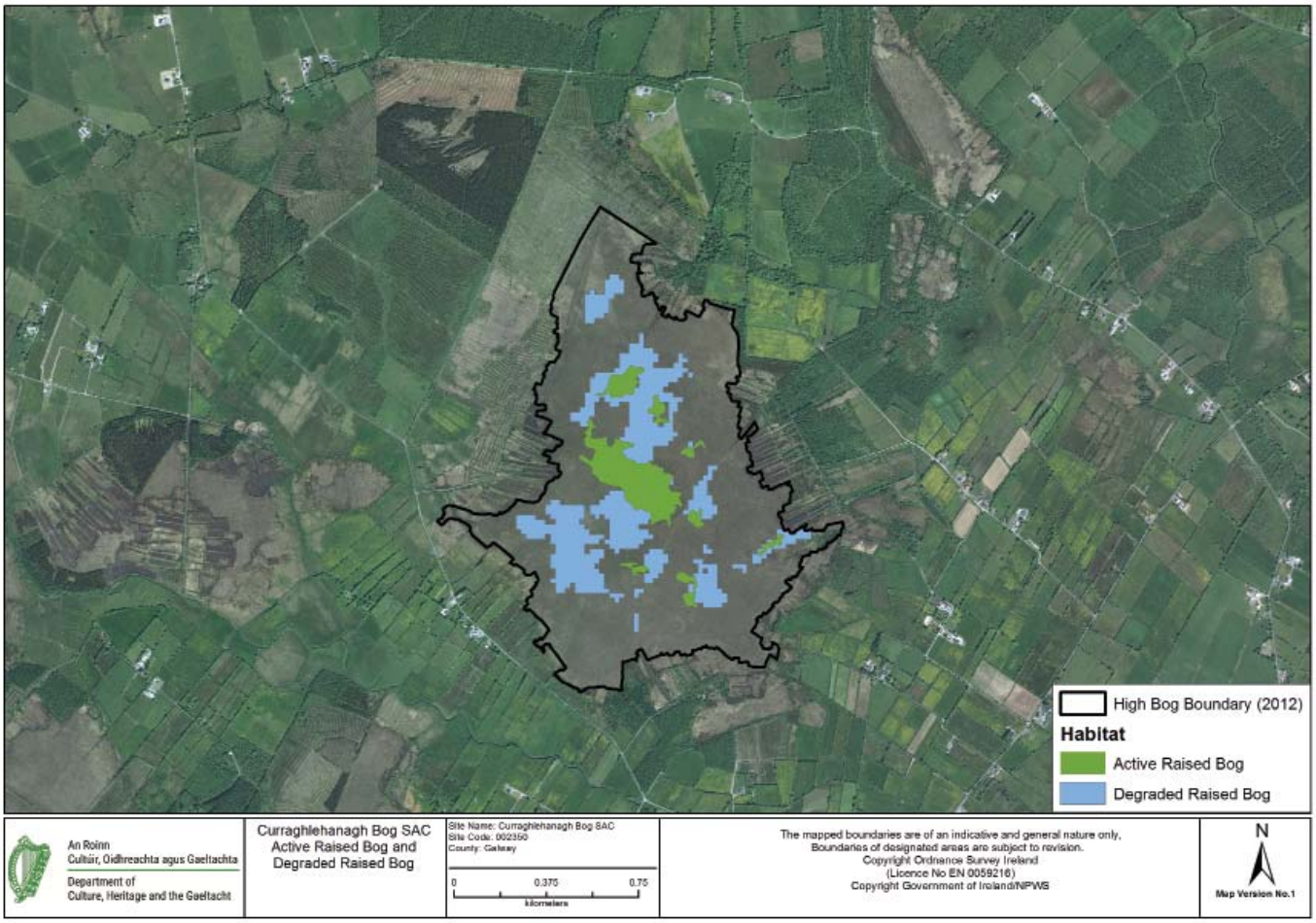
Site Statistics

Area of high bog in 1995 (ha):	150.7
Area of high bog in 2012 (ha):	146.4
Change in high bog (ha):	-4.3
Change in high bog (%):	-2.9%
Area of active raised bog in 1994 (ha) (Kelly et al. 1995)	22.4
Area of active raised bog in 2012 (ha) (Fernandez et al. 2014)	9.8
Change in active raised bog (ha):	-12.6
Change in active raised bog (%):	-56.3%
Area of degraded raised bog (ha):	19.8
Potential area bog peat-forming habitats (ha)	5.9

Composition of High Bog



- Active raised bog
- Degraded raised bog
- Potential supporting high bog habitat

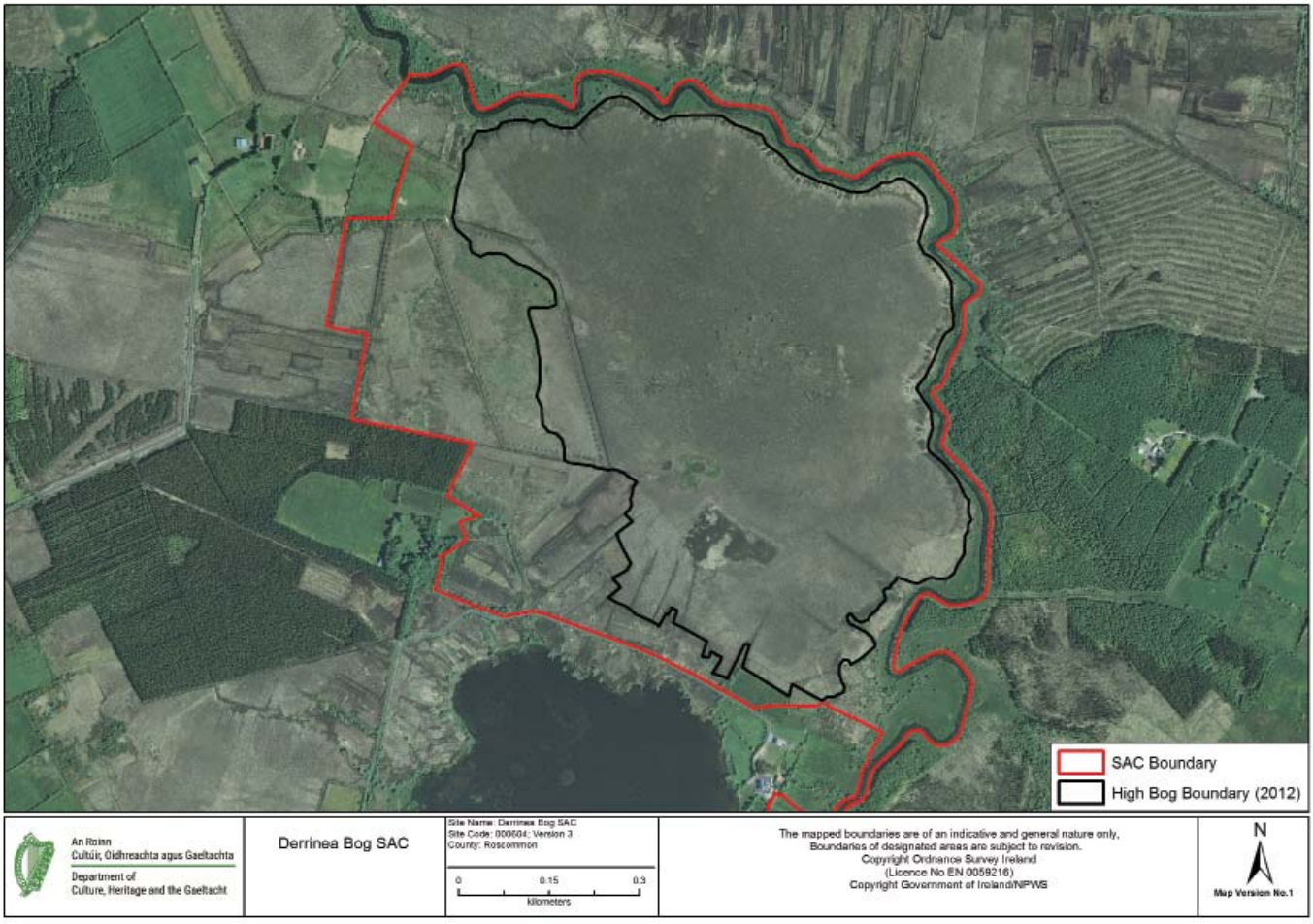


Derrinea Bog SAC - Summary

Site Name:	Derrinea Bog SAC
Site Code:	000604
Counties:	Roscommon
River Basin District:	Shannon
Sub-Catchment:	Lung_SC_010
Further Information:	http://www.npws.ie/protected-sites/sac/000604

Site Summary:

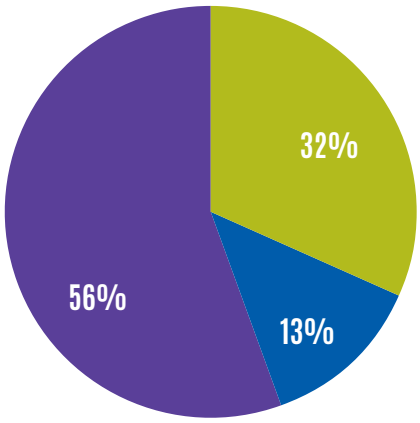
Derrinea Bog is a small raised bog site situated on the northern margin of Cloonagh Lough, just east of the Mayo/Roscommon border and 10 km north-west of Ballyhaunis. The bog is of high conservation value due to the occurrence of a significant area of high quality active raised bog vegetation. A series of large pools on the high bog and the presence of a natural transition between the bog and the River Anaderryboy to the east and north add to the interest of the site.



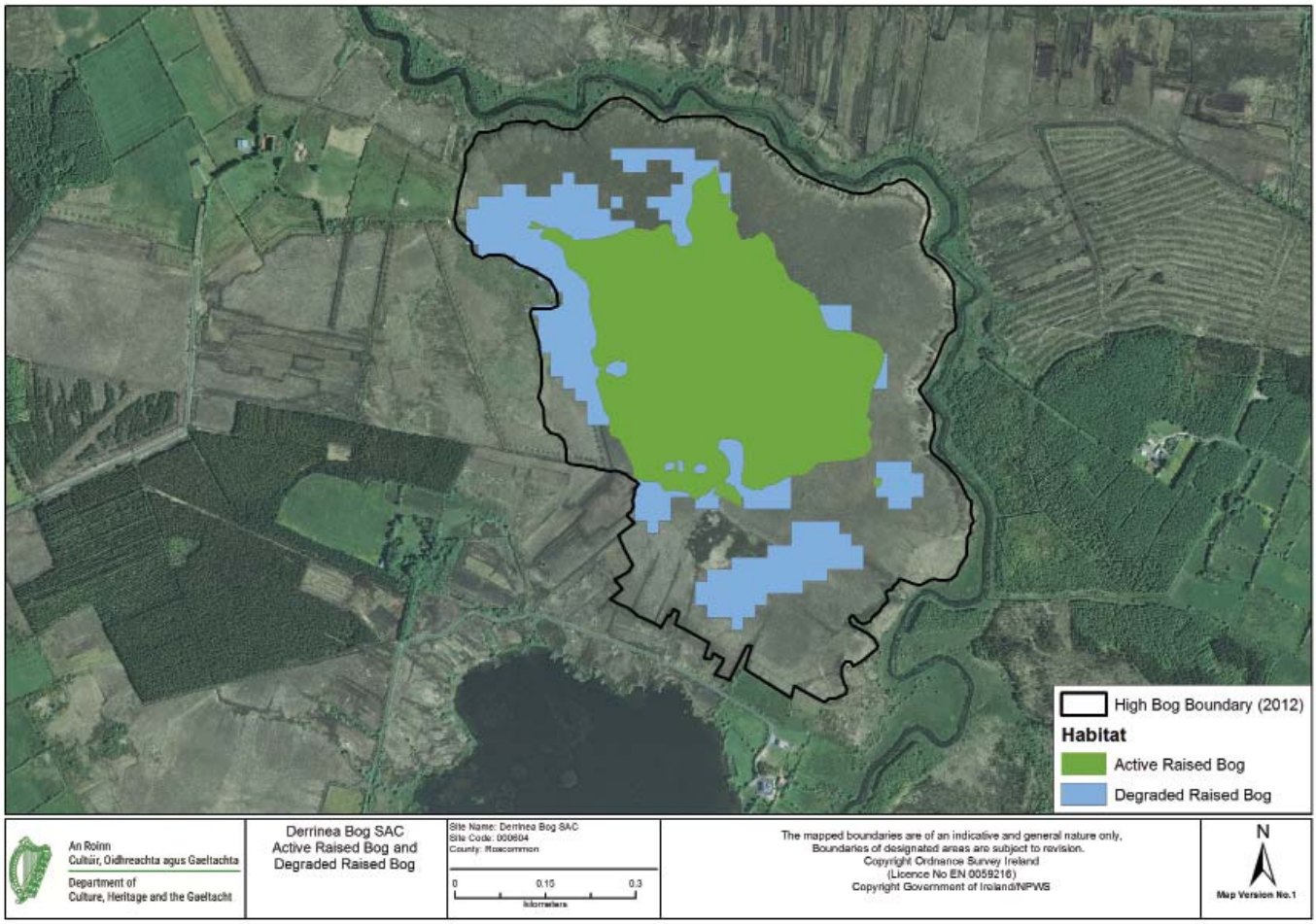
Site Statistics

Area of high bog in 1995 (ha):	53.8
Area of high bog in 2012 (ha):	53.8
Change in high bog (ha):	0.0
Change in high bog (%):	0.0%
Area of active raised bog in 1994 (ha) (Kelly et al. 1995*) (*Revised by NPWS in 2014)	17.4
Area of active raised bog in 2012 (ha) (Fernandez et al. 2014)	17.1
Change in active raised bog (ha):	-0.3
Change in active raised bog (%):	-1.7%
Area of degraded raised bog (ha):	6.8
Potential area bog peat-forming habitats (ha)	0.8

Composition of High Bog



- Active raised bog
- Degraded raised bog
- Potential supporting high bog habitat

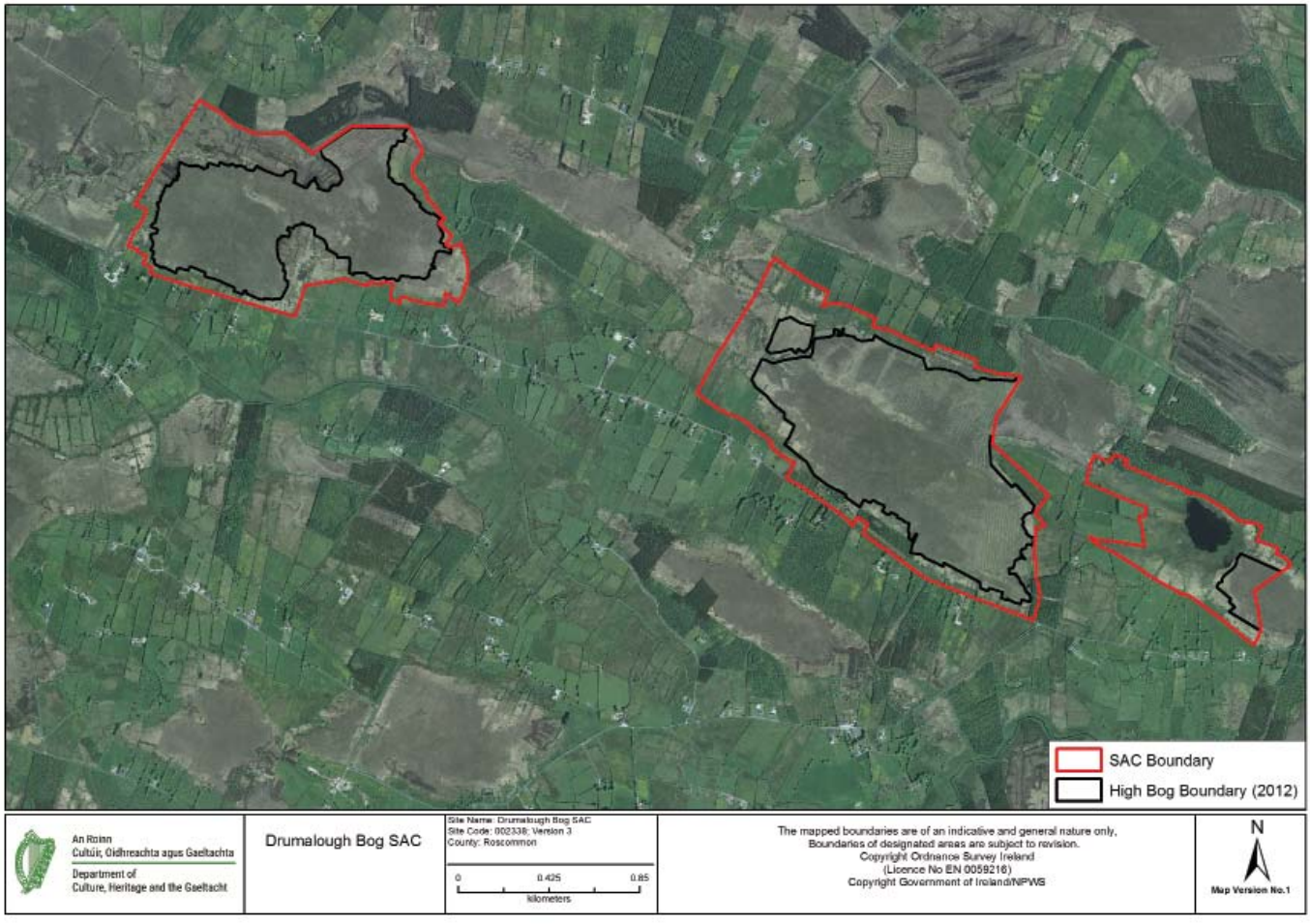


Drumalough Bog SAC - Summary

Site Name:	Drumalough Bog SAC
Site Code:	002338
Counties:	Roscommon
River Basin District:	Shannon
Sub-Catchment:	Lung_SC_010, Suck_SC_010
Further Information:	http://www.npws.ie/protected-sites/sac/002338

Site Summary:

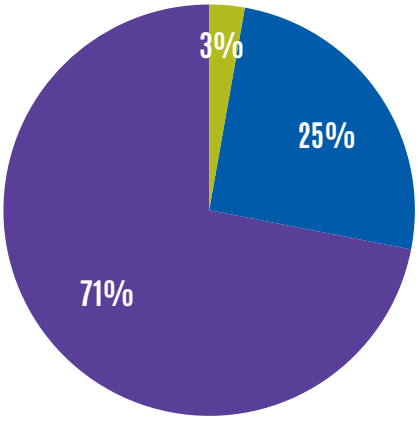
Drumalough Bog is located 5 km north-west of Castlerea , Co. Roscommon. The SAC is comprised of three separate bogs which were once part of an extensive bog complex, now separated by cutover bog. Two of these subsites are high bog, with associated cutover. Drumalough Bog is of conservation value due to the occurrence of a moderate area of Active Raised Bog vegetation. Restoration works in the form of tree removal and drain blocking have been undertaken by Coillte.



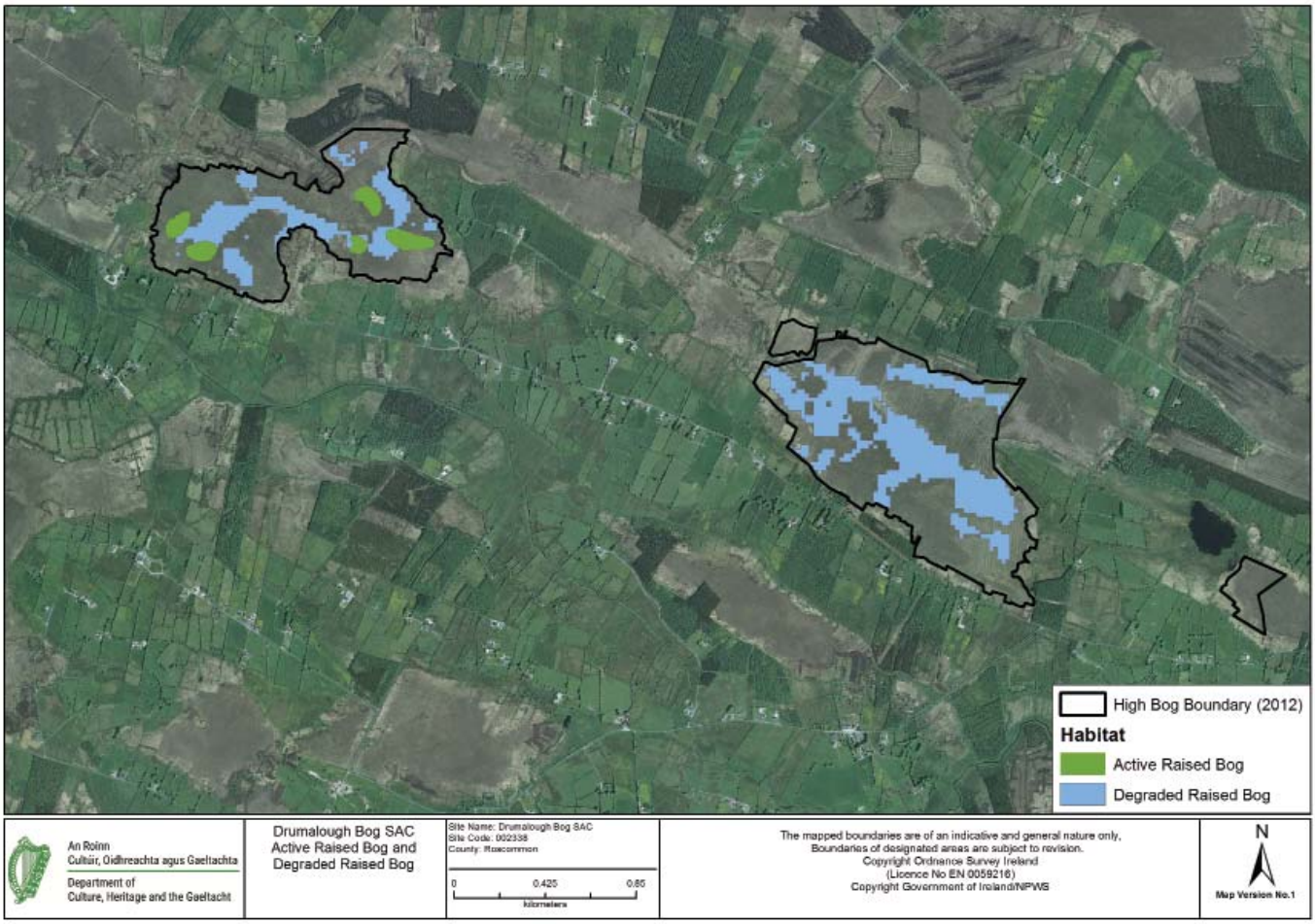
Site Statistics

Area of high bog in 1995 (ha):	154.3
Area of high bog in 2012 (ha):	153.7
Change in high bog (ha):	-0.6
Change in high bog (%):	-0.4%
No earlier survey available	N/A
Drumalough Bog East - no survey available. Area of active raised bog in Drumalough Bog West in 2003 (ha) (Fernandez et al. 2006)	5.1
Change in active raised bog (ha):	N/A
Change in active raised bog (%):	N/A
Area of degraded raised bog (ha):	38.9
Potential area bog peat-forming habitats (ha)	1.1

Composition of High Bog



- Active raised bog
- Degraded raised bog
- Potential supporting high bog habitat

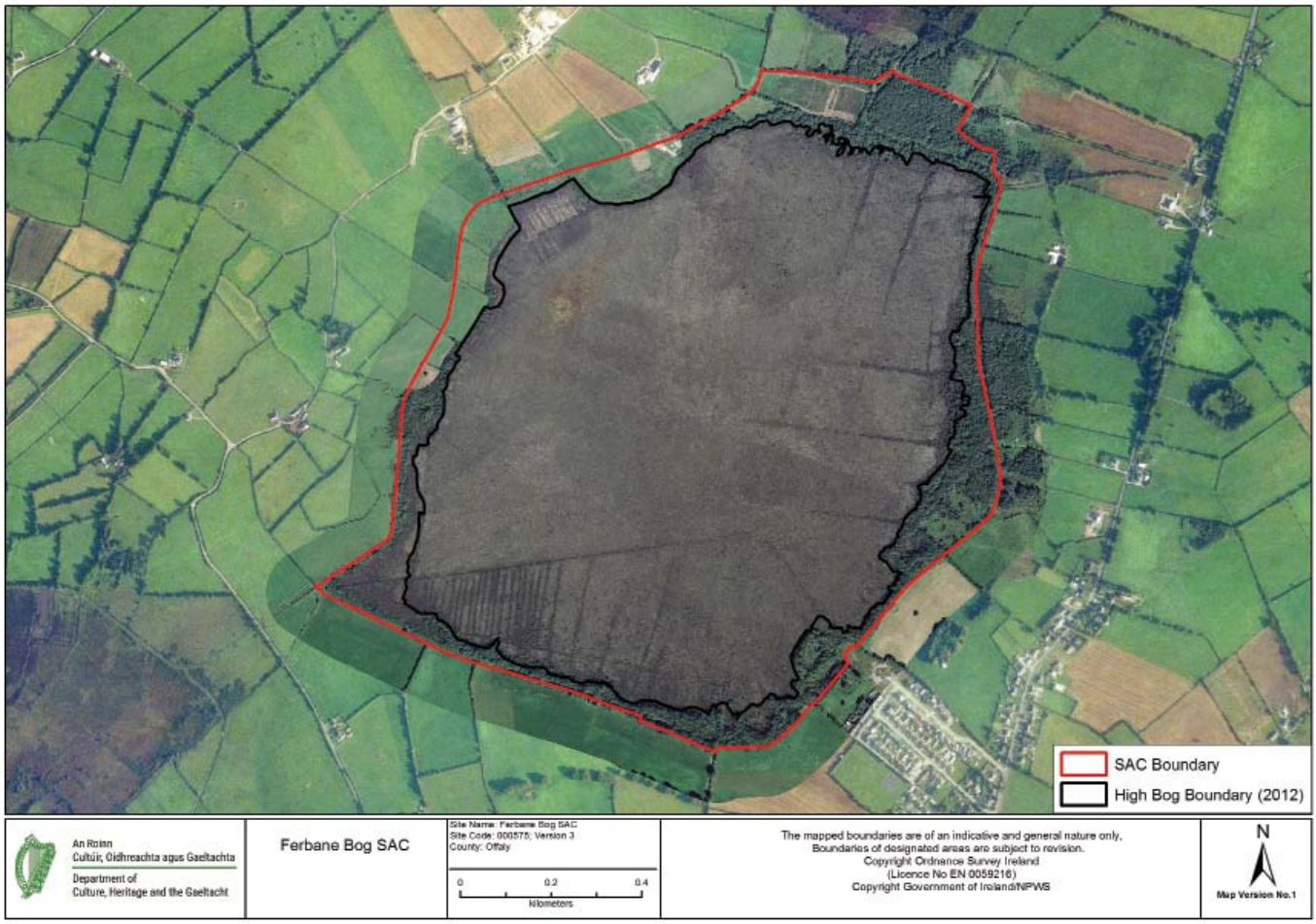


Ferbane Bog SAC - Summary

Site Name:	Ferbane Bog SAC
Site Code:	000575
Counties:	Offaly
River Basin District:	Shannon
Sub-Catchment:	Shannon[Lower]_SC_030
Further Information:	http://www.npws.ie/protected-sites/sac/000575

Site Summary:

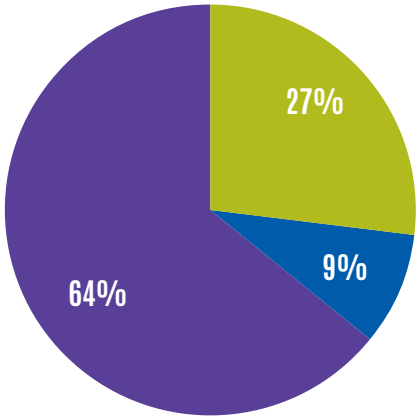
Ferbane Bog is a relatively large, domed, raised bog located about 10 km east of Shannonbridge. The bog is of high conservation value due to the occurrence of an extensive area of active raised bog vegetation and a relatively intact margin.



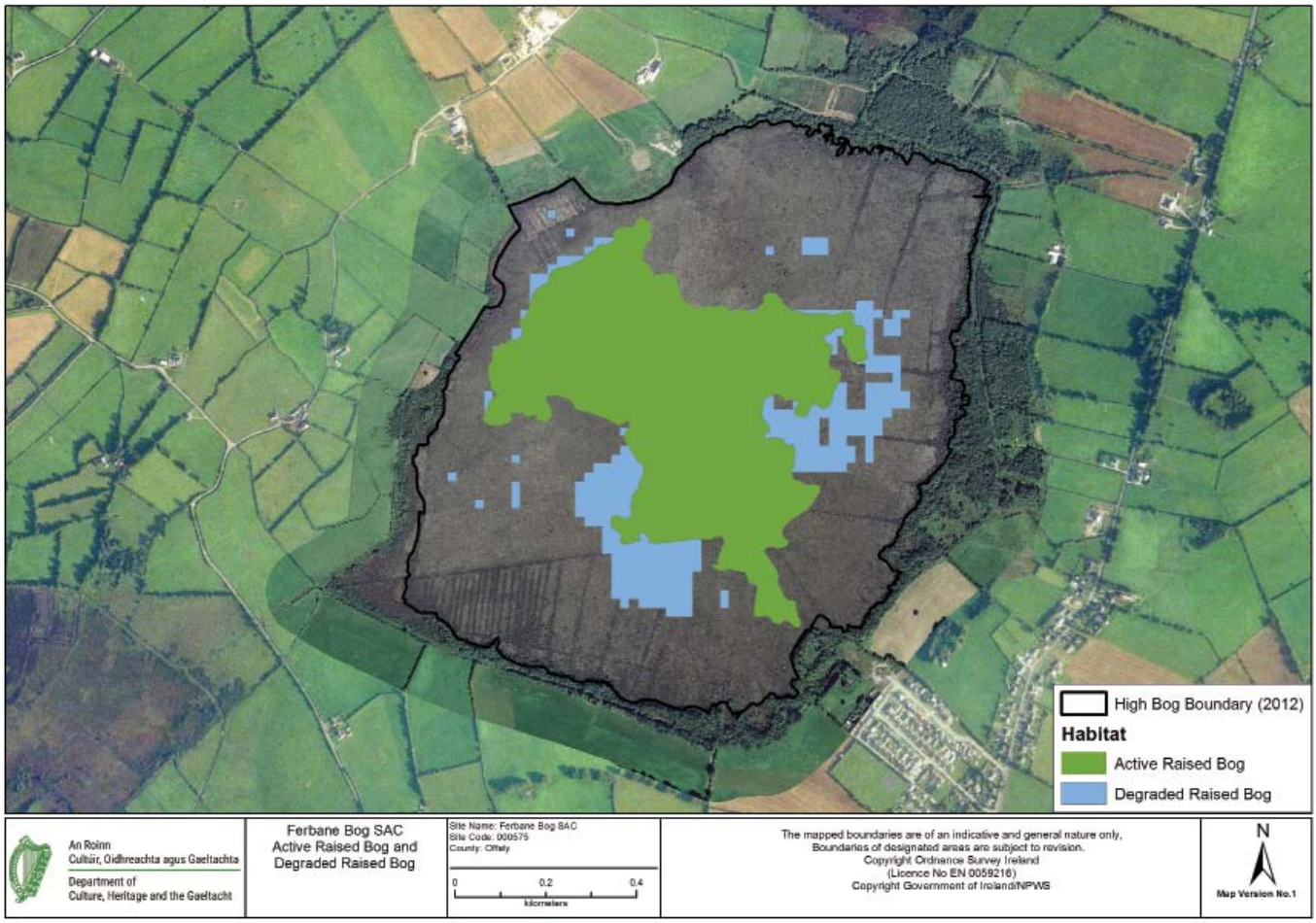
Site Statistics

Area of high bog in 1995 (ha):	120.0
Area of high bog in 2012 (ha):	120.0
Change in high bog (ha):	0.0
Change in high bog (%):	0.0%
Area of active raised bog in 1994 (ha) (Kelly et al. 1995)	41.7
Area of active raised bog in 2012 (ha) (Fernandez et al. 2014)	32.6
Change in active raised bog (ha):	-9.1
Change in active raised bog (%):	-21.8%
Area of degraded raised bog (ha):	10.9
Potential area bog peat-forming habitats (ha)	0.0

Composition of High Bog



- Active raised bog
- Degraded raised bog
- Potential supporting high bog habitat

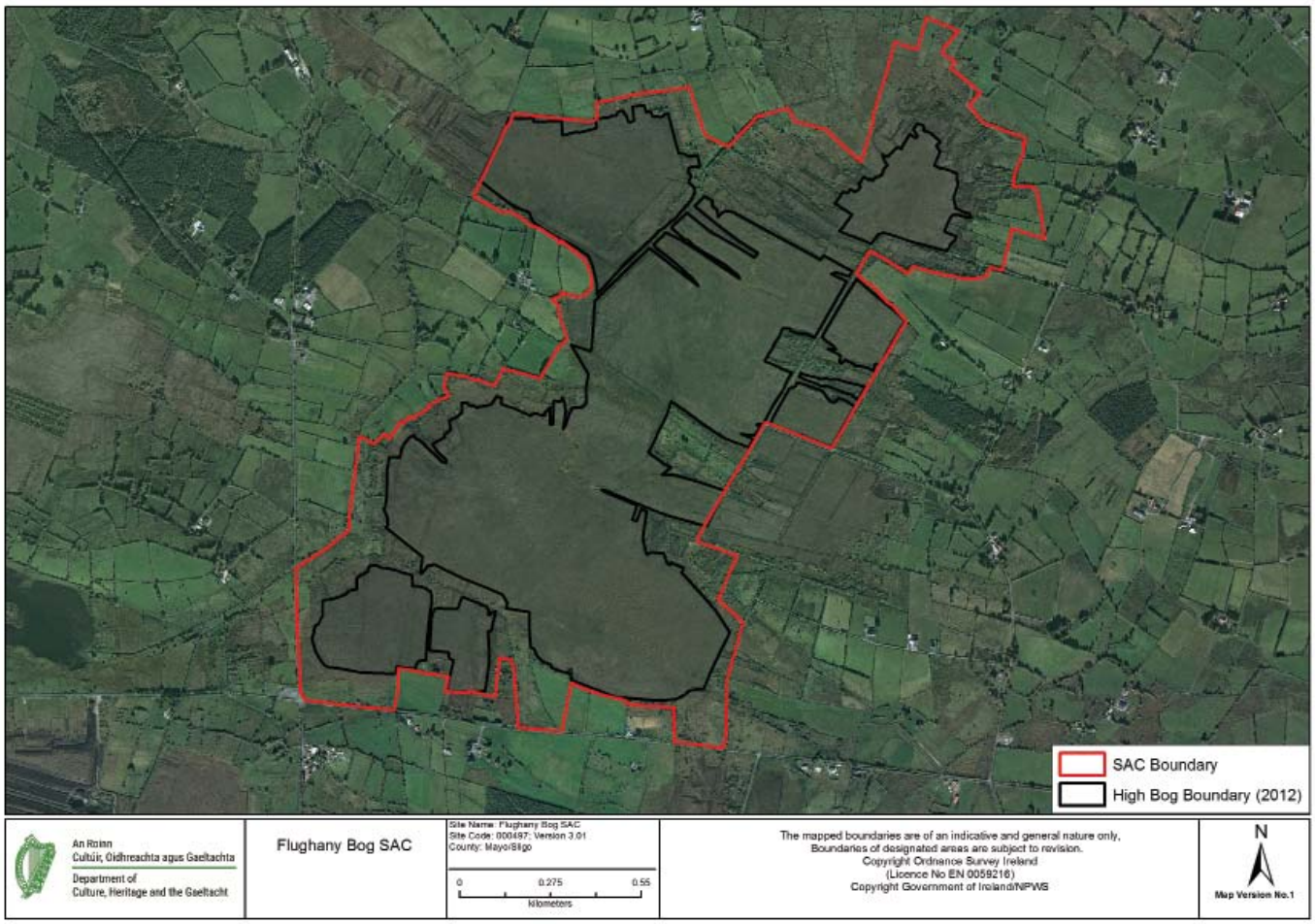


Flughany Bog SAC - Summary

Site Name:	Flughany Bog SAC
Site Code:	000497
Counties:	Mayo / Sligo
River Basin District:	Western
Sub-Catchment:	Owenmore[Sligo]_SC_020, Owenmore[Sligo]_SC_010
Further Information:	http://www.npws.ie/protected-sites/sac/000497

Site Summary:

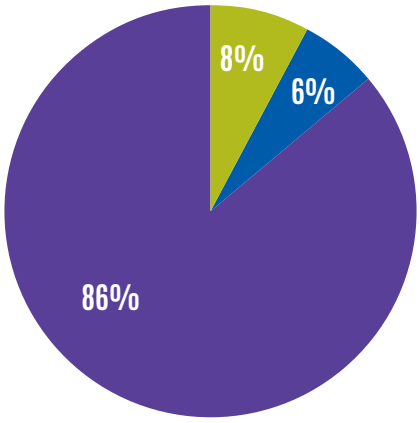
Flughany Bog is a raised bog, located on the Mayo/Sligo county border, 10km southeast of Tobercurry. It is the most northerly of a series of raised bogs in this area, the others being part of the River Moy SAC. This bog is of high conservation value due to the occurrence of a significant area of active raised bog vegetation. The bog is also of importance as it is located at the north western edge of the range.

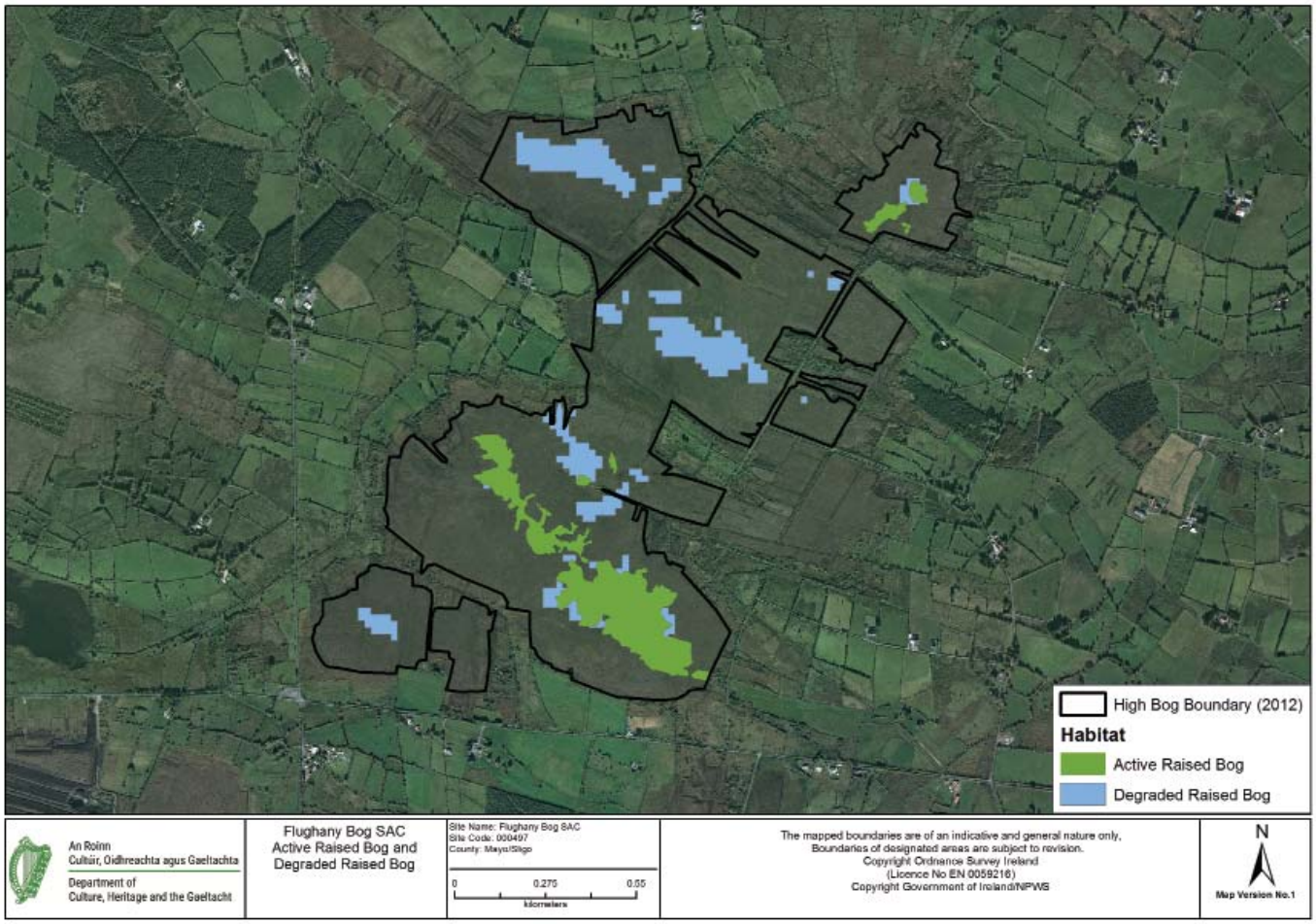


Site Statistics

Area of high bog in 1995 (ha):	143.8
Area of high bog in 2012 (ha):	143.6
Change in high bog (ha):	-0.2
Change in high bog (%):	-0.1%
Area of active raised bog in 1994 (ha) (Kelly et al. 1995*) (*Revised by NPWS in 2014)	14
Area of active raised bog in 2012 (ha) (Fernandez et al. 2014)	11.4
Change in active raised bog (ha):	-2.6
Change in active raised bog (%):	-18.6%
Area of degraded raised bog (ha):	9.2
Potential area bog peat-forming habitats (ha)	3.0

Composition of High Bog



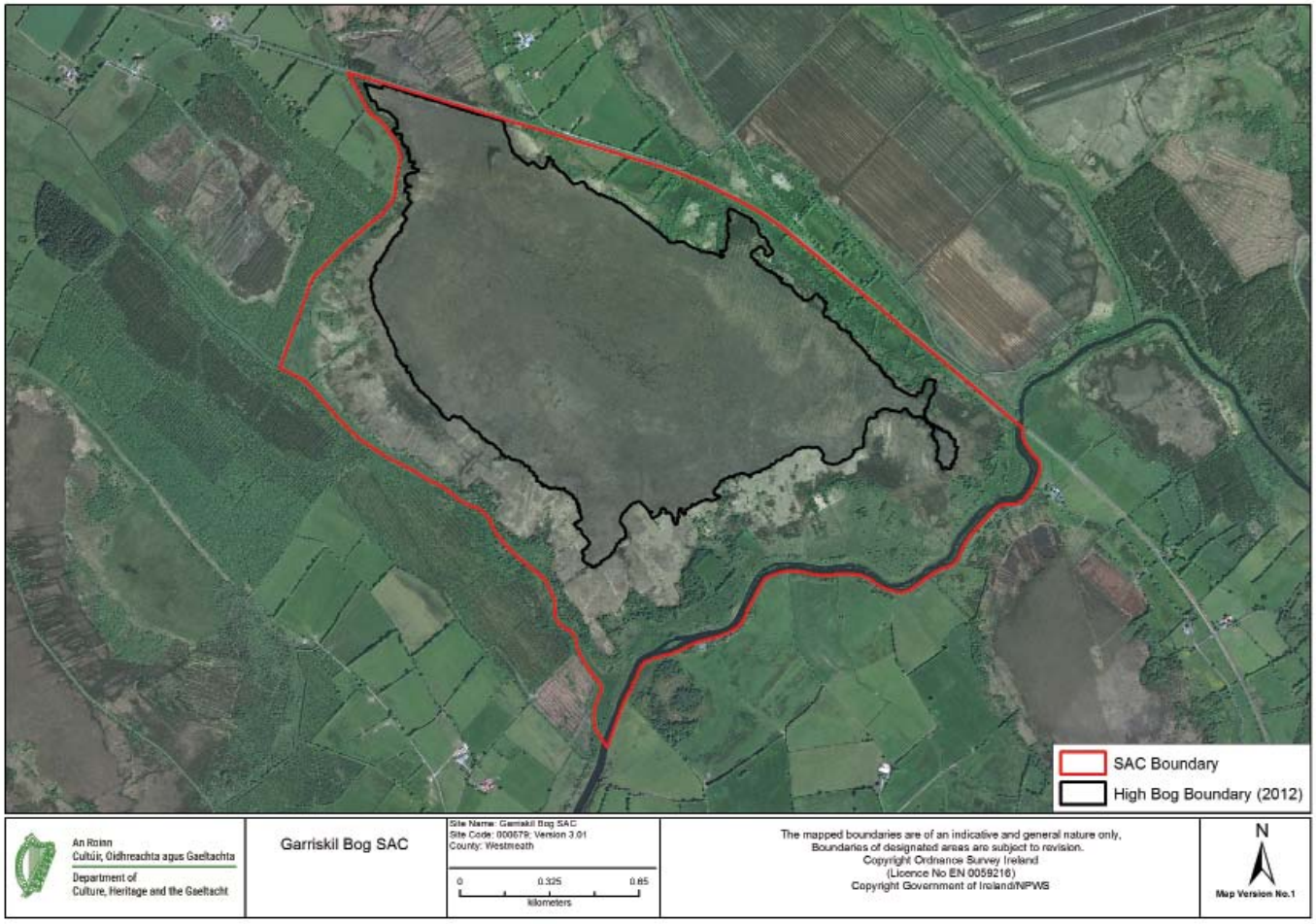


Garriskil Bog SAC - Summary

Site Name:	Garriskil Bog SAC
Site Code:	000679
Counties:	Westmeath
River Basin District:	Shannon
Sub-Catchment:	Inny[Shannon]_SC_030, Inny[Shannon]_SC_050
Further Information:	http://www.npws.ie/protected-sites/sac/000679

Site Summary:

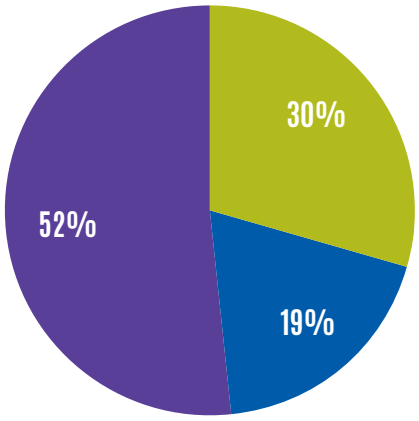
Garriskill Bog lies 3 km west of Lough Derravaragh and 3 km east of Rathowen. The bog is of high conservation value due to the occurrence of a very extensive area of high quality active raised bog vegetation with hummocks, hollows and pools. Restoration works in the form of drain blocking have been undertaken by NPWS.



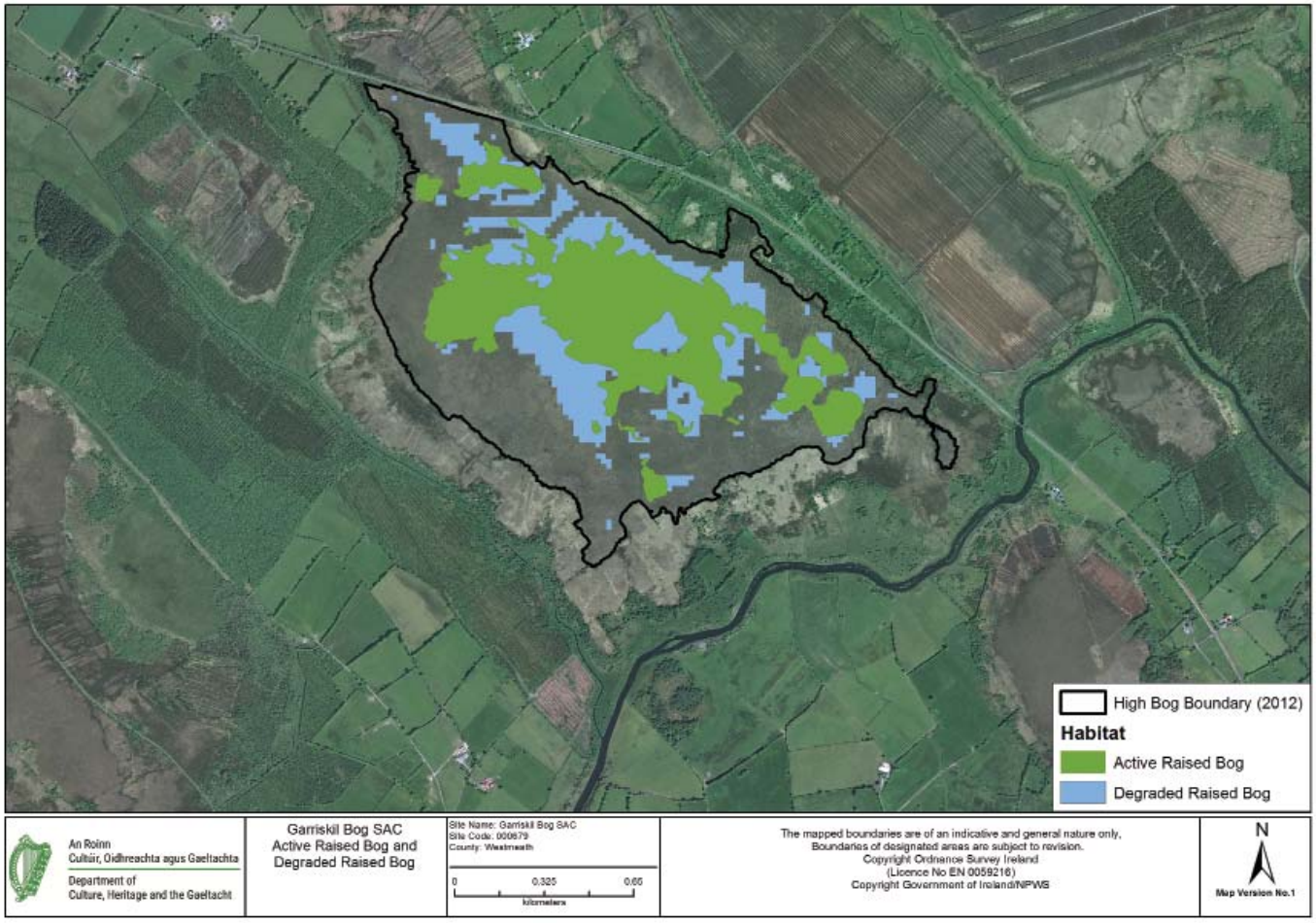
Site Statistics

Area of high bog in 1995 (ha):	170.3
Area of high bog in 2012 (ha):	170.3
Change in high bog (ha):	0.0
Change in high bog (%):	0.0%
Area of active raised bog in 1994 (ha) (Kelly et al. 1995)	71.2
Area of active raised bog in 2011 (ha) (Fernandez et al. 2012)	50.9
Change in active raised bog (ha):	-20.3
Change in active raised bog (%):	-28.5%
Area of degraded raised bog (ha):	31.6
Potential area bog peat-forming habitats (ha)	2.4

Composition of High Bog



- Active raised bog
- Degraded raised bog
- Potential supporting high bog habitat

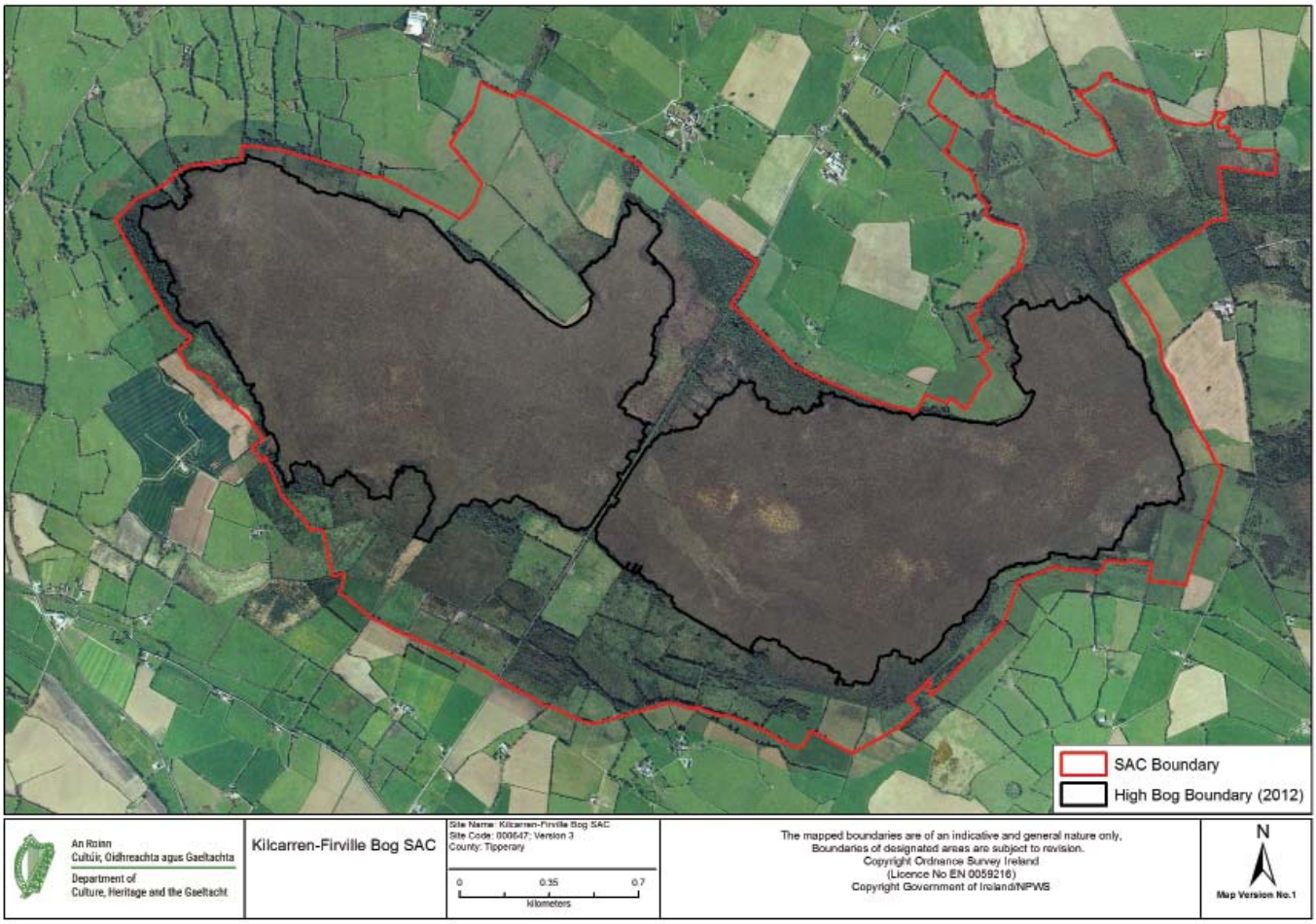


Kilcarren-Firville Bog SAC - Summary

Site Name:	Kilcarren-Firville Bog SAC
Site Code:	000647
Counties:	Tipperary
River Basin District:	Shannon
Sub-Catchment:	LorrhaStream_SC_010
Further Information:	http://www.npws.ie/protected-sites/sac/000647

Site Summary:

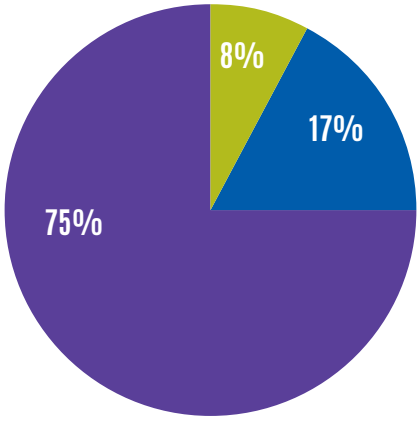
Kilcarren - Firville Bog is situated approximately 2 km east of the village of Carrigahorig in north Tipperary. The bog is of high ecological value due to the presence of an extensive area of high quality active raised bog. In addition, the site has a remnant intact lagg zone (the natural boundary between the bog and surrounding mineral land), which is a rare feature on Irish raised bogs.



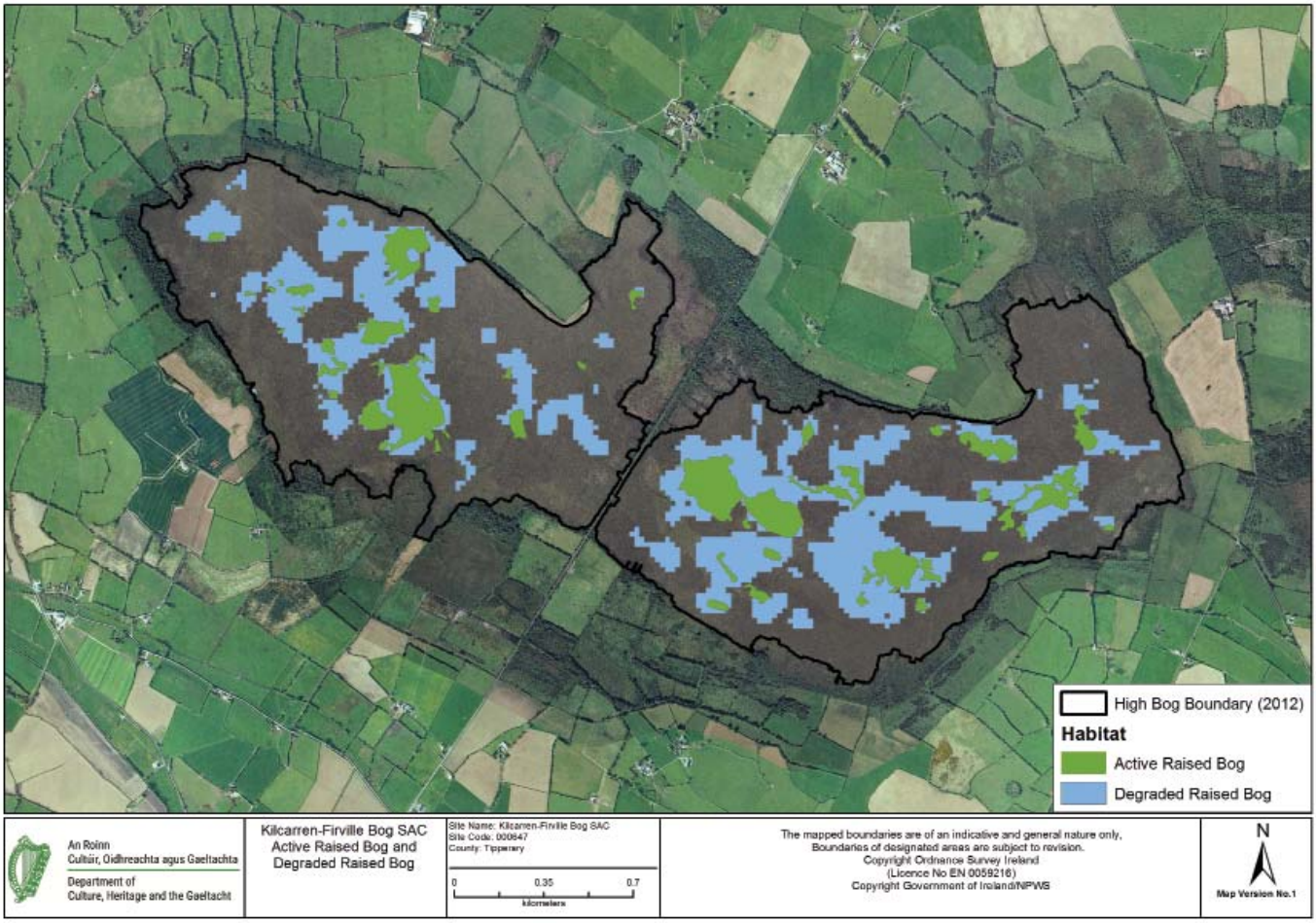
Site Statistics

Area of high bog in 1995 (ha):	362.6
Area of high bog in 2012 (ha):	362.3
Change in high bog (ha):	-0.3
Change in high bog (%):	-0.1%
Area of active raised bog in 1994 (ha) (Kelly et al. 1995)	59.7
Area of active raised bog in 2011 (ha) (Fernandez et al. 2012)	28.7
Change in active raised bog (ha):	-31
Change in active raised bog (%):	-51.9%
Area of degraded raised bog (ha):	60.3
Potential area bog peat-forming habitats (ha)	3.4

Composition of High Bog



- Active raised bog
- Degraded raised bog
- Potential supporting high bog habitat

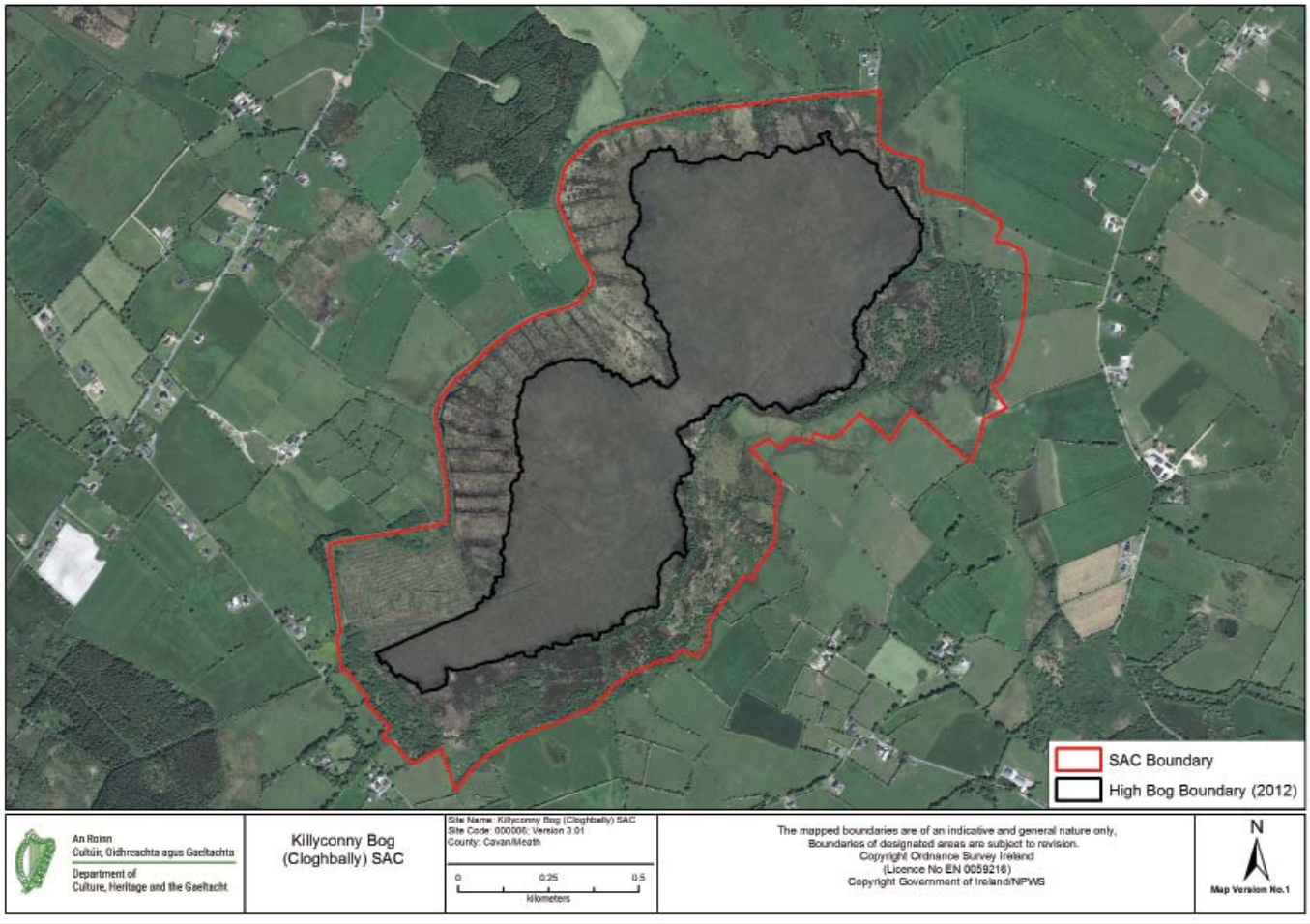


Killyconny Bog (Cloghbally) SAC - Summary

Site Name:	Killyconny Bog (Cloghbally) SAC
Site Code:	000006
Counties:	Cavan / Meath
River Basin District:	Eastern
Sub-Catchment:	Blackwater[Kells]_SC_030, Moynalty_SC_010
Further Information:	http://www.npws.ie/protected-sites/sac/000006

Site Summary:

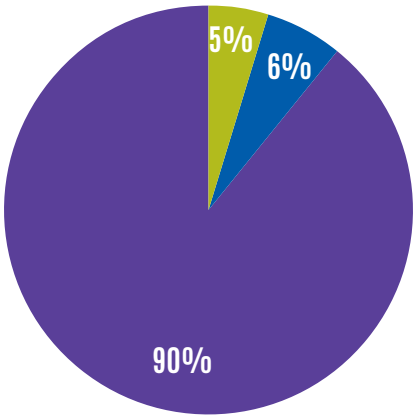
Killyconny Bog is situated approximately half way between Virginia and Kells on the Cavan/Meath border and some 8km from each. The bog is of conservation value due to the occurrence of a moderate area of active raised bog vegetation. The bog is also of importance as it is located at the north eastern edge of the range. Restoration works in the form of tree removal, drain blocking and construction of a marginal bund have been undertaken by Coillte and NPWS.



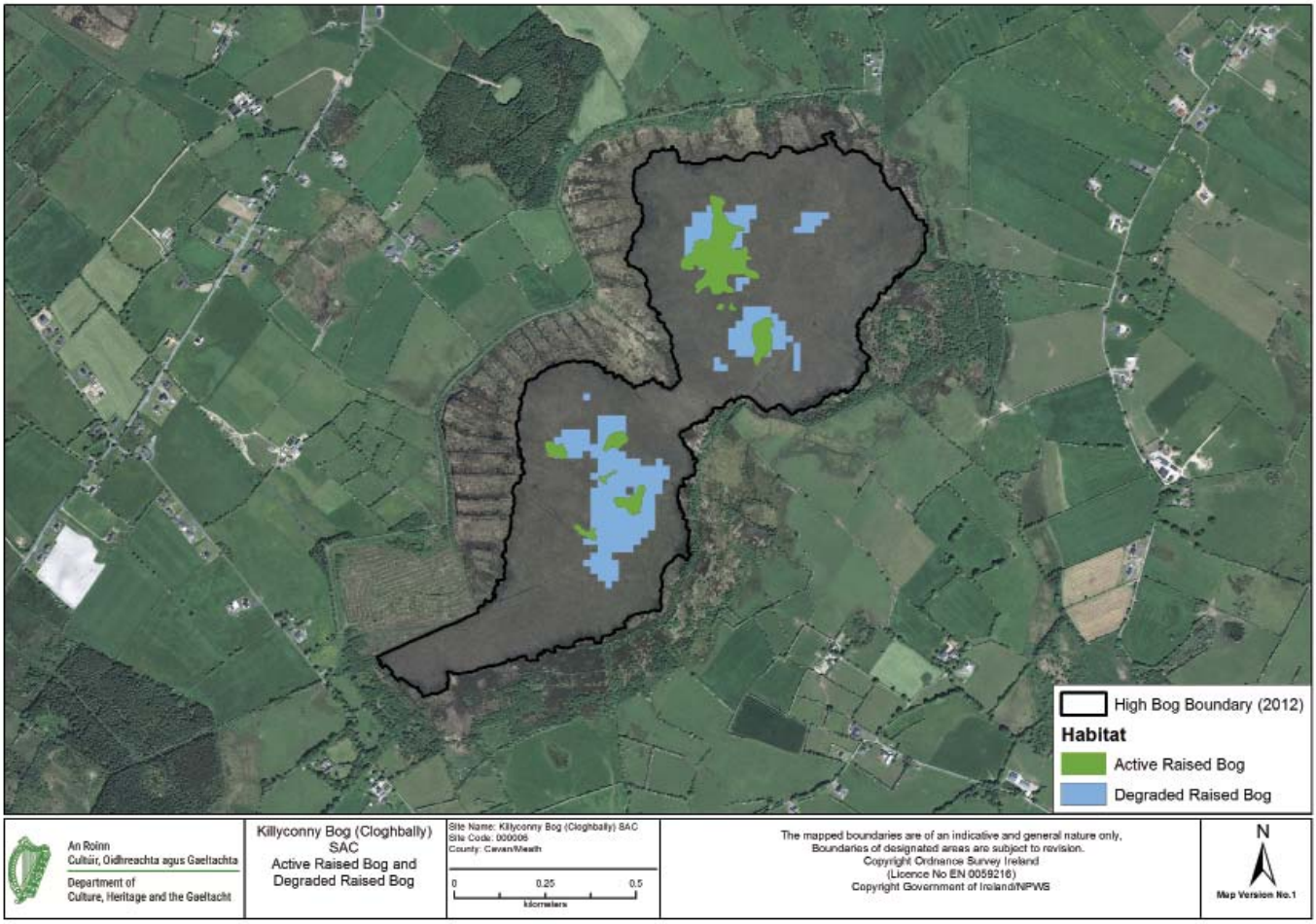
Site Statistics

Area of high bog in 1995 (ha):	83.9
Area of high bog in 2012 (ha):	83.0
Change in high bog (ha):	-0.9
Change in high bog (%):	-1.1%
Area of active raised bog in 1994 (ha) (Kelly et al. 1995*) (*Revised by NPWS in 2014)	17
Area of active raised bog in 2011 (ha) (Fernandez et al. 2012)	3.9
Change in active raised bog (ha):	-13.1
Change in active raised bog (%):	-77.1%
Area of degraded raised bog (ha):	4.8
Potential area bog peat-forming habitats (ha)	4.5

Composition of High Bog



Active raised bog
Degraded raised bog
Potential supporting high bog habitat

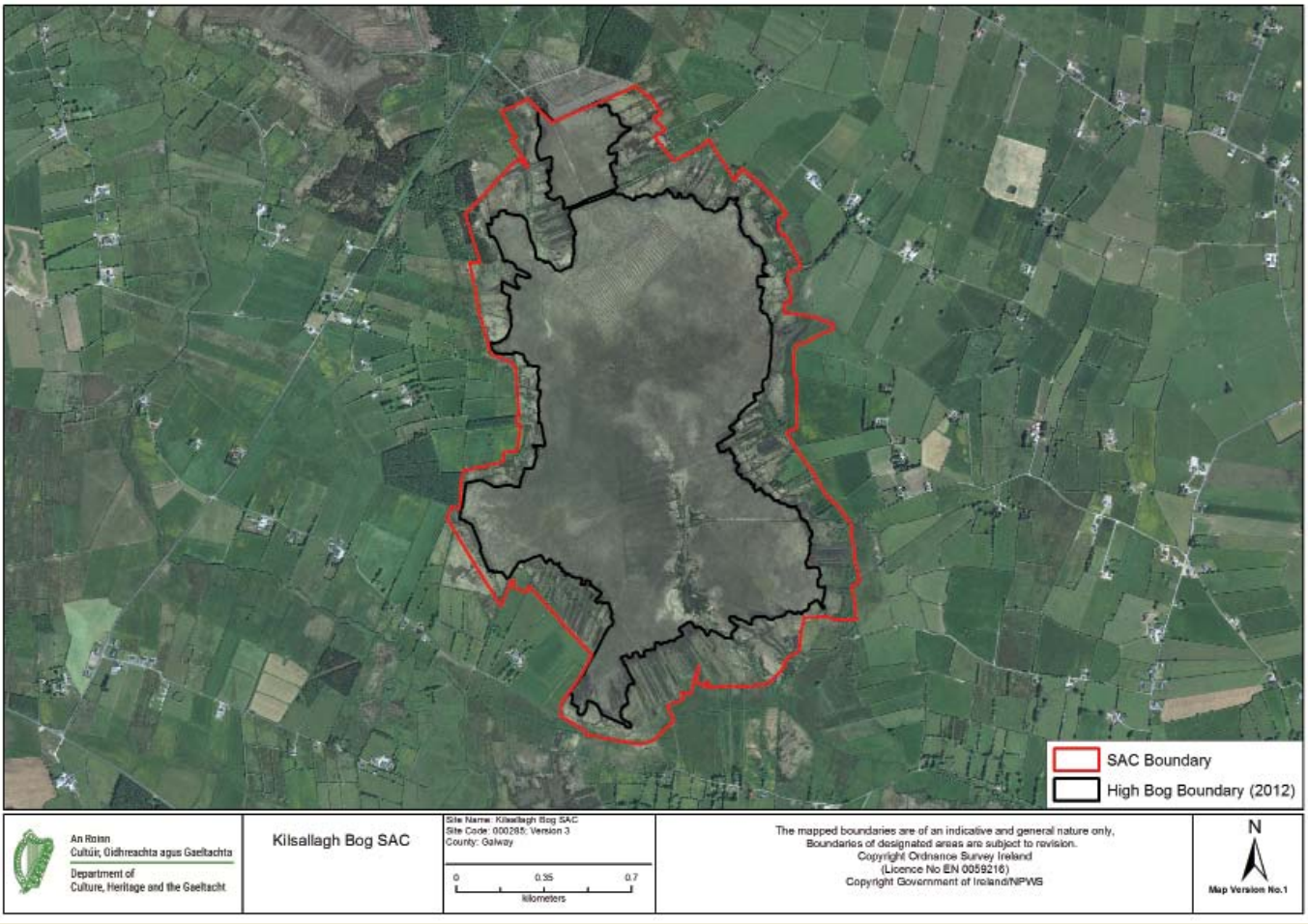


Kilsallagh Bog SAC - Summary

Site Name:	Kilsallagh Bog SAC
Site Code:	000285
Counties:	Galway
River Basin District:	Shannon
Sub-Catchment:	Suck_SC_040, Suck_SC_020
Further Information:	http://www.npws.ie/protected-sites/sac/000285

Site Summary:

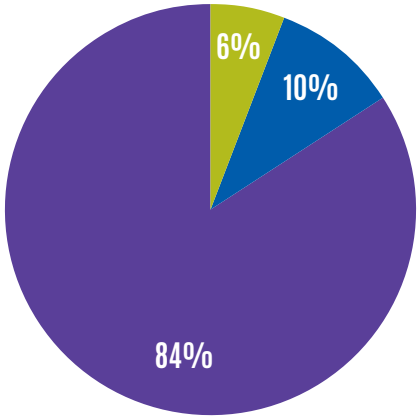
Kilsallagh Bog is a large raised bog with a largely intact dome set in a peat basin almost completely surrounded by mineral soil. It is situated about 7 km north of Glenamaddy. The bog is of high conservation value due to the occurrence of a significant area of active raised bog vegetation. The central part of the bog is extremely wet. This grades down on the north-east slope into an unusual wet community which is flushed. Restoration works in the form of tree removal and drain blocking have been undertaken by Coillte.

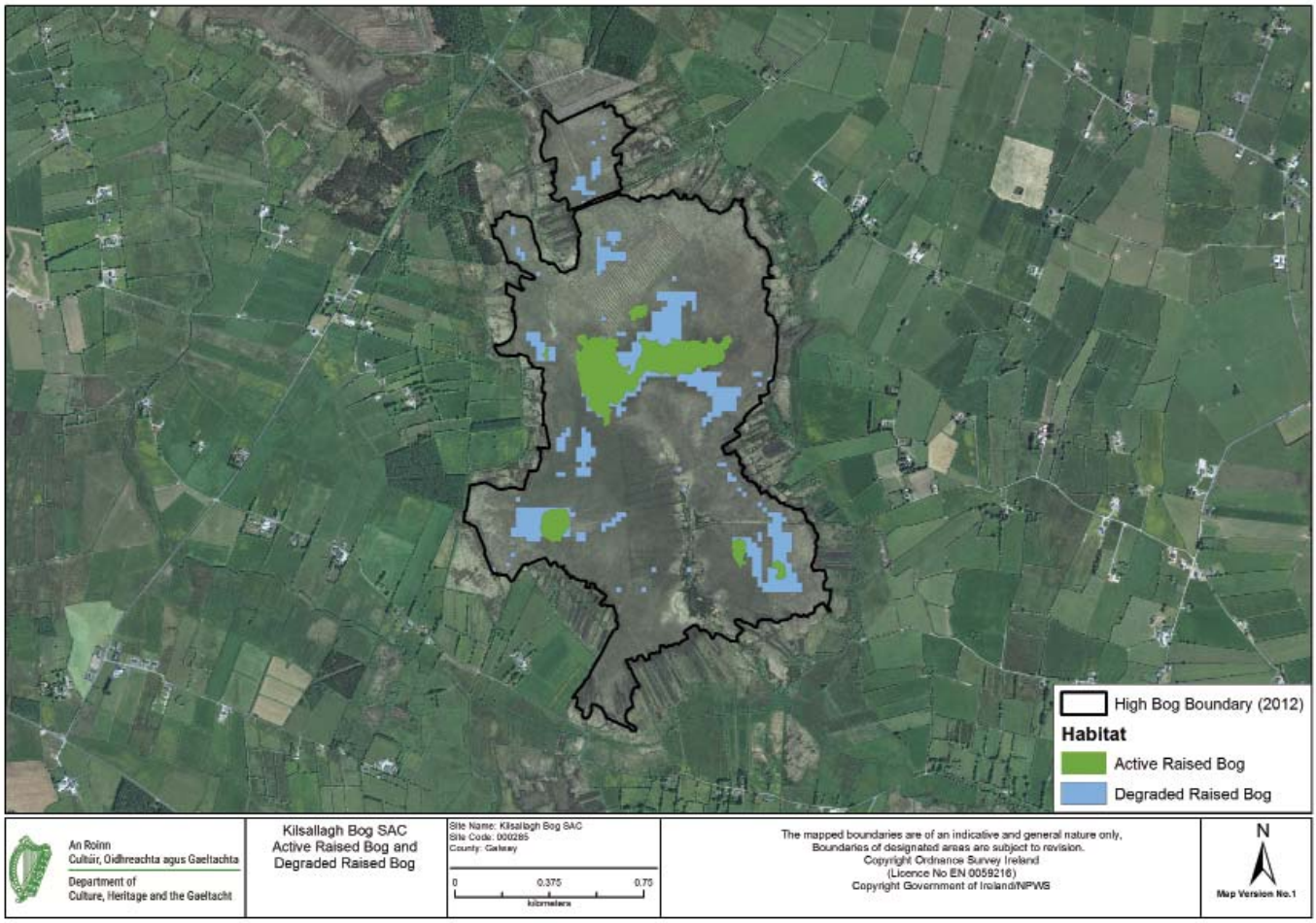


Site Statistics

Area of high bog in 1995 (ha):	186.7
Area of high bog in 2012 (ha):	182.1
Change in high bog (ha):	-4.6
Change in high bog (%):	-2.5%
Area of active raised bog in 1994 (ha) (Kelly et al. 1995)	19.1
Area of active raised bog in 2012 (ha) (Fernandez et al. 2014)	11.5
Change in active raised bog (ha):	-7.6
Change in active raised bog (%):	-39.8%
Area of degraded raised bog (ha):	18.1
Potential area bog peat-forming habitats (ha)	6.0

Composition of High Bog



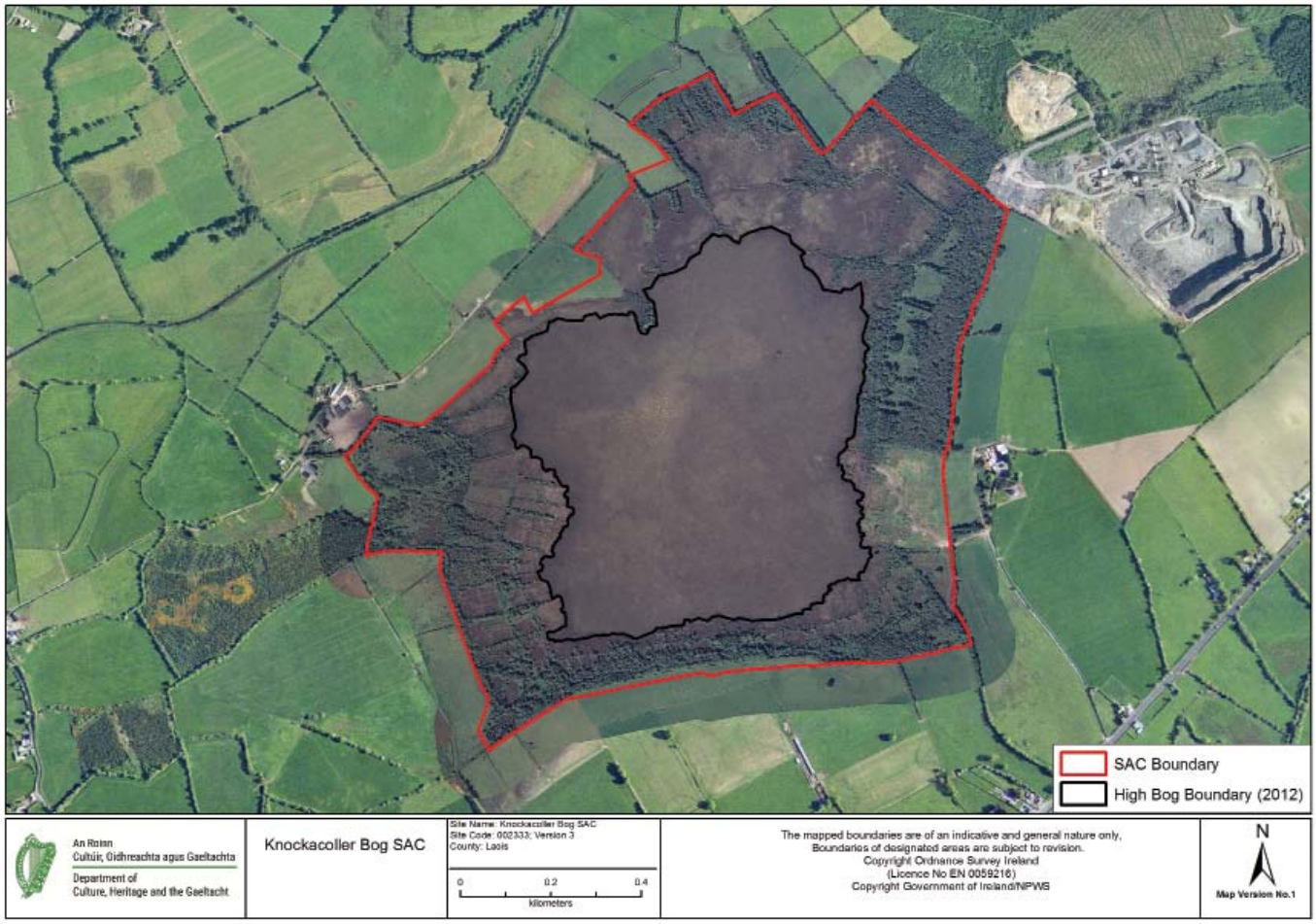


Knockacoller Bog SAC - Summary

Site Name:	Knockacoller Bog SAC
Site Code:	002333
Counties:	Laois
River Basin District:	South Eastern
Sub-Catchment:	Nore_SC_050
Further Information:	http://www.npws.ie/protected-sites/sac/002333

Site Summary:

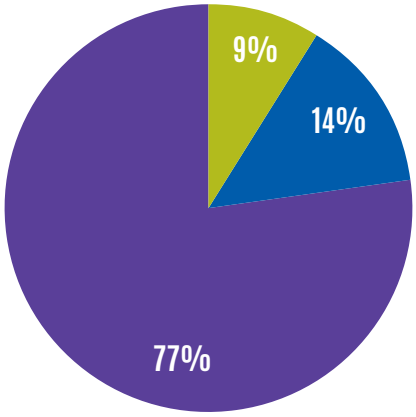
Knockacoller Bog is situated approximately 2 km south west of Castletown, Co. Laois. It is of conservation value due to the occurrence of a moderate area of active raised bog vegetation. The site has been significantly affected by marginal turf-cutting and drainage in the surrounding areas.



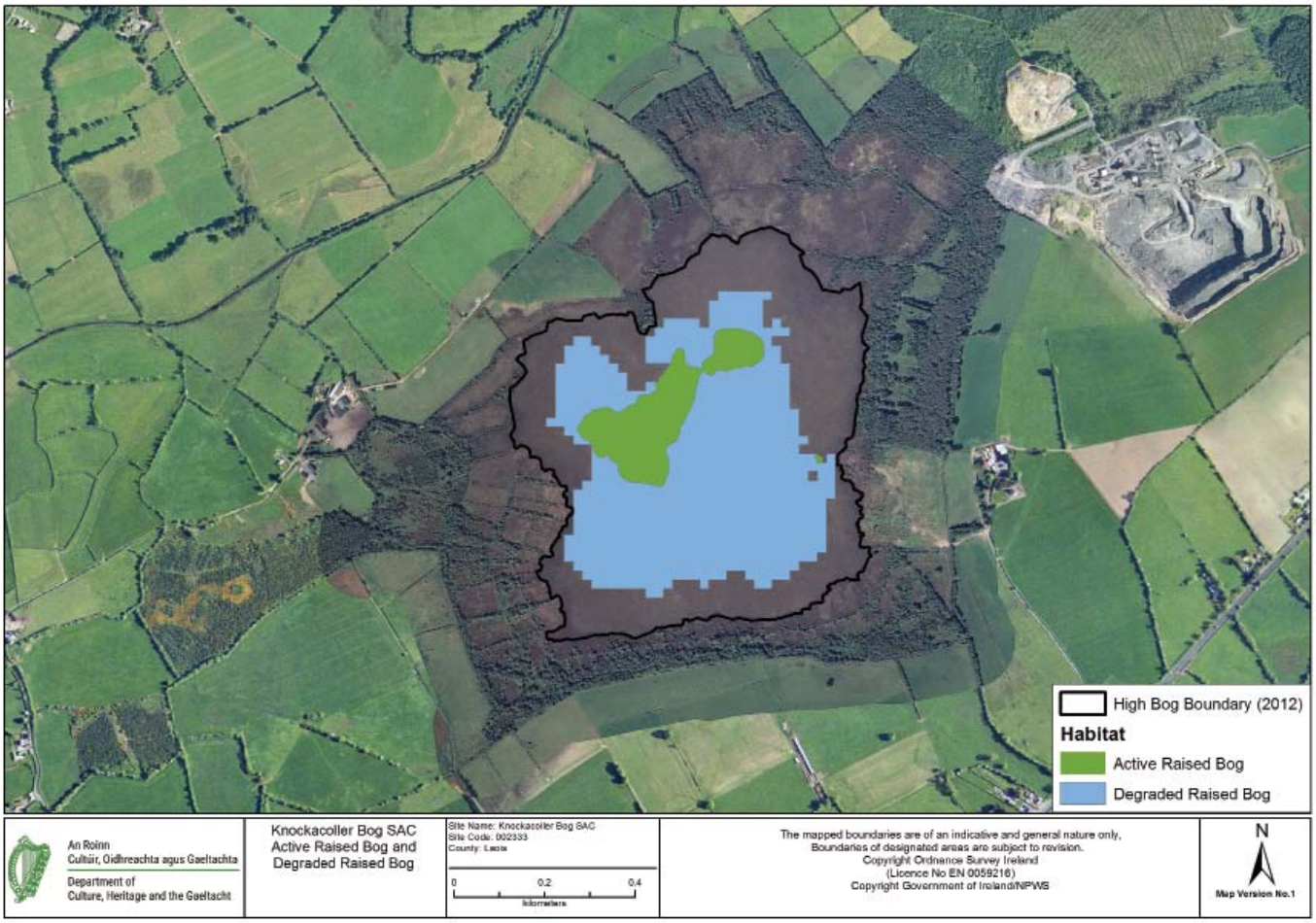
Site Statistics

Area of high bog in 1995 (ha):	54.3
Area of high bog in 2012 (ha):	53.3
Change in high bog (ha):	-1.0
Change in high bog (%):	-1.8%
Area of active raised bog in 1994 (ha) (Kelly et al. 1995)	17.1
Area of active raised bog in 2012 (ha) (Fernandez et al. 2014)	4.8
Change in active raised bog (ha):	-12.3
Change in active raised bog (%):	-71.9%
Area of degraded raised bog (ha):	7.5
Potential area bog peat-forming habitats (ha)	1.2

Composition of High Bog



- Active raised bog
- Degraded raised bog
- Potential supporting high bog habitat

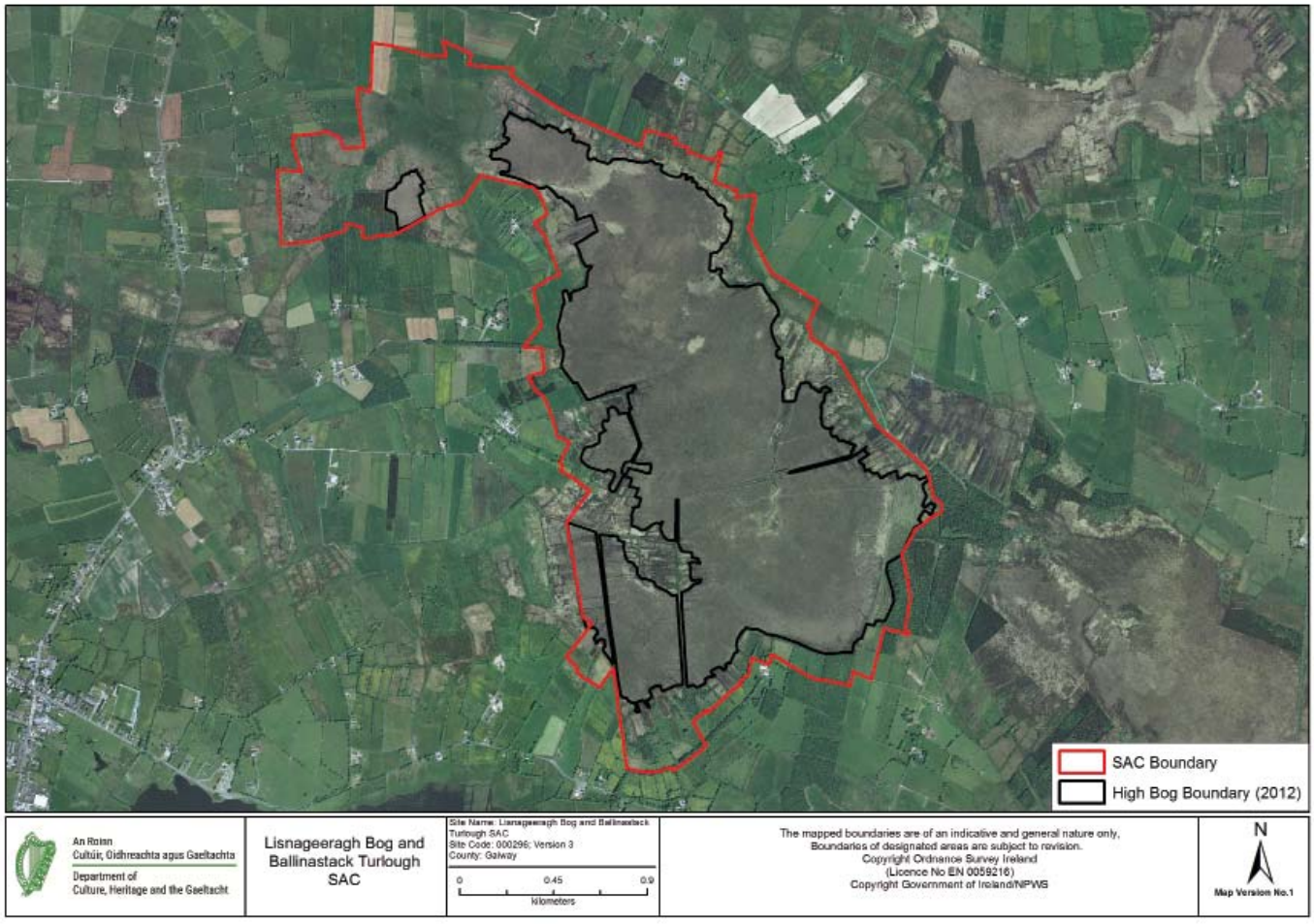


Lisnageeragh Bog and Ballinastack Turlough SAC - Summary

Site Name:	Lisnageeragh Bog and Ballinastack Turlough SAC
Site Code:	000296
Counties:	Galway
River Basin District:	Shannon/Western
Sub-Catchment:	Sinking_SC_010, Suck_SC_020
Further Information:	http://www.npws.ie/protected-sites/sac/000296

Site Summary:

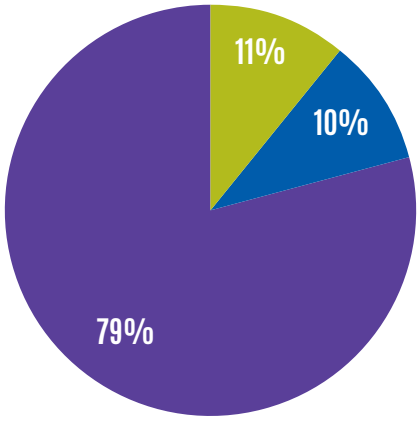
Lisnageeragh Bog comprises a large raised bog and a small turlough, situated about 3 km northeast of Glenamaddy in County Galway. The bog has a large dome with an extensive area of high quality active raised bog. The presence of the small turlough, which is of value to wintering wildfowl, adjoining the bog adds interest to the site. Restoration works in the form of tree removal and drain blocking have been undertaken by Coillte and NPWS which has resulted in a significant increase in the area of active raised bog.



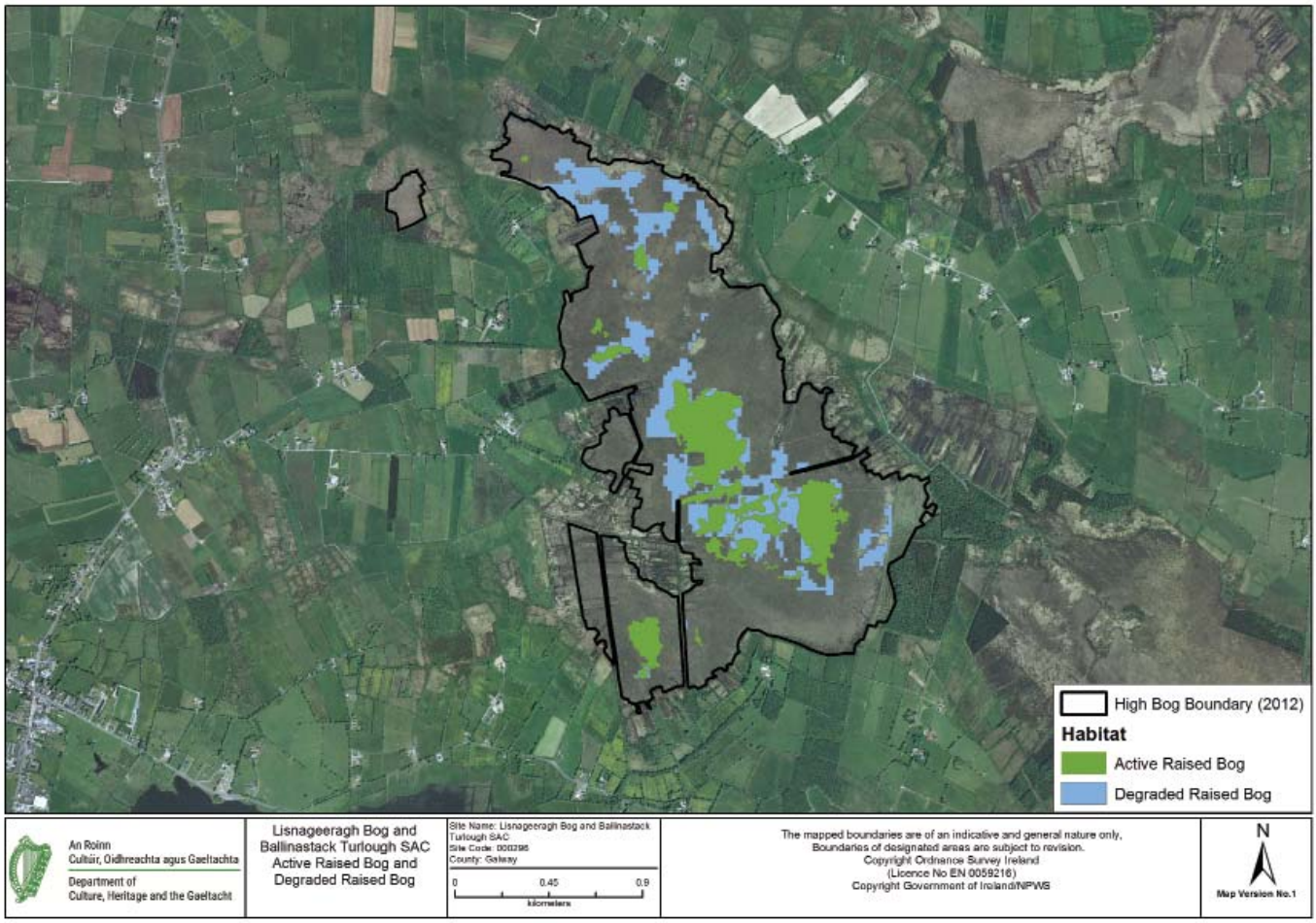
Site Statistics

Area of high bog in 1995 (ha):	270.8
Area of high bog in 2012 (ha):	269.5
Change in high bog (ha):	-1.3
Change in high bog (%):	-0.5%
Area of active raised bog in 1994 (ha) (Kelly et al. 1995)	13
Area of active raised bog in 2012 (ha) (Fernandez et al. 2014)	29.6
Change in active raised bog (ha):	16.6
Change in active raised bog (%):	127.7%
Area of degraded raised bog (ha):	26.6
Potential area bog peat-forming habitats (ha)	2.6

Composition of High Bog



- Active raised bog
- Degraded raised bog
- Potential supporting high bog habitat

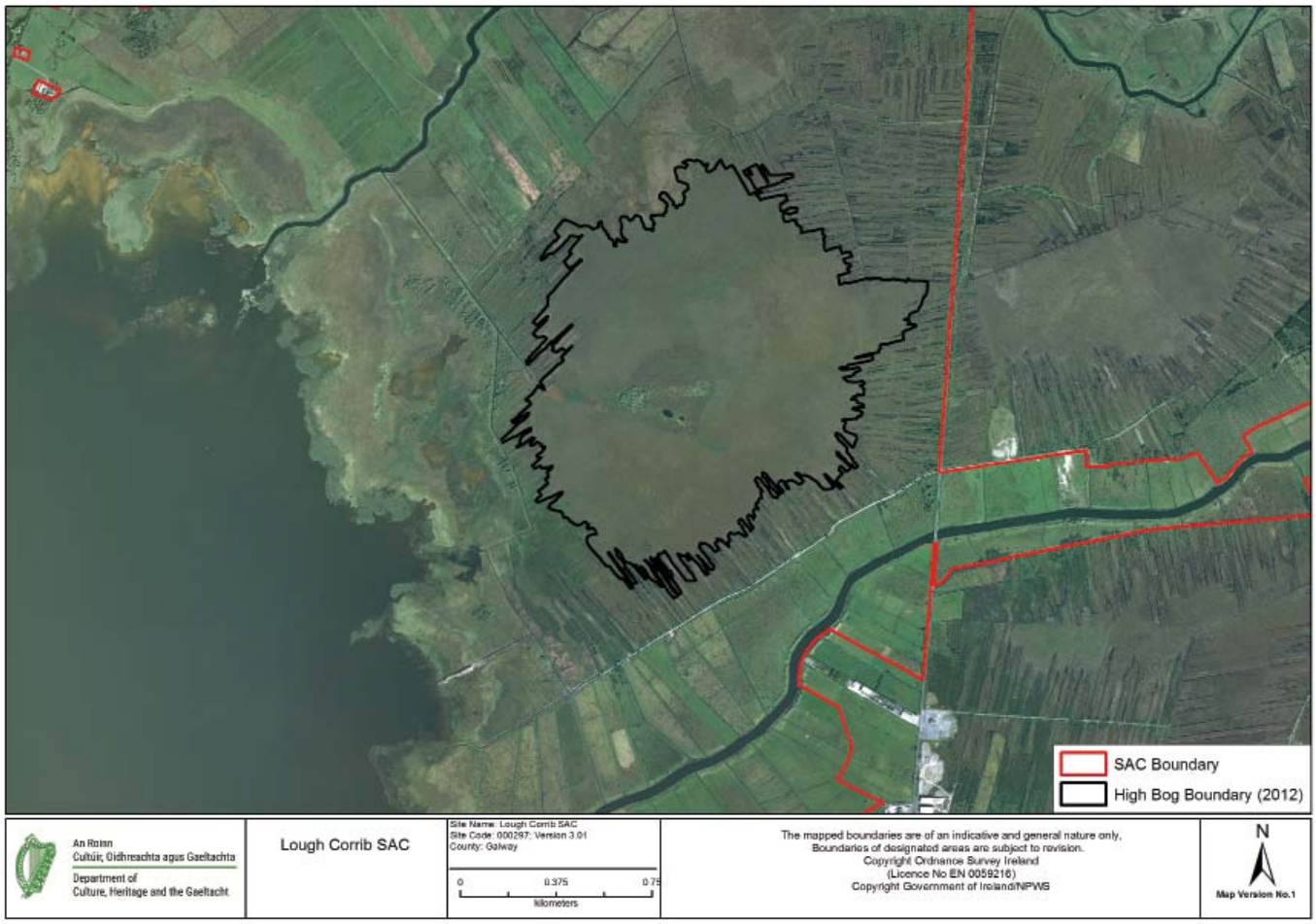


Lough Corrib SAC - Summary

Site Name:	Lough Corrib SAC
Site Code:	000297
Counties:	Galway
River Basin District:	Western
Sub-Catchment:	Clare[Galway]_SC_060, Corrib_SC_010
Further Information:	http://www.npws.ie/protected-sites/sac/000297

Site Summary:

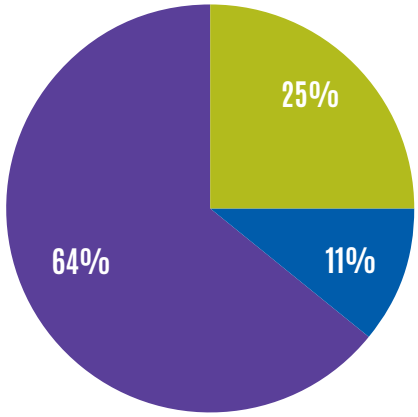
Lough Corrib is situated to the north of Galway city and is the second largest lake in Ireland. Addergoole Bog is located on the eastern shore of Lough Corrib and is one of the most westerly, relatively intact raised bogs in the country. The bog is of high conservation value due to the occurrence of a very extensive area of active raised bog vegetation. A substantial bog lake or soak occurs on the bog surface. This area is associated with an important area of wet bog woodland.

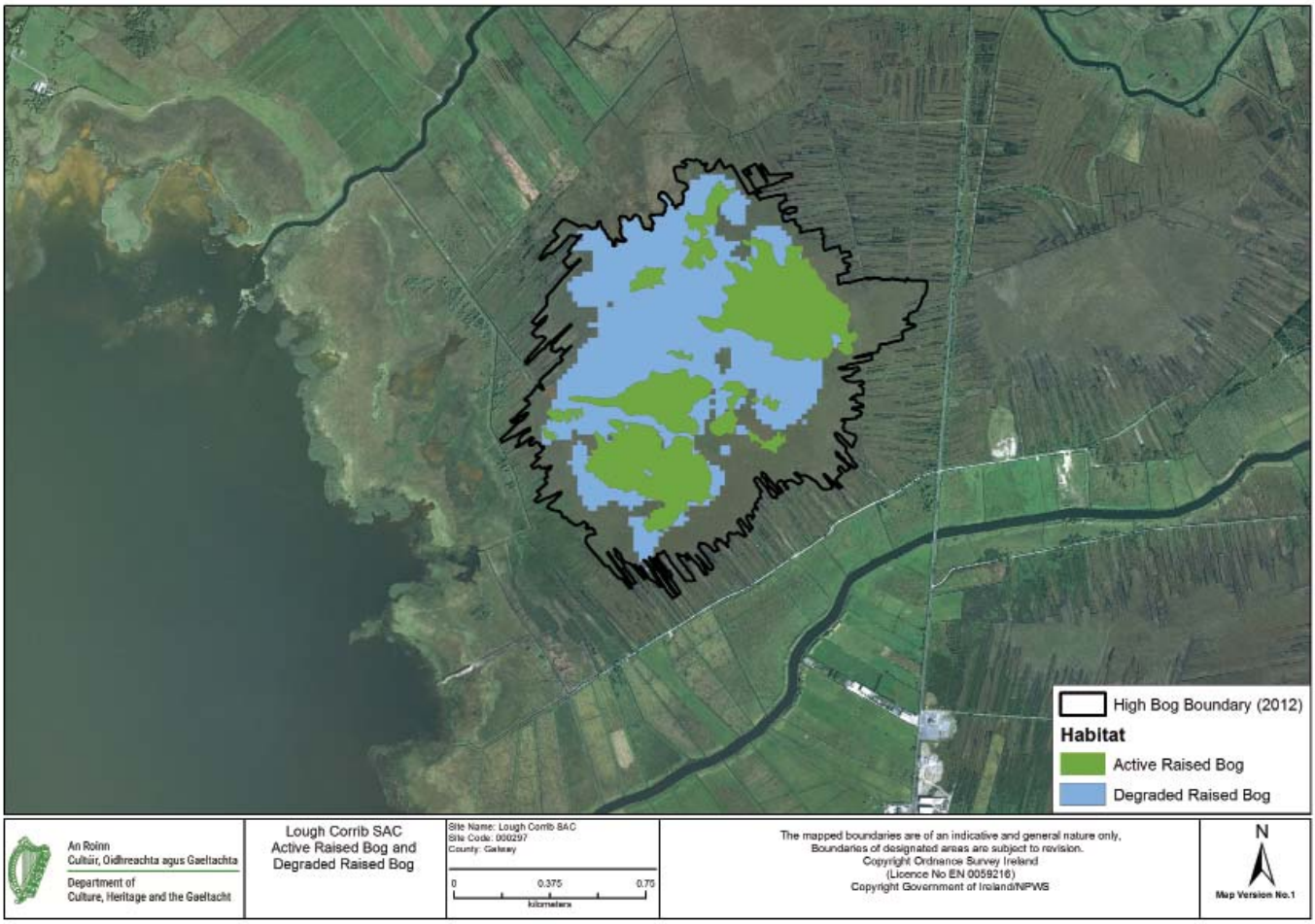


Site Statistics

Area of high bog in 1995 (ha):	161.4
Area of high bog in 2012 (ha):	157.4
Change in high bog (ha):	-4.0
Change in high bog (%):	-2.5%
Area of active raised bog in 1994 (ha) (Kelly et al. 1995*) (*Revised by NPWS in 2014)	59
Area of active raised bog in 2012 (ha) (Fernandez et al. 2014)	39.2
Change in active raised bog (ha):	-19.8
Change in active raised bog (%):	-33.6%
Area of degraded raised bog (ha):	17.7
Potential area bog peat-forming habitats (ha)	7.8

Composition of High Bog



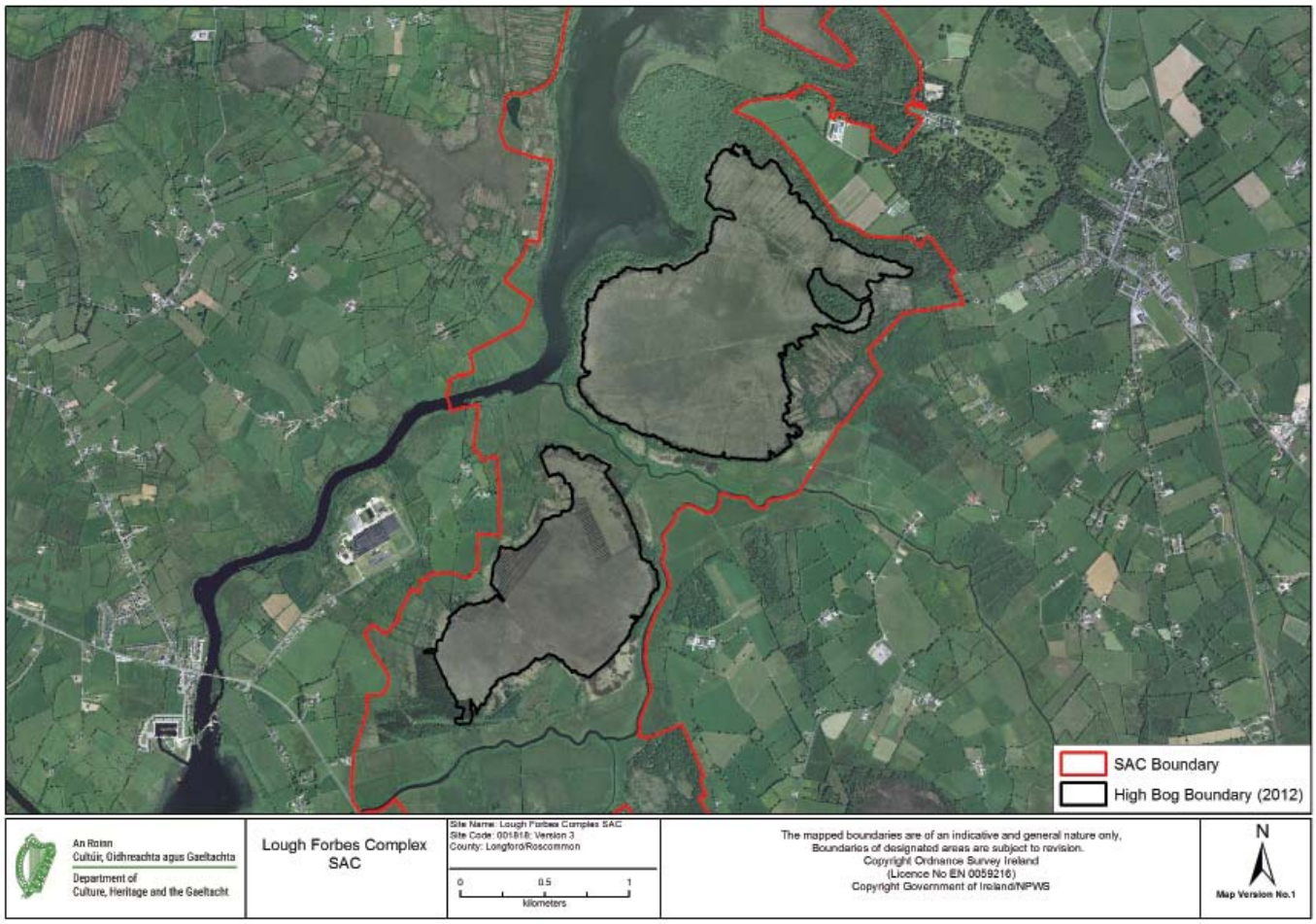


Lough Forbes Complex SAC - Summary

Site Name:	Lough Forbes Complex SAC
Site Code:	001818
Counties:	Longford
River Basin District:	Shannon
Sub-Catchment:	Shannon[Upper]_SC_050, Shannon[Upper]_SC_060
Further Information:	http://www.npws.ie/protected-sites/sac/001818

Site Summary:

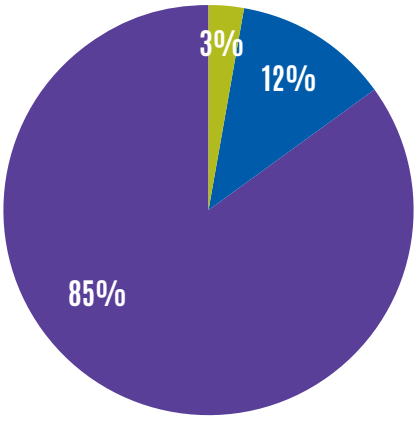
The raised bogs, located on the south-eastern shore of Lough Forbes (Ballykenny & Fishertown) are of international importance as unique examples of Shannon River edge bogs and they are also the most northerly intact bogs adjacent to the River Shannon. The bogs are of conservation value due to the occurrence of a moderate area of active raised bog vegetation. Restoration works in the form of tree removal and drain blocking have been undertaken by Coillte and NPWS.



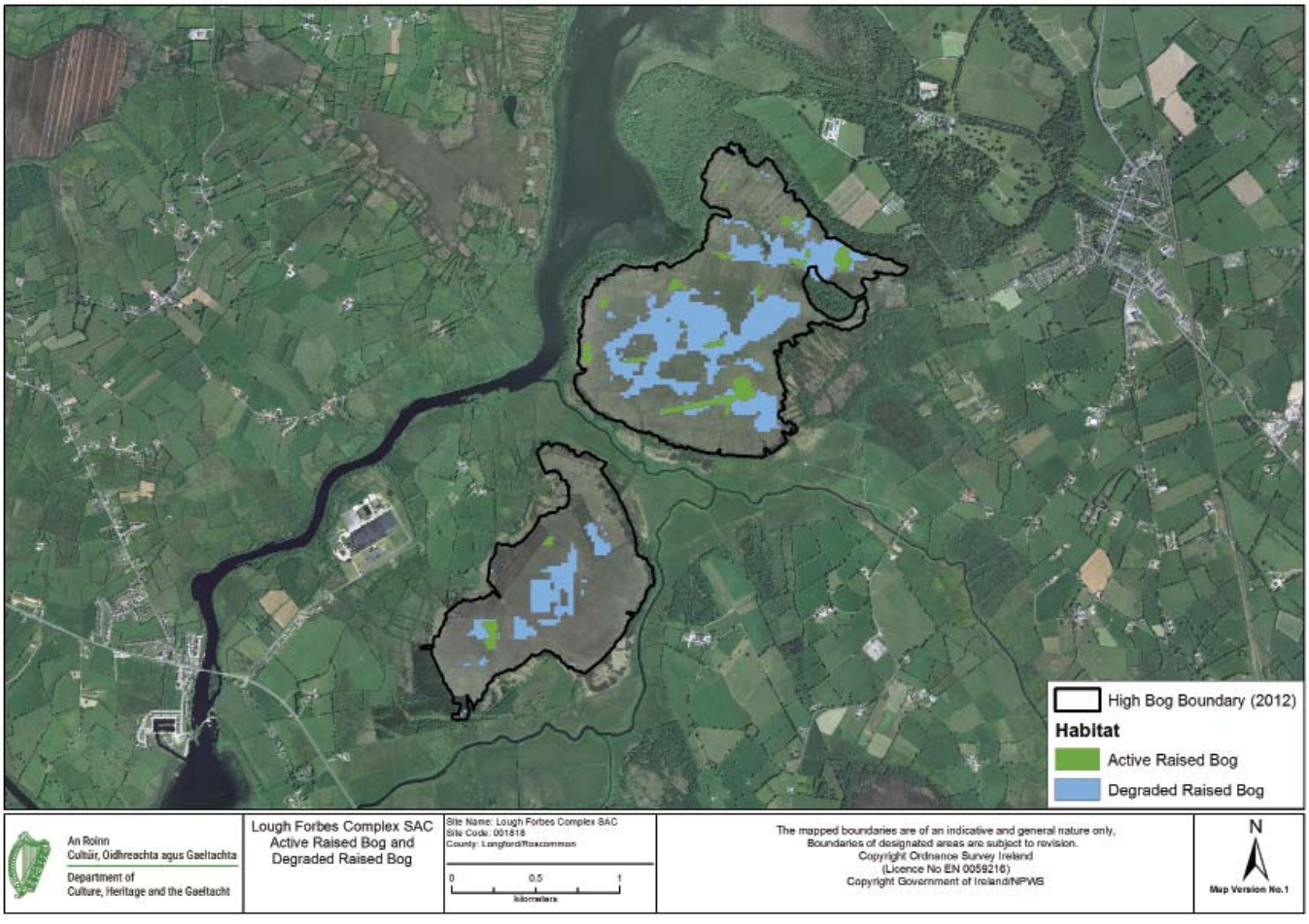
Site Statistics

Area of high bog in 1995 (ha):	283.9
Area of high bog in 2012 (ha):	283.2
Change in high bog (ha):	-0.7
Change in high bog (%):	-0.3%
Area of active raised bog in Ballykenny Bog 1994 (ha) (Kelly et al. 1995)& Fisherstown Bog 1994 (ha)(Kelly et al. 1995*) (*Revised by NPWS in 2014)	80.4
Area of active raised bog in Ballykenny Bog 2011 (ha) (Fernandez et al. 2012). Area of active raised bog in Fisherstown Bog 2012 (ha) (Fernandez et al. 2014).	9.0
Change in active raised bog (ha):	-71.4
Change in active raised bog (%):	-88.8%
Area of degraded raised bog (ha):	33.5
Potential area bog peat-forming habitats (ha)	1.0

Composition of High Bog



- Active raised bog
- Degraded raised bog
- Potential supporting high bog habitat

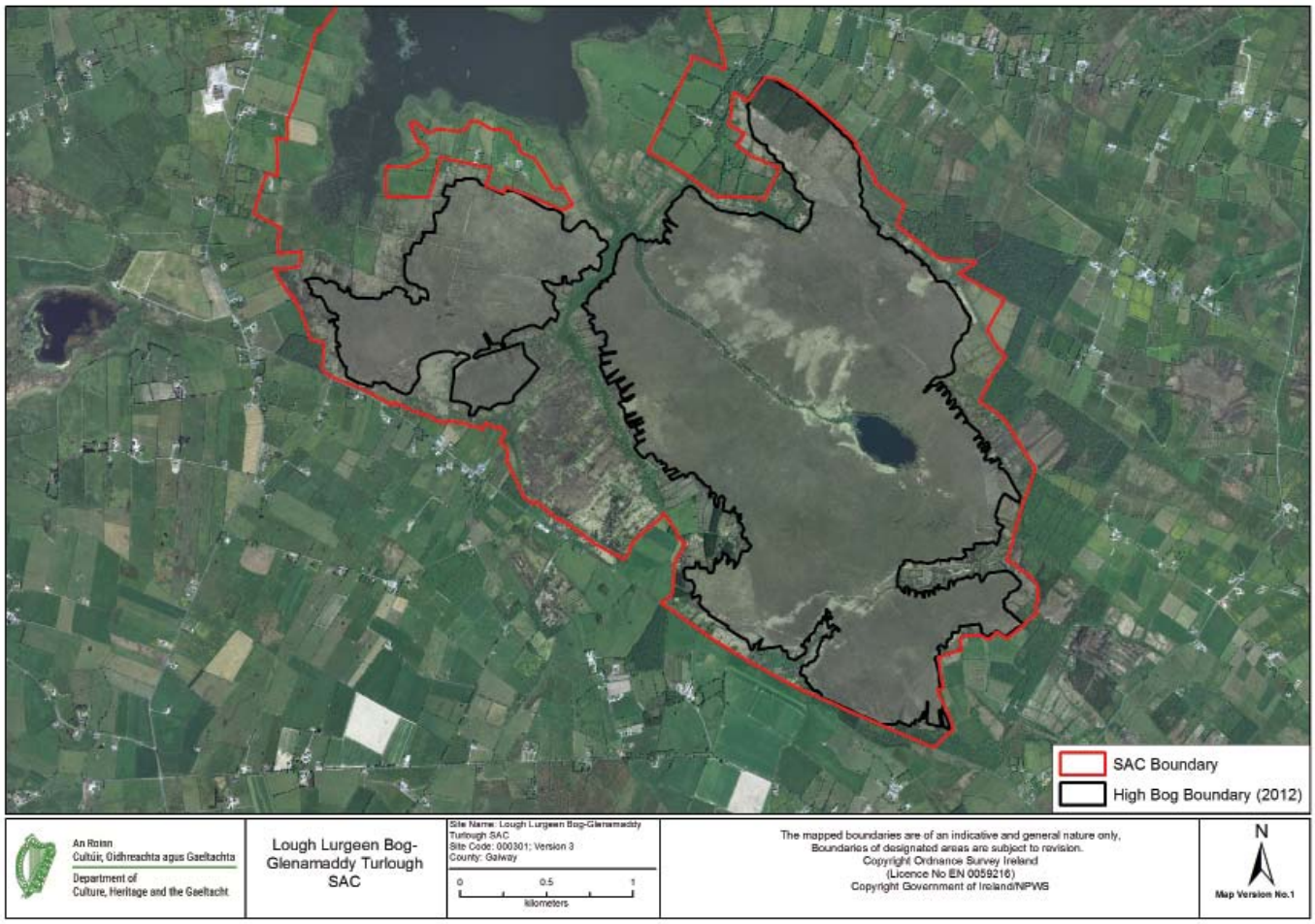


Lough Lurgeen Bog/Glenamaddy Turlough SAC - Summary

Site Name:	Lough Lurgeen Bog/Glenamaddy Turlough SAC
Site Code:	000301
Counties:	Galway
River Basin District:	Shannon / Western
Sub-Catchment:	Sinking_SC_010, Suck_SC_050
Further Information:	http://www.npws.ie/protected-sites/sac/000301

Site Summary:

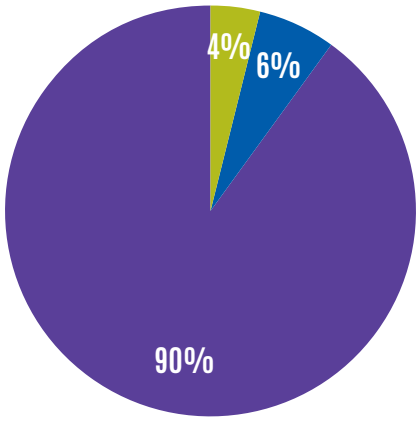
Lough Lurgeen Bog/Glenamaddy Turlough is situated east of the town of Glenamaddy. Lough Lurgeen Bog is of high conservation value due to the occurrence of a significant area of active raised bog vegetation. The presence of a turlough adjacent to the bog and a lake within the bog also adds interest to the site. Restoration works in the form of tree removal and drain blocking have been undertaken by Coillte.

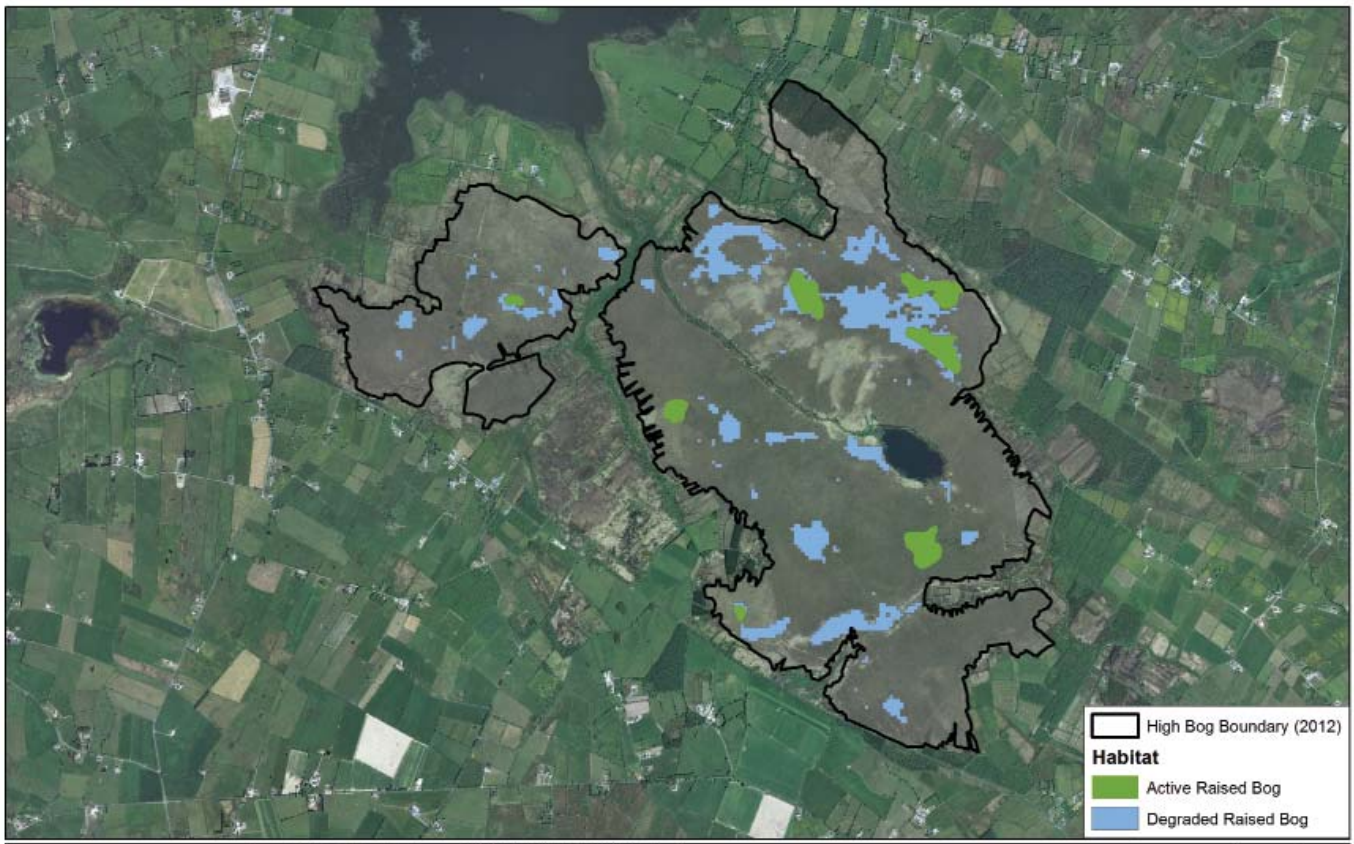


Site Statistics

Area of high bog in 1995 (ha):	616.3
Area of high bog in 2012 (ha):	613.5
Change in high bog (ha):	-2.8
Change in high bog (%):	-0.5%
No earlier survey available	N/A
Area of active raised bog in Lough Lurgeen East 1994 (ha) (Kelly et al. 1995*) & Lough Lurgeen West in 2004 (Fernandez et al. 2006) (*Revised by NPWS in 2014)	21.5
Change in active raised bog (ha):	N/A
Change in active raised bog (%):	N/A
Area of degraded raised bog (ha):	39.2
Potential area bog peat-forming habitats (ha)	2.2

Composition of High Bog



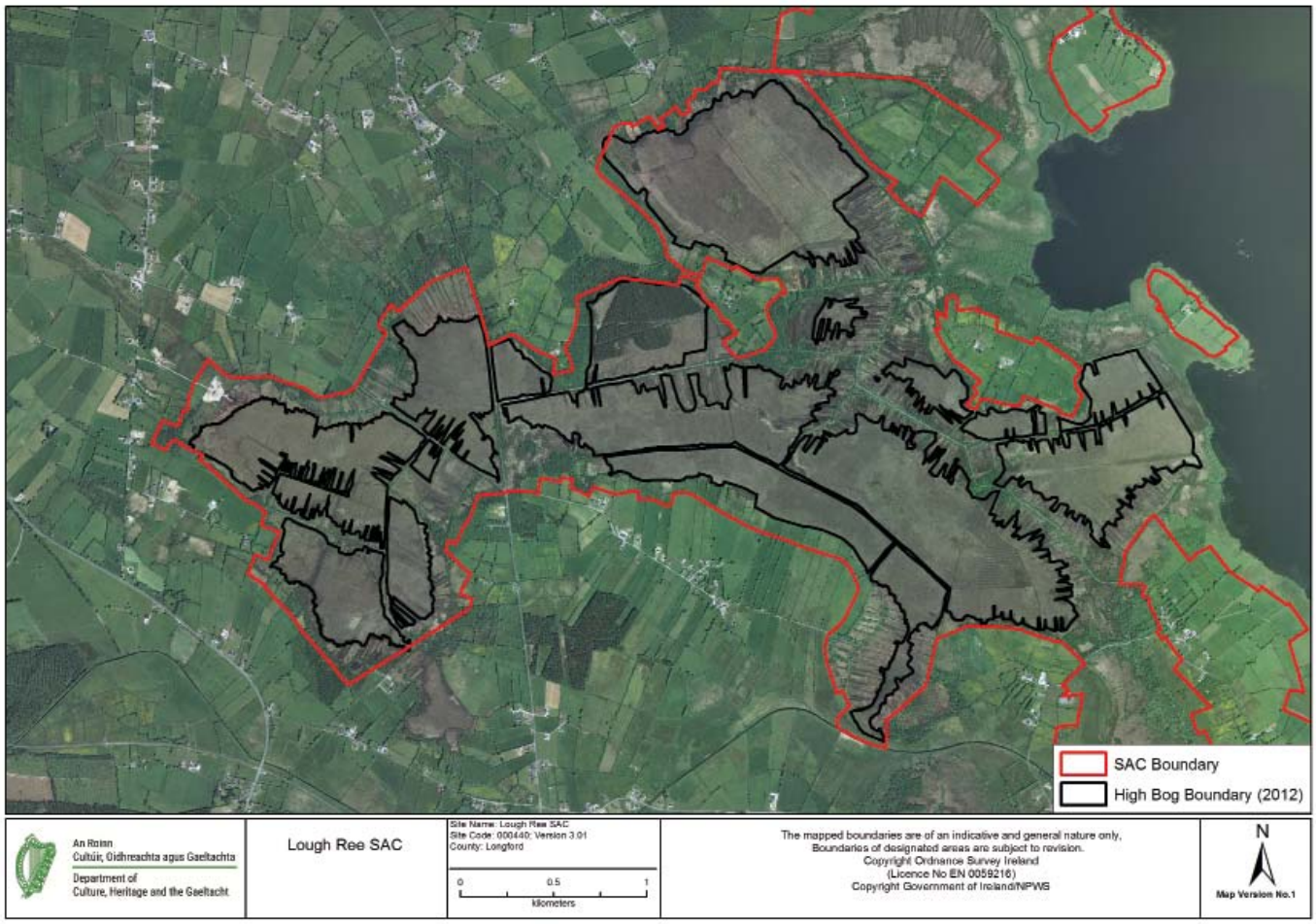


Lough Ree SAC - Summary

Site Name:	Lough Ree SAC
Site Code:	000440
Counties:	Roscommon
River Basin District:	Shannon
Sub-Catchment:	Clooneigh_SC_010, Shannon[Upper]_SC_090, Hind_SC_010
Further Information:	http://www.npws.ie/protected-sites/sac/000440

Site Summary:

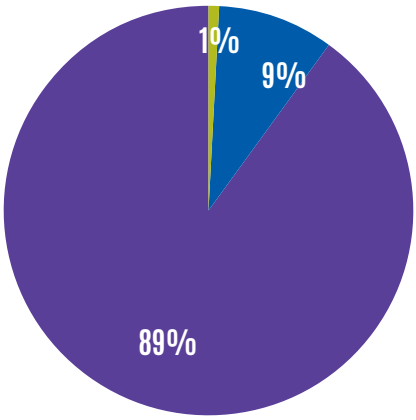
Lough Ree is the third largest lake in the Republic of Ireland and is situated between Lanesborough and Athlone. Clooncraff and Cloonlarge Bogs are of high conservation value due to the occurrence of a moderate area of active raised bog vegetation. A large flush feature and occurance of bog woodland adds interest to the site. Restoration works in the form of tree removal and drain blocking have been undertaken by Coillte.



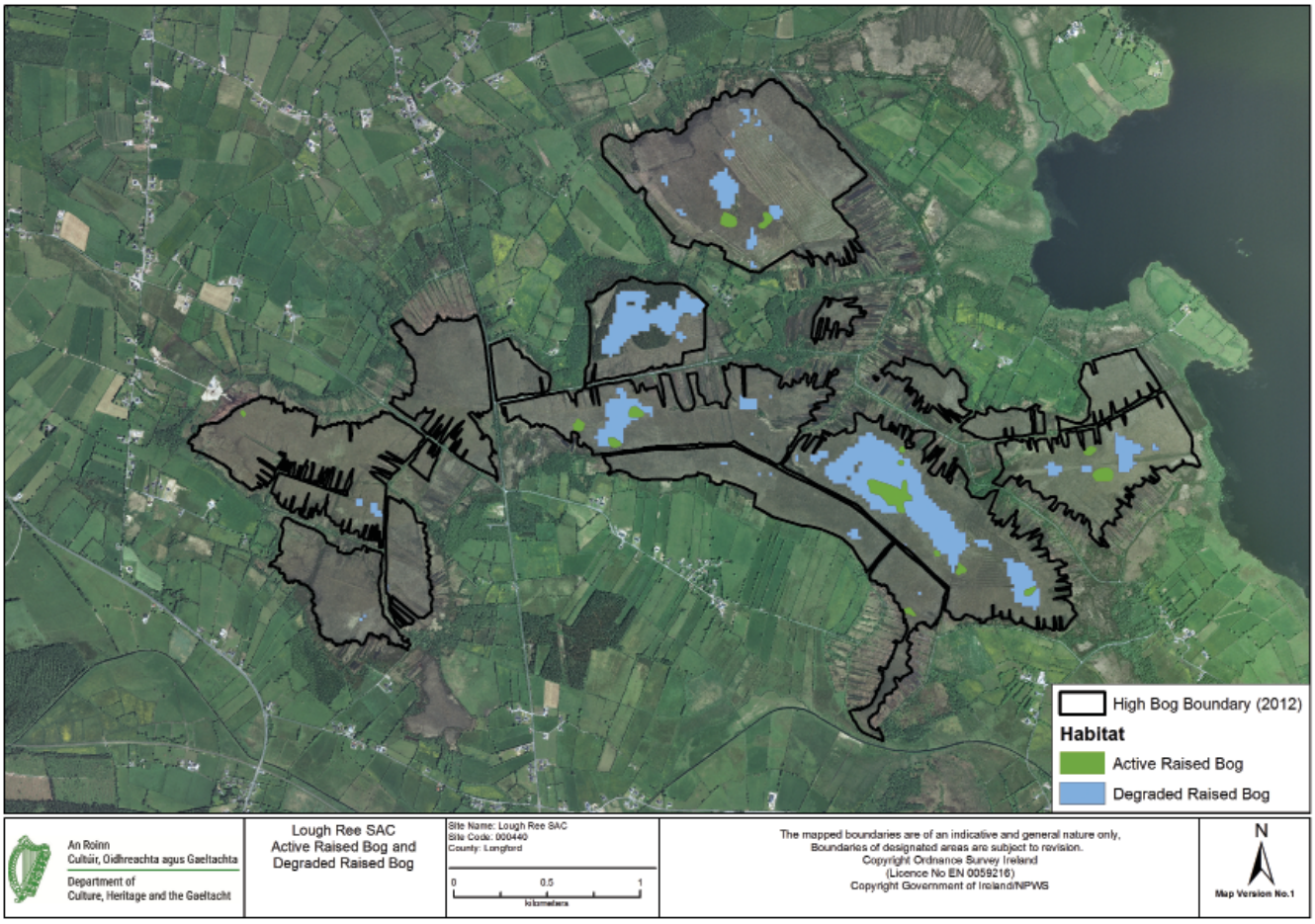
Site Statistics

Area of high bog in 1995 (ha):	501.9
Area of high bog in 2012 (ha):	474.5
Change in high bog (ha):	-27.4
Change in high bog (%):	-5.5%
No earlier survey available	N/A
Area of active raised bog in 2003 (Fernandez et al. 2006)	5.9
Change in active raised bog (ha):	N/A
Change in active raised bog (%):	N/A
Area of degraded raised bog (ha):	44.7
Potential area bog peat-forming habitats (ha)	19.5

Composition of High Bog



- Active raised bog
- Degraded raised bog
- Potential supporting high bog habitat

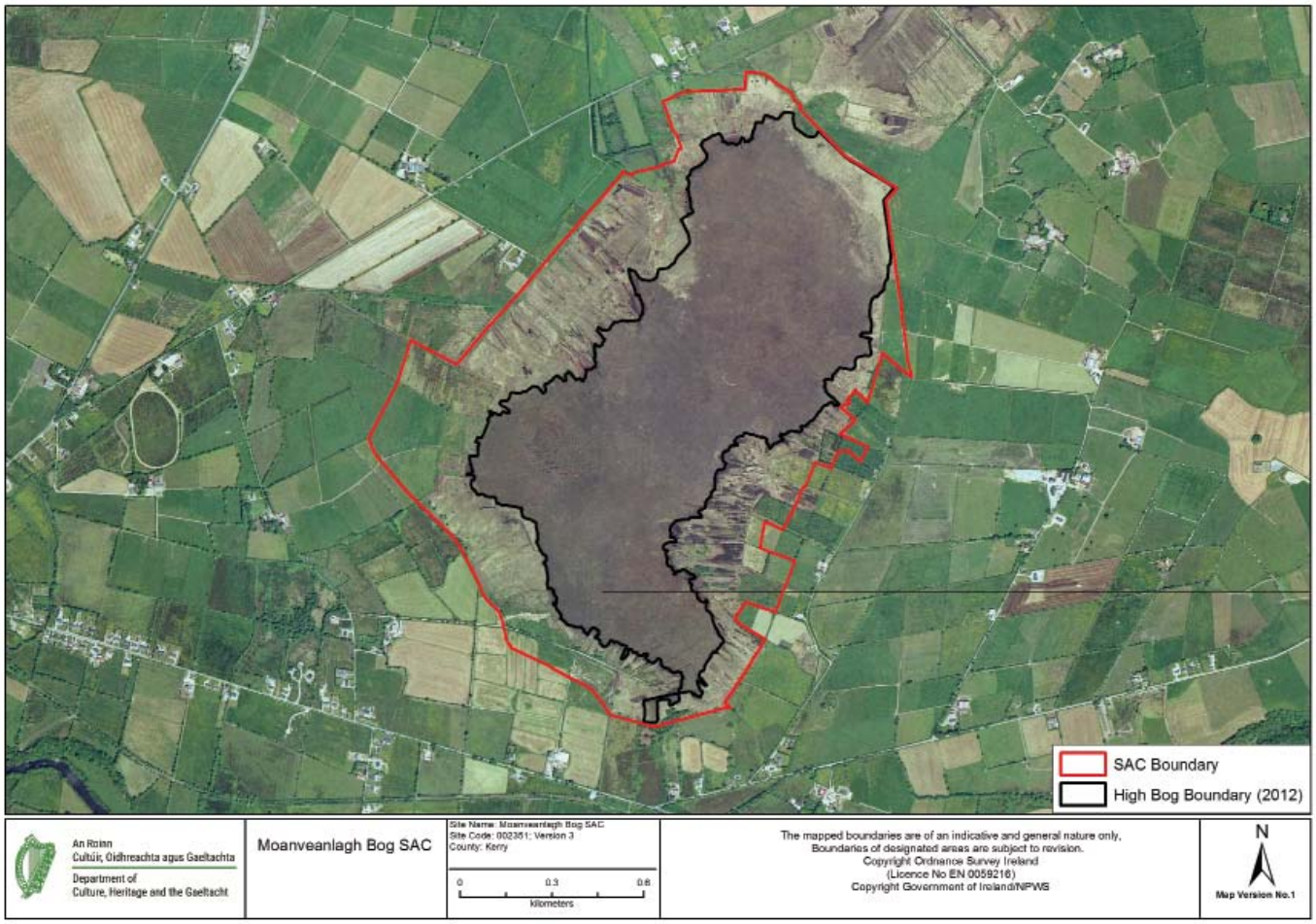


Moanveanlagh Bog SAC - Summary

Site Name:	Moanveanlagh Bog SAC
Site Code:	002351
Counties:	Kerry
River Basin District:	Shannon
Sub-Catchment:	Galey_SC_010, Feale_SC_040
Further Information:	http://www.npws.ie/protected-sites/sac/002351

Site Summary:

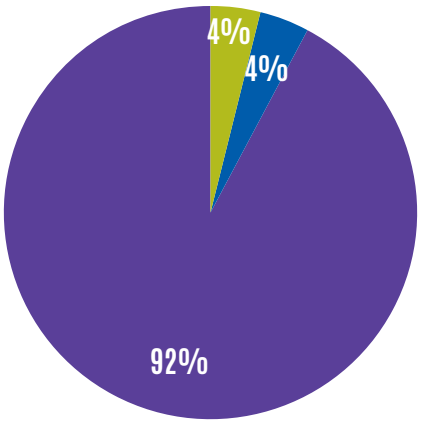
Moanveanlagh Bog is situated in Co. Kerry approximately 6 km east of Listowel. The bog retains a small area of active raised bog vegetation. The bog is also of importance as it is one of the only relatively intact bogs in the south-west of Ireland. The site has however been affected by ongoing turf-cutting and drainage.

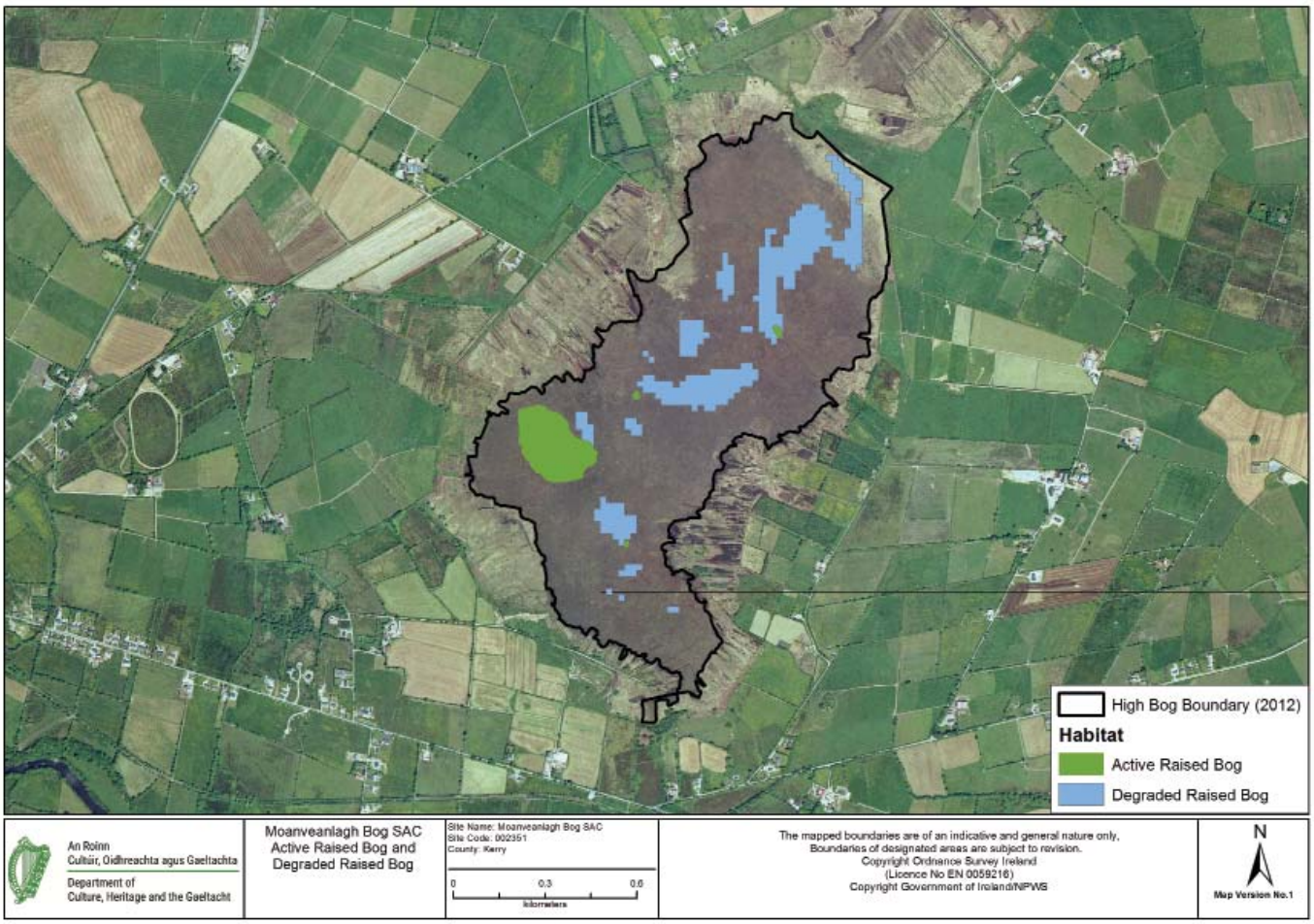


Site Statistics

Area of high bog in 1995 (ha):	119.6
Area of high bog in 2012 (ha):	117.4
Change in high bog (ha):	-2.2
Change in high bog (%):	-1.8%
Area of active raised bog in 1994 (ha) (Kelly et al. 1995*) (*Revised by NPWS in 2014)	4.6
Area of active raised bog in 2012 (ha) (Fernandez et al. 2014)	4.6
Change in active raised bog (ha):	0
Change in active raised bog (%):	0%
Area of degraded raised bog (ha):	4.4
Potential area bog peat-forming habitats (ha)	3.8

Composition of High Bog



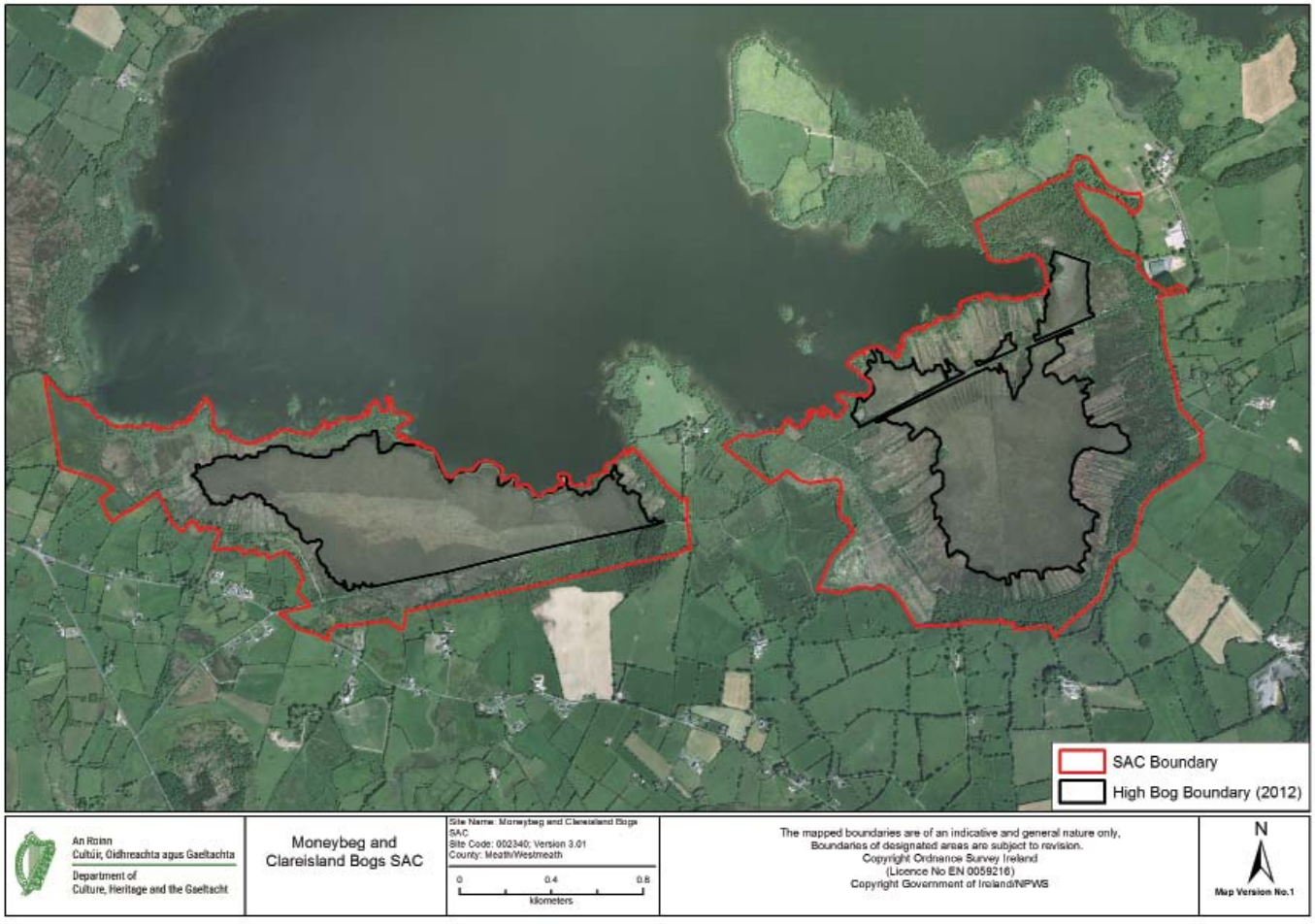


Moneybeg and Clareisland Bogs SAC - Summary

Site Name:	Moneybeg and Clareisland Bogs SAC
Site Code:	002340
Counties:	Meath / Westmeath
River Basin District:	Shannon
Sub-Catchment:	Inny[Shannon]_SC_010
Further Information:	http://www.npws.ie/protected-sites/sac/002340

Site Summary:

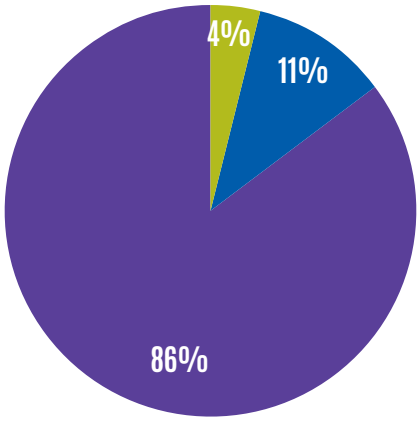
Moneybeg and Clareisland Bogs are located on the border of Counties Meath and Westmeath 9 km east of the town of Granard. The site consists of two lowland raised bogs on the shores of Lough Sheelin at Moneybeg and Clareisland. These bogs are of high conservation value due to the occurrence of a small area of active raised bog. An important feature of these bogs is that in some areas the transition from high bog to open water is intact and not separated by cutover. Restoration works in the form of tree removal and drain blocking have recently been undertaken by Coillte.



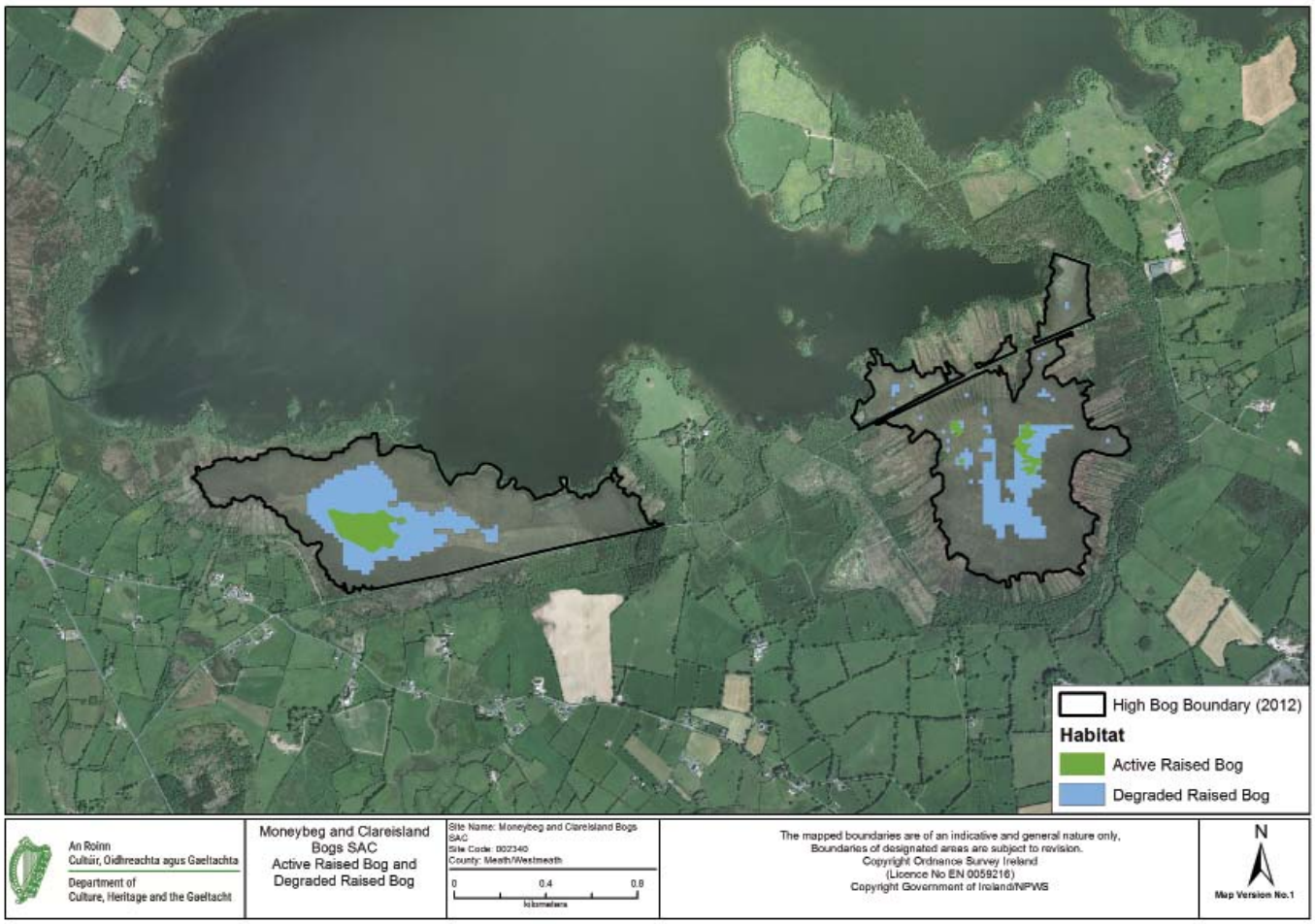
Site Statistics

Area of high bog in 1995 (ha):	149.8
Area of high bog in 2012 (ha):	141.5
Change in high bog (ha):	-8.3
Change in high bog (%):	-5.5%
Area of active raised bog in 2000 (ha) (Derwin & MacGowan, 2000*) (*Revised by NPWS in 2014)	39.9
Area of active raised bog in 2015 (ha) (Crowley and Crushell, 2015)	5.3
Change in active raised bog (ha):	-34.6
Change in active raised bog (%):	-86.7%
Area of degraded raised bog (ha):	14.8
Potential area bog peat-forming habitats (ha)	11.6

Composition of High Bog



- Active raised bog
- Degraded raised bog
- Potential supporting high bog habitat

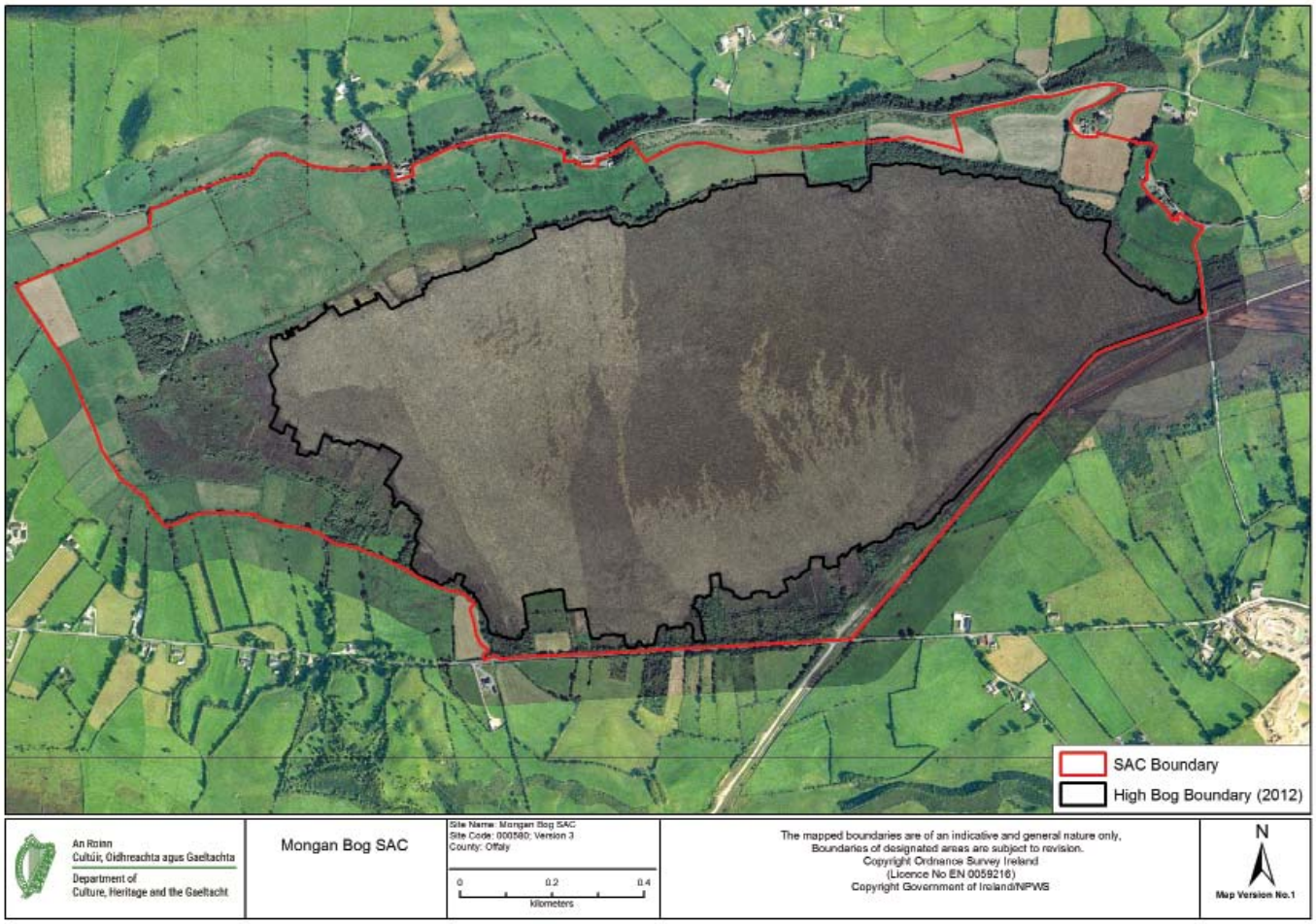


Mongan Bog SAC - Summary

Site Name:	Mongan Bog SAC
Site Code:	000580
Counties:	Offaly
River Basin District:	Shannon
Sub-Catchment:	Shannon[Lower]_SC_030, Shannon[Lower]_SC_010
Further Information:	http://www.npws.ie/protected-sites/sac/000580

Site Summary:

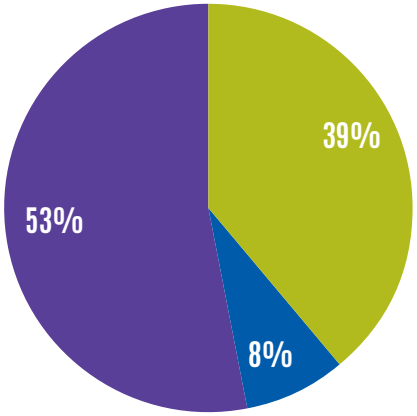
Mongan Bog is a midland raised bog of medium size situated immediately east of the monastic site of Clonmacnoise, Co. Offaly. Mongan Bog is of high conservation value due to the occurrence of a very extensive area of active raised bog. The bog has a very well-developed surface of hummocks, pools and lawns. It has several features of special zoological interest. Restoration works in the form of drain blocking have recently been undertaken by NPWS.



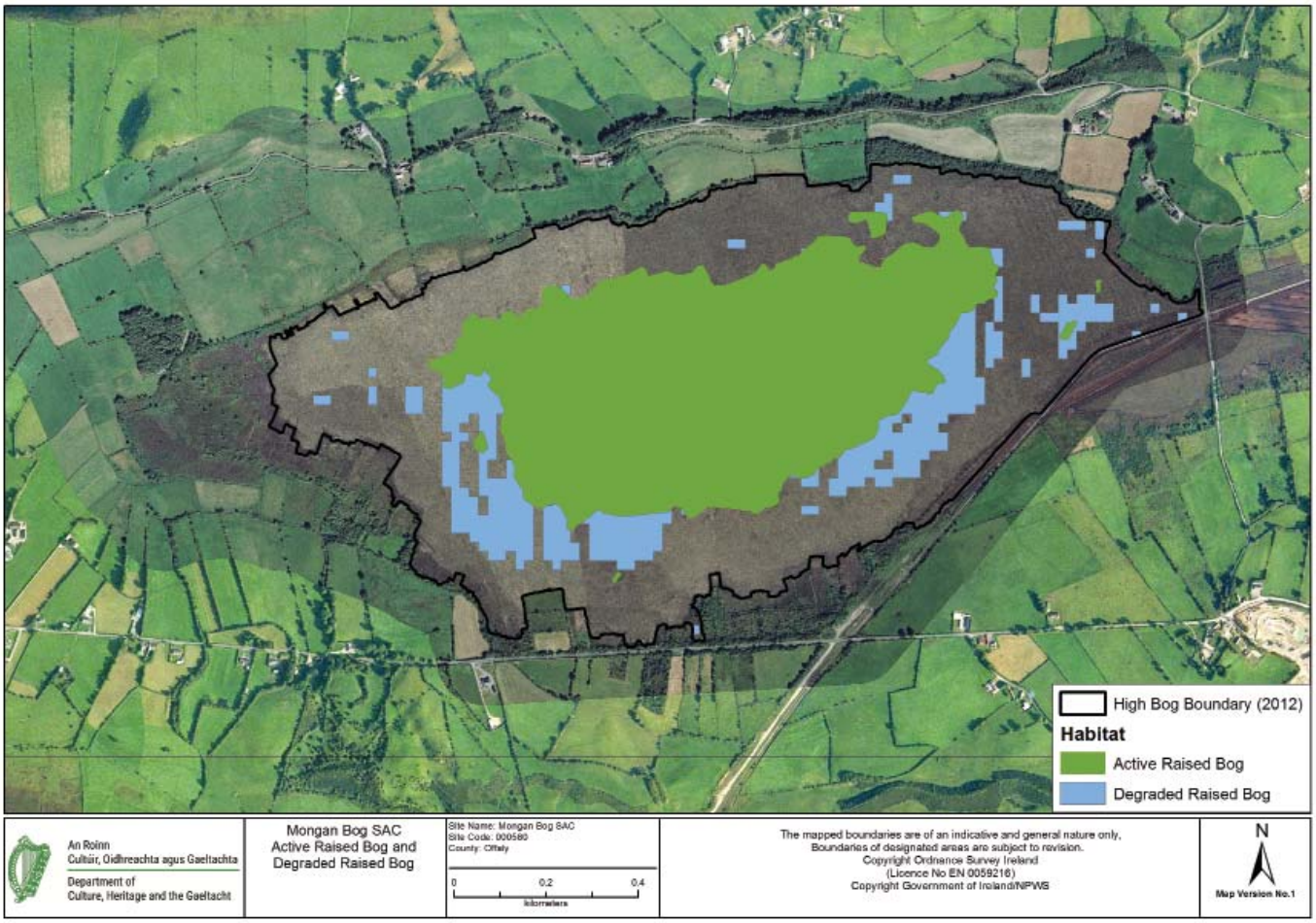
Site Statistics

Area of high bog in 1995 (ha):	124.4
Area of high bog in 2012 (ha):	124.4
Change in high bog (ha):	0.0
Change in high bog (%):	0.0%
Area of active raised bog in 1994 (ha) (Kelly et al. 1995)	50.9
Area of active raised bog in 2011 (ha) (Fernandez et al. 2012)	48.3
Change in active raised bog (ha):	-2.6
Change in active raised bog (%):	-5.1%
Area of degraded raised bog (ha):	10.4
Potential area bog peat-forming habitats (ha)	4.1

Composition of High Bog



- Active raised bog
- Degraded raised bog
- Potential supporting high bog habitat

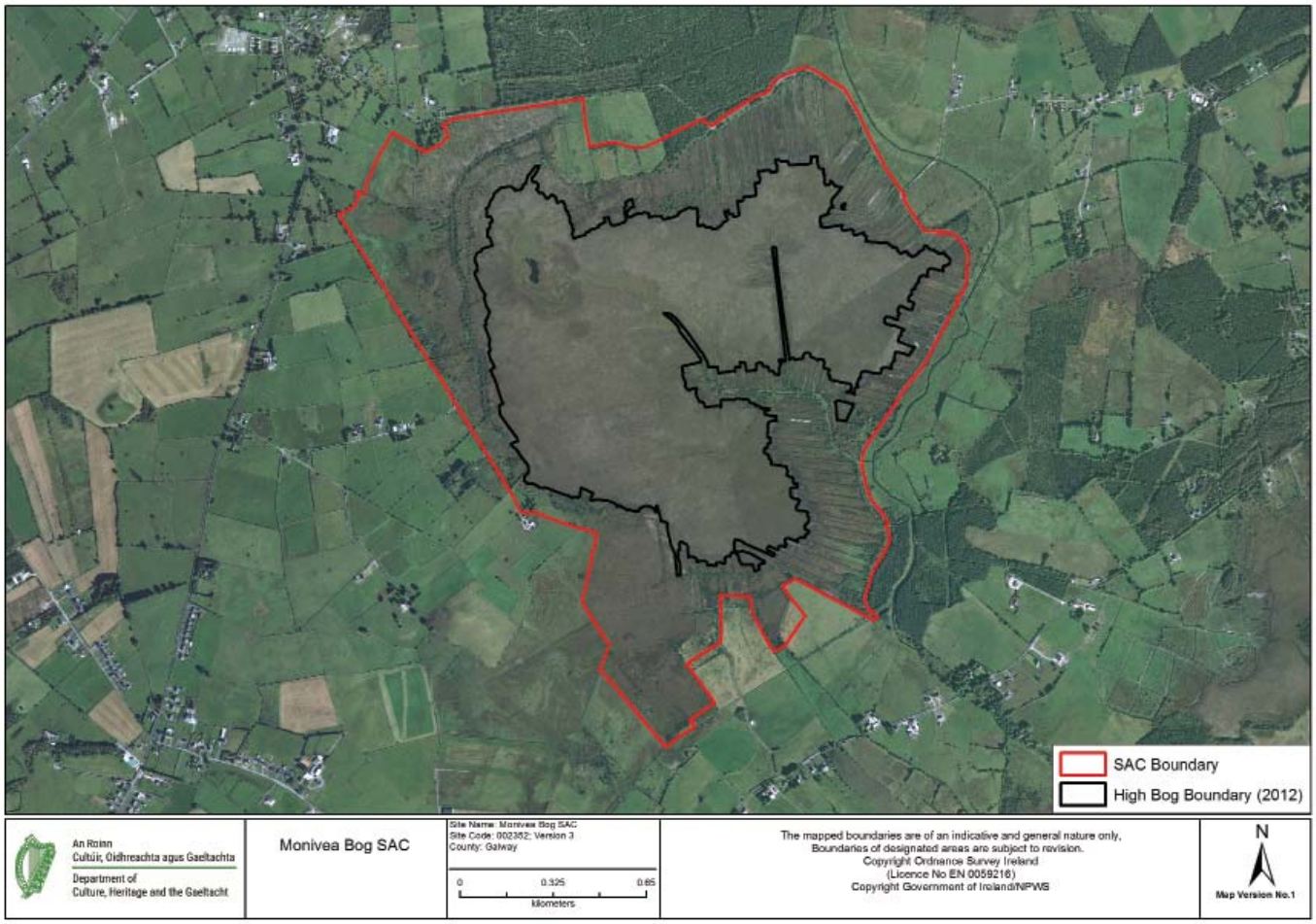


Monivea Bog SAC - Summary

Site Name:	Monivea Bog SAC
Site Code:	002352
Counties:	Galway
River Basin District:	Western
Sub-Catchment:	Clare[Galway]_SC_050
Further Information:	http://www.npws.ie/protected-sites/sac/002352

Site Summary:

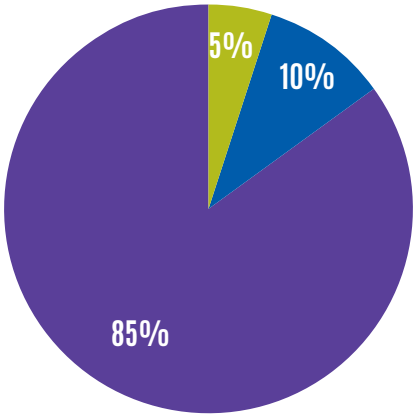
Monivea Bog is situated approximately 5 km north-east of Athenry, Co. Galway. Monivea Bog is a good example of a western raised bog with a central area of active raised bog. The presence of a small internal lake and natural drainage features adds interest to the site. Restoration works in the form of tree removal and drain blocking have recently been undertaken by Coillte.



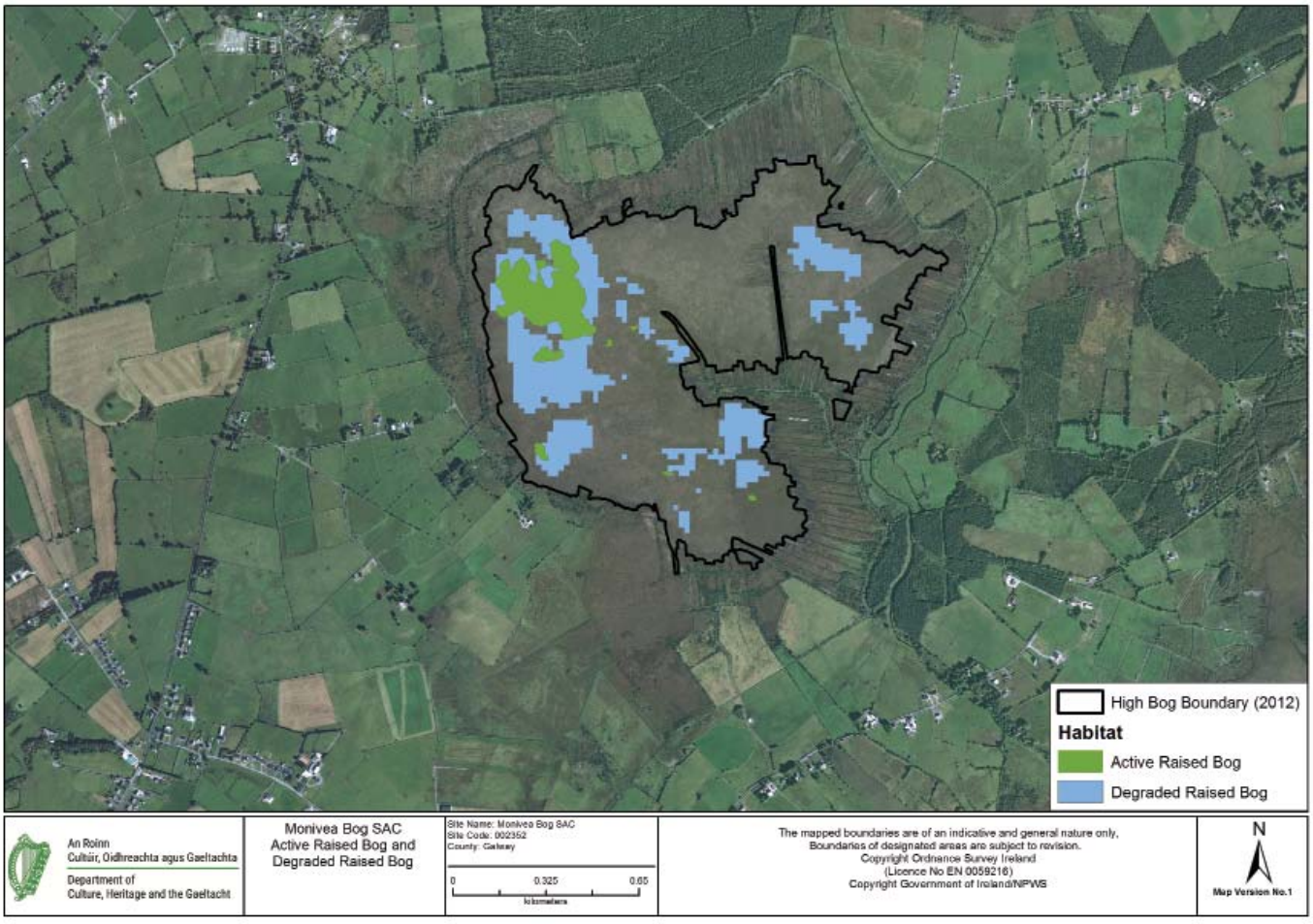
Site Statistics

Area of high bog in 1995 (ha):	140.6
Area of high bog in 2012 (ha):	130.6
Change in high bog (ha):	-10.0
Change in high bog (%):	-7.1%
Area of active raised bog in 1994 (ha) (Kelly et al. 1995)	4.1
Area of active raised bog in 2012 (ha) (Fernandez et al. 2014)	7.0
Change in active raised bog (ha):	2.9
Change in active raised bog (%):	70.7%
Area of degraded raised bog (ha):	12.9
Potential area bog peat-forming habitats (ha)	12.1

Composition of High Bog



- Active raised bog
- Degraded raised bog
- Potential supporting high bog habitat

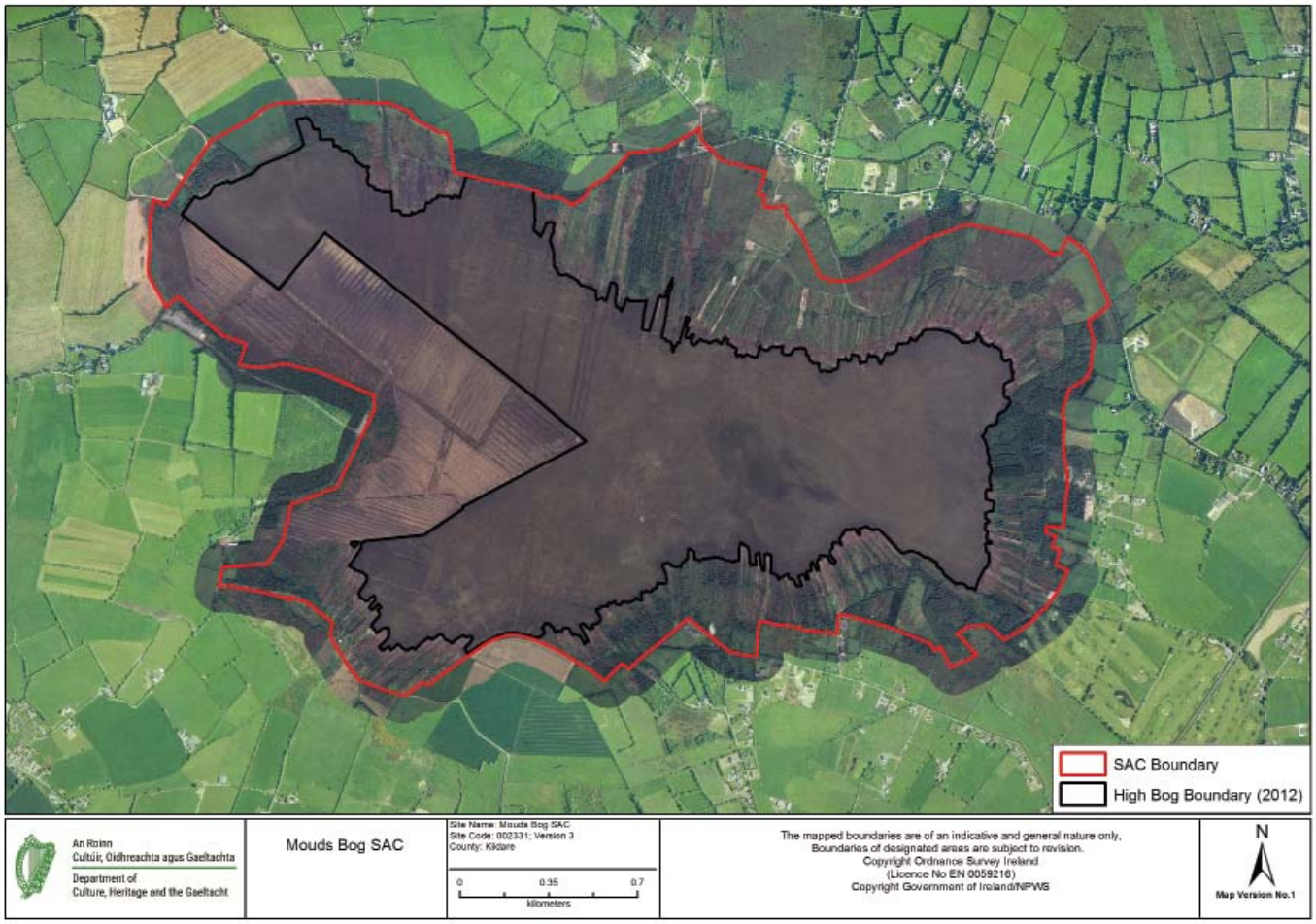


Mouds Bog SAC - Summary

Site Name:	Mouds Bog SAC
Site Code:	002331
Counties:	Kildare
River Basin District:	Eastern/South Eastern
Sub-Catchment:	Slate_SC_010, Liffey_SC_040
Further Information:	http://www.npws.ie/protected-sites/sac/002331

Site Summary:

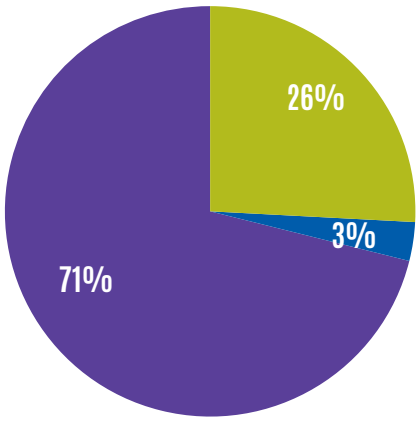
Mouds Bog (an example of a Midland Raised Bog) is located about 3 km north-west of Newbridge in Co. Kildare, close to the Hill of Allen. The bog comprises a large dome with a very extensive area of active raised bog recorded during the most recent surveys. The site is also of interest as an example of one of Ireland's most eastern raised bogs.



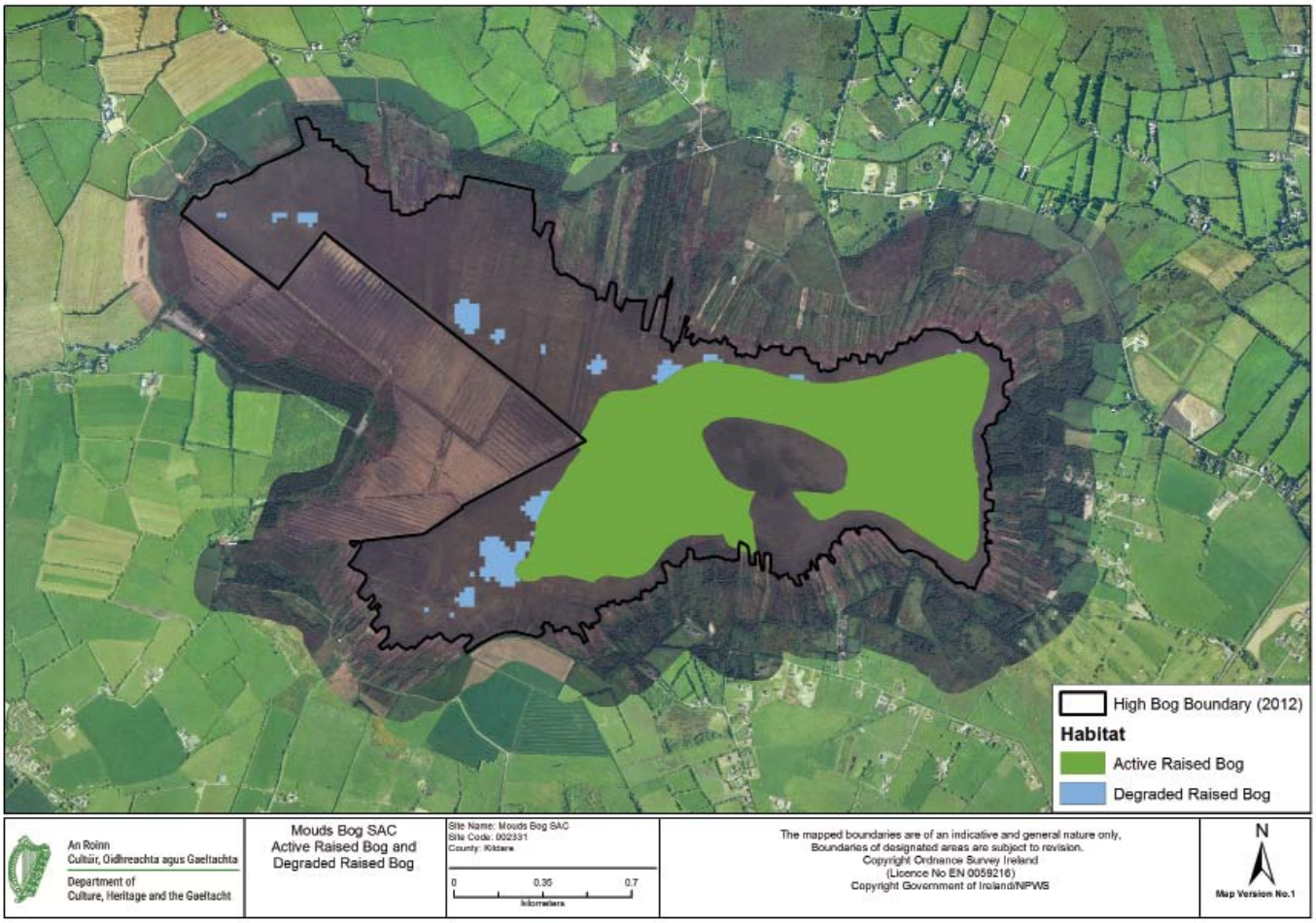
Site Statistics

Area of high bog in 1995 (ha):	285.1
Area of high bog in 2012 (ha):	267.7
Change in high bog (ha):	-17.4
Change in high bog (%):	-6.1%
No earlier survey available	N/A
Area of active raised bog in 1999 (ha) (Derwin & MacGowan, 2000*) (*Revised by NPWS in 2014)	70.0
Change in active raised bog (ha):	N/A
Change in active raised bog (%):	N/A
Area of degraded raised bog (ha):	7.4
Potential area bog peat-forming habitats (ha)	28.4

Composition of High Bog



- Active raised bog
- Degraded raised bog
- Potential supporting high bog habitat

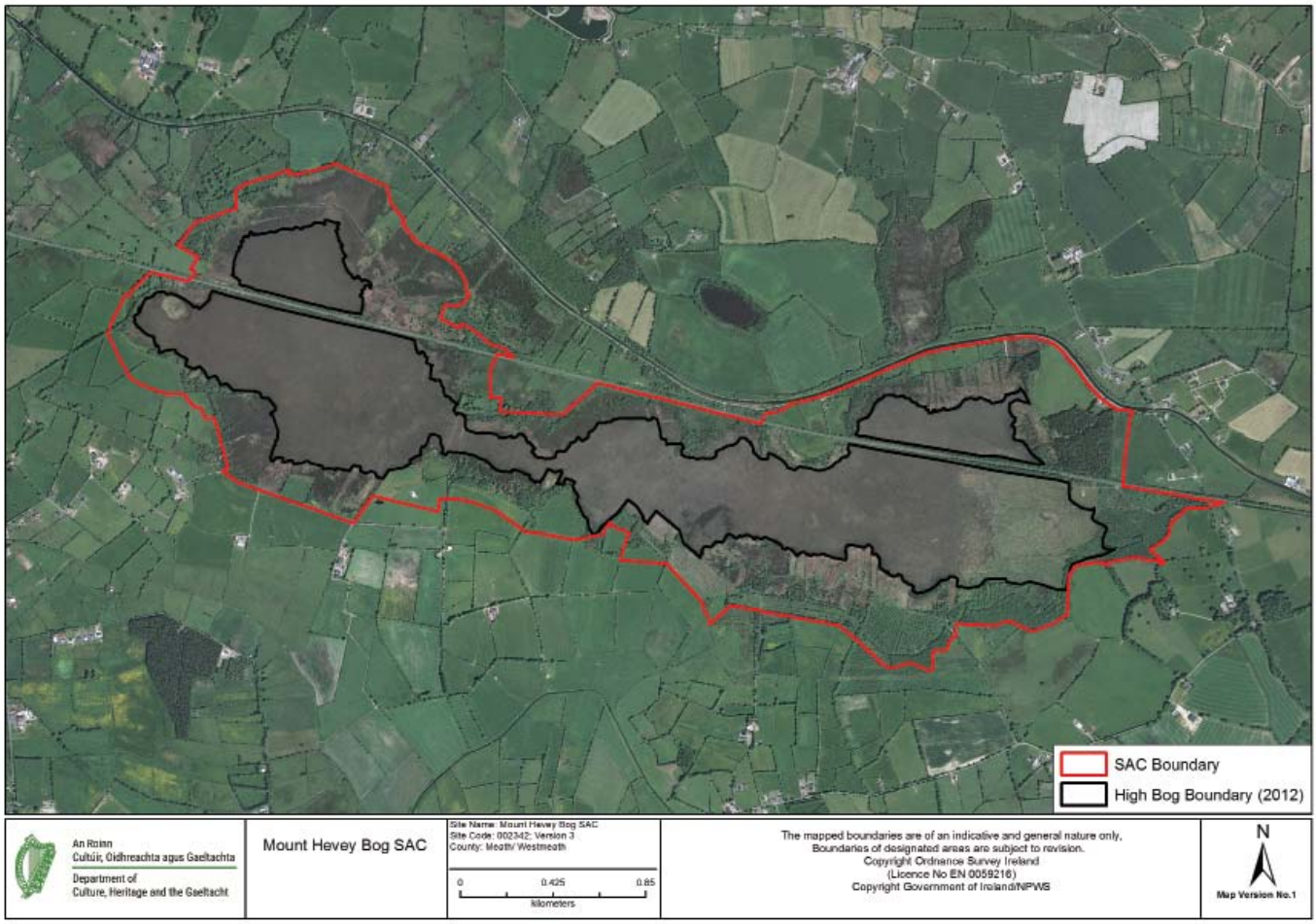


Mount Hevey Bog SAC - Summary

Site Name:	Mount Hevey Bog SAC
Site Code:	002342
Counties:	Meath / Westmeath
River Basin District:	Eastern
Sub-Catchment:	Boyne_SC_040, Boyne_SC_030
Further Information:	http://www.npws.ie/protected-sites/sac/002342

Site Summary:

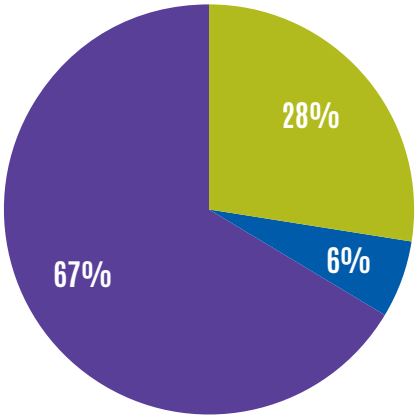
Mount Hevey Bog is situated approximately 4 km north-east of Kinnegad. The Meath-Westmeath county boundary runs through the centre of the bog. The bog is of high conservation value due to the occurrence of a very extensive area of active raised bog. Restoration works in the form of tree removal and drain blocking have recently been undertaken by Coillte on the eastern half of the site.



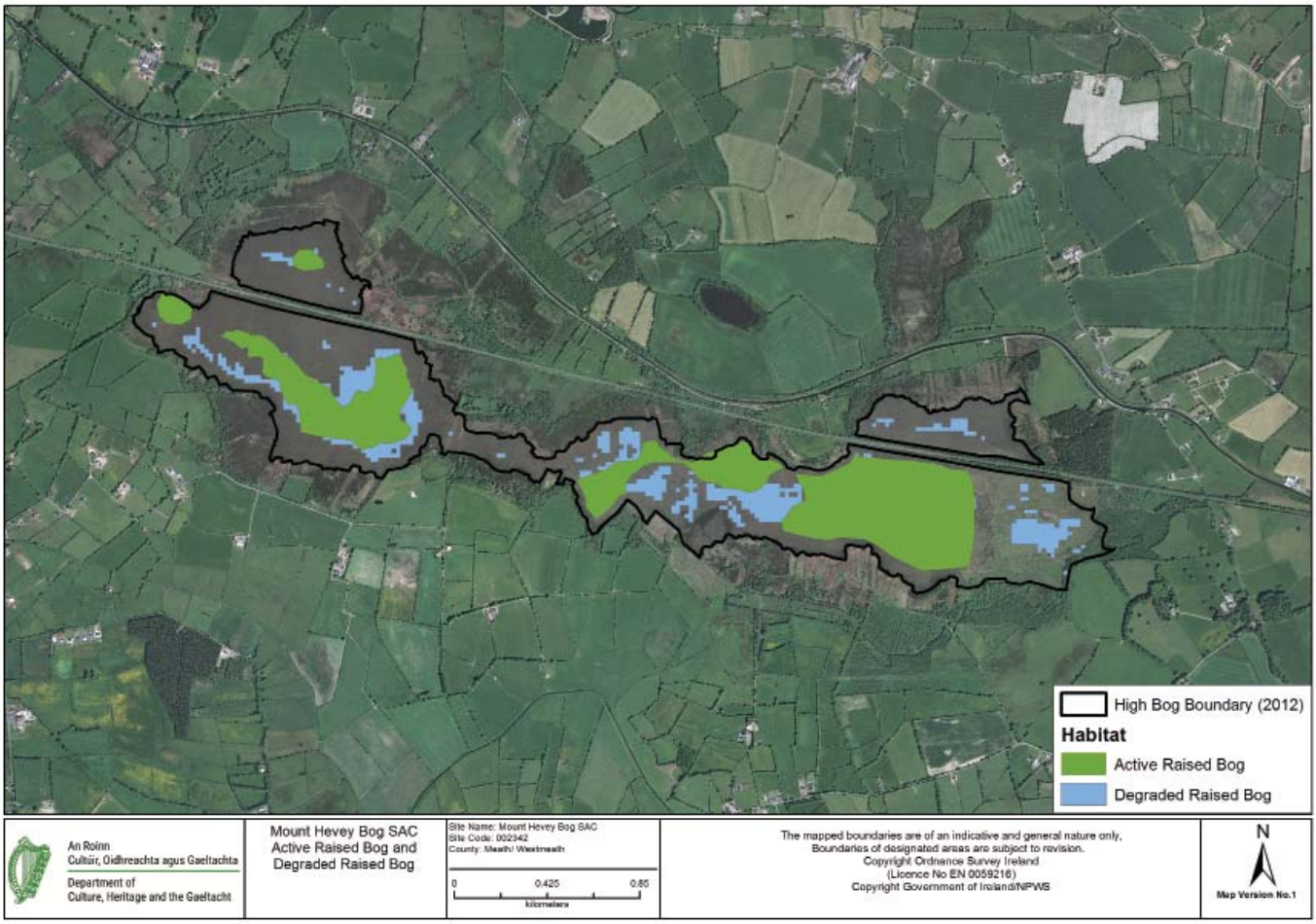
Site Statistics

Area of high bog in 1995 (ha):	222.5
Area of high bog in 2012 (ha):	217.5
Change in high bog (ha):	-5.0
Change in high bog (%):	-2.3%
No earlier survey available	N/A
Area of active raised bog in 2000 (ha) (Derwin & MacGowan, 2000*) (*Revised by NPWS in 2014)	60.0
Change in active raised bog (ha):	N/A
Change in active raised bog (%):	N/A
Area of degraded raised bog (ha):	12.3
Potential area bog peat-forming habitats (ha)	5.5

Composition of High Bog



- Active raised bog
- Degraded raised bog
- Potential supporting high bog habitat



An Roinn Cultúir, Oidhreachta agus Gaeltachta
Department of Culture, Heritage and the Gaeltacht

Mount Hevey Bog SAC
Active Raised Bog and Degraded Raised Bog

Site Name: Mount Hevey Bog SAC
Site Code: 002342
County: Meath/ Westmeath

0 0.425 0.85
kilometers

The mapped boundaries are of an indicative and general nature only.
Boundaries of designated areas are subject to revision.
Copyright Ordnance Survey Ireland
(Licence No EN 0059216)
Copyright Government of Ireland/NPWS

N

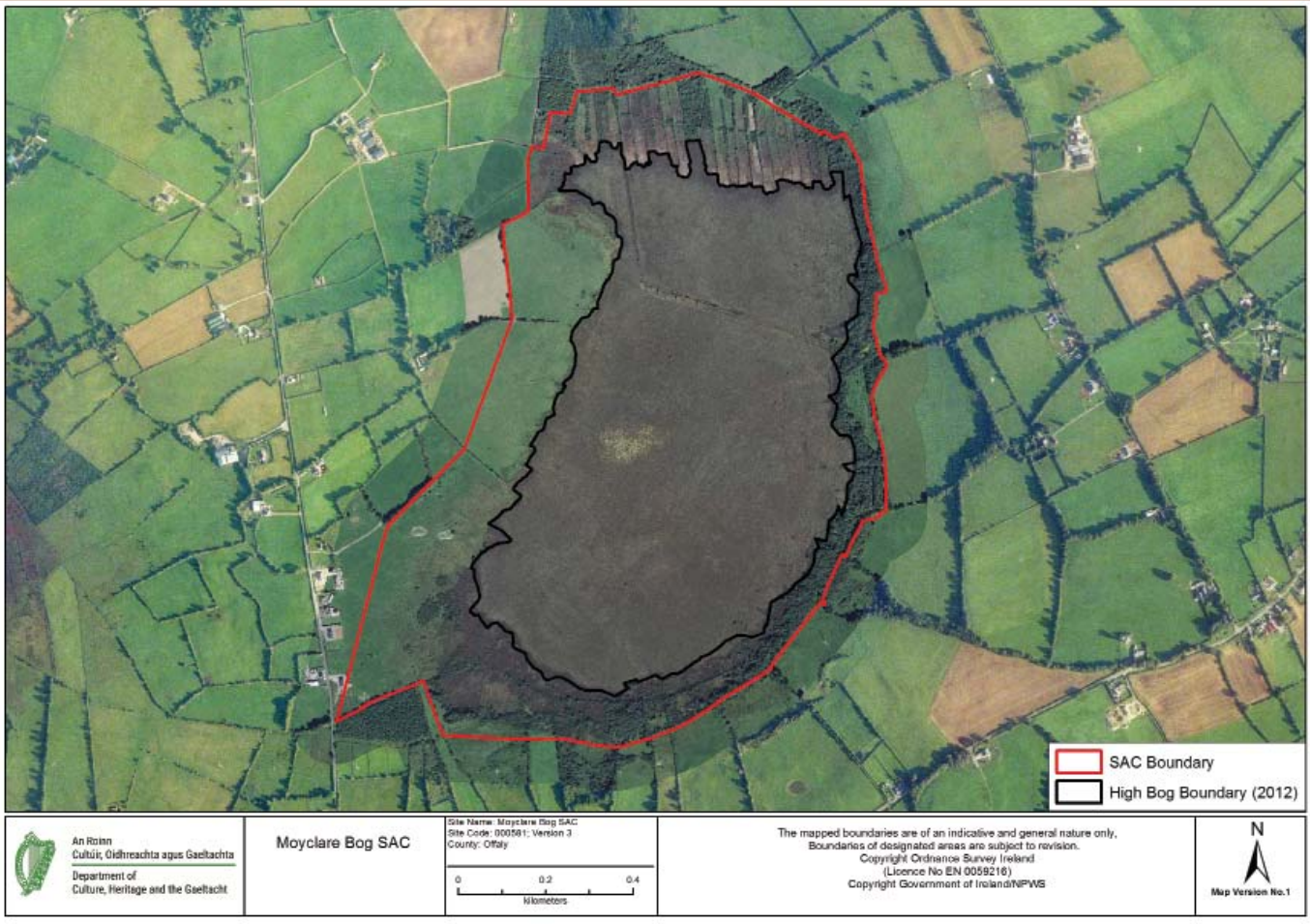
Map Version No.1

Moyclare Bog SAC - Summary

Site Name:	Moyclare Bog SAC
Site Code:	000581
Counties:	Offaly
River Basin District:	Shannon
Sub-Catchment:	Shannon[Lower]_SC_030
Further Information:	http://www.npws.ie/protected-sites/sac/000581

Site Summary:

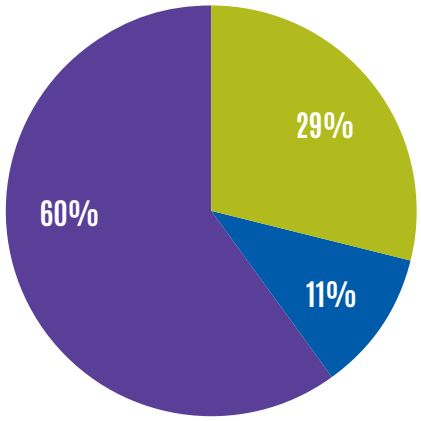
Moyclare Bog is a small raised bog situated 4 km west of Ferbane. On the western edge of the bog, a low peatface with no perimeter drain lies adjacent to wet peaty pasture, which has a spring-line at its junction with mineral soil. The bog is of high conservation value due to the occurrence of an extensive area of active raised bog. The site remains largely intact with undisturbed margins. Restoration works in the form of drain blocking have recently been undertaken by NPWS.



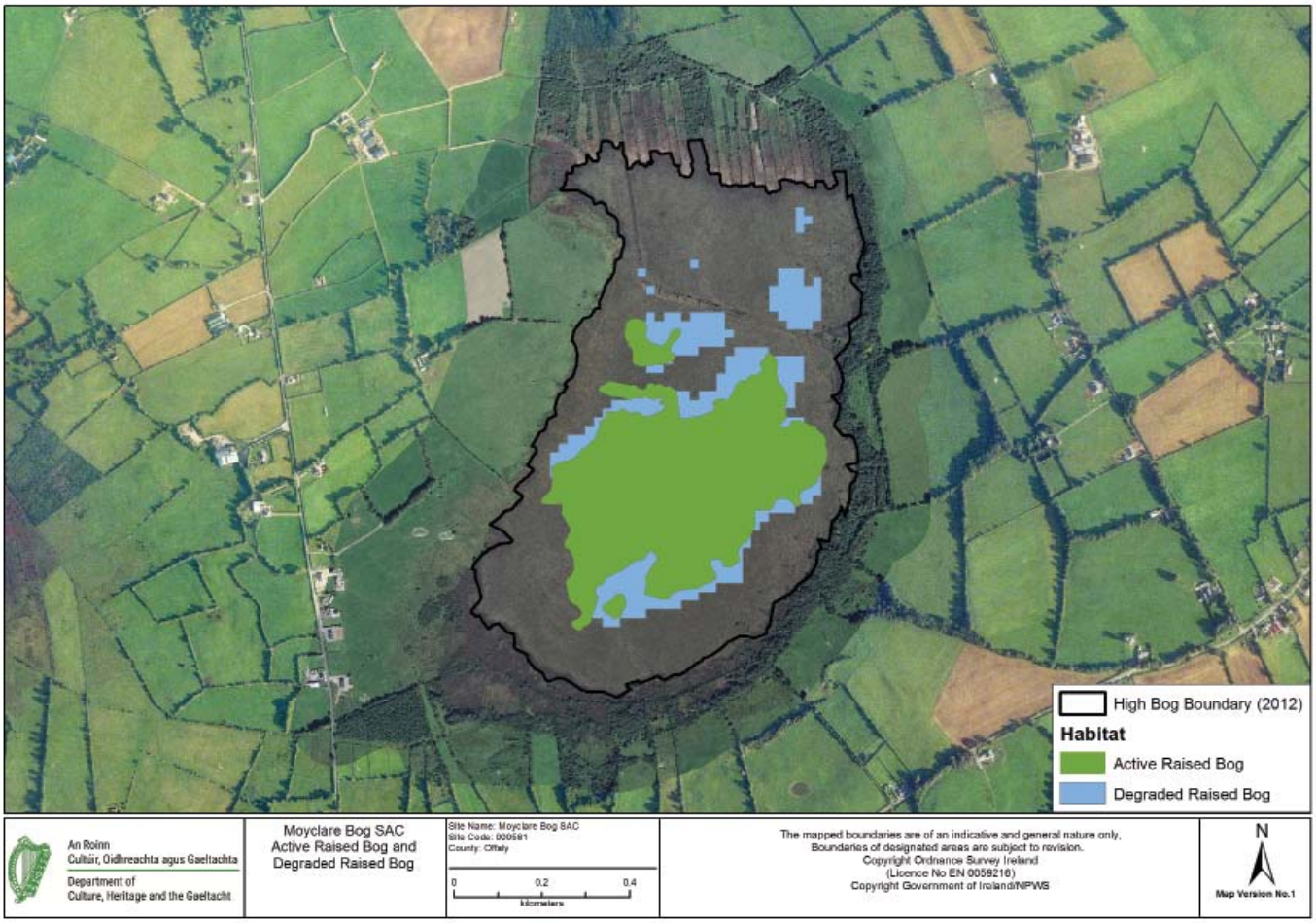
Site Statistics

Area of high bog in 1995 (ha):	75.8
Area of high bog in 2012 (ha):	74.3
Change in high bog (ha):	-1.5
Change in high bog (%):	-2.0%
Area of active raised bog in 1994 (ha) (Kelly et al. 1995)	24.2
Area of active raised bog in 2012 (ha) (Fernandez et al. 2014)	21.7
Change in active raised bog (ha):	-2.5
Change in active raised bog (%):	-10.3%
Area of degraded raised bog (ha):	8.3
Potential area bog peat-forming habitats (ha)	4.5

Composition of High Bog



- Active raised bog
- Degraded raised bog
- Potential supporting high bog habitat

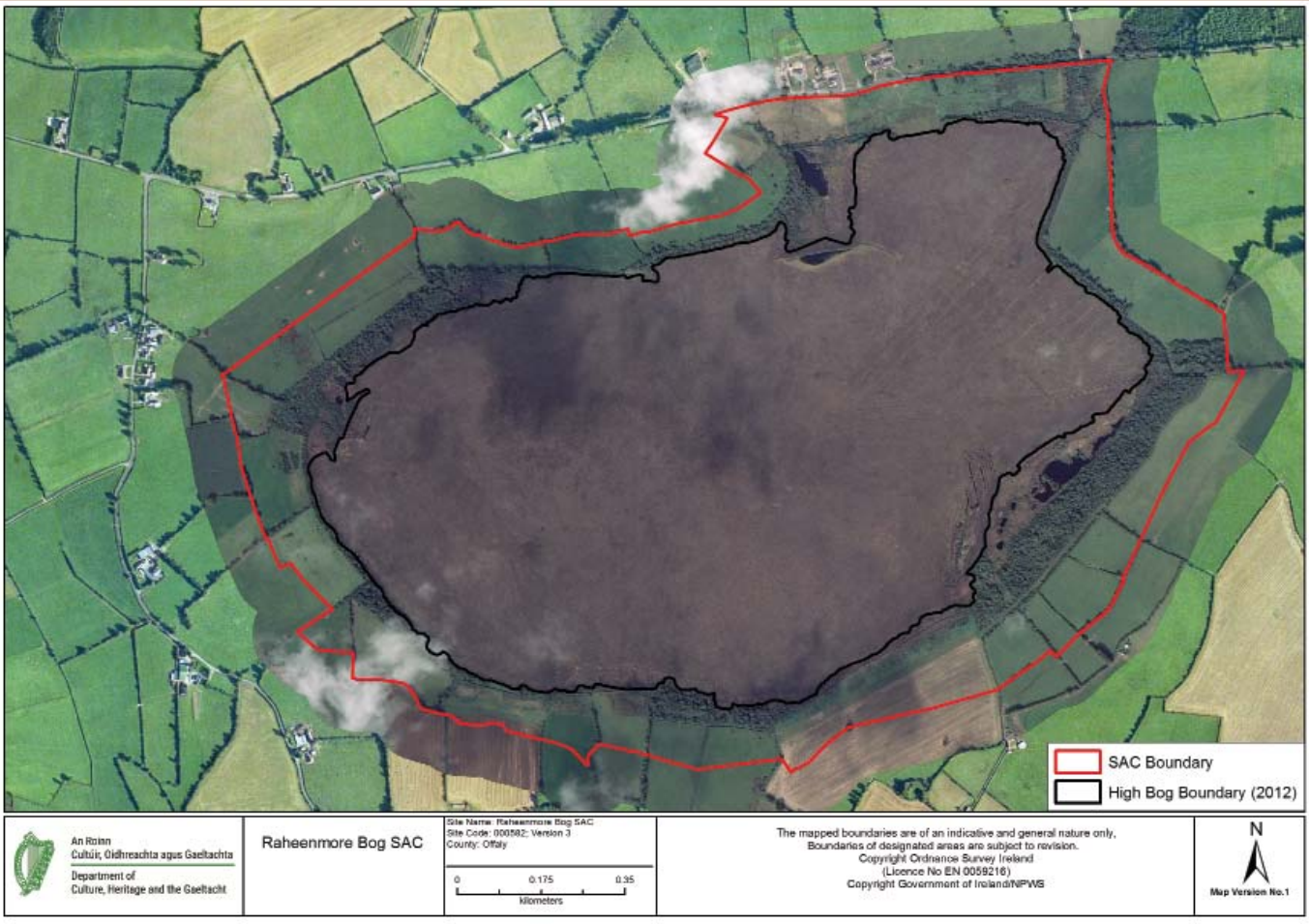


Raheenmore Bog SAC - Summary

Site Name:	Raheenmore Bog SAC
Site Code:	000582
Counties:	Offaly
River Basin District:	Shannon/Eastern
Sub-Catchment:	Yellow[Castlejordan]_SC_010, Silver[Tullamore]_SC_010
Further Information:	http://www.npws.ie/protected-sites/sac/000582

Site Summary:

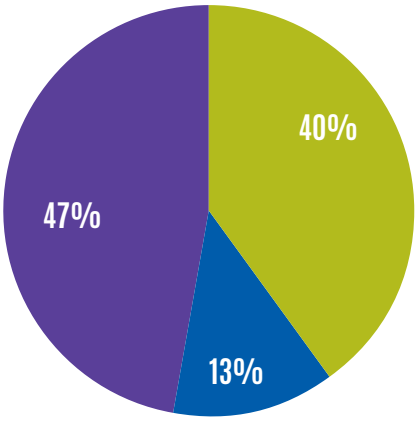
This raised bog developed in a small basin in the catchment of two major river systems i.e. the Brosna and the Boyne. It is situated about 5 km from Daingean. The peat is very deep, being up to 15 m in places. Raheenmore Bog is of high conservation value due to the occurrence of a very extensive area of active raised bog. The bog has a well-developed hummock and hollow system. Restoration works in the form of drain blocking and hydrological works have been undertaken by NPWS.



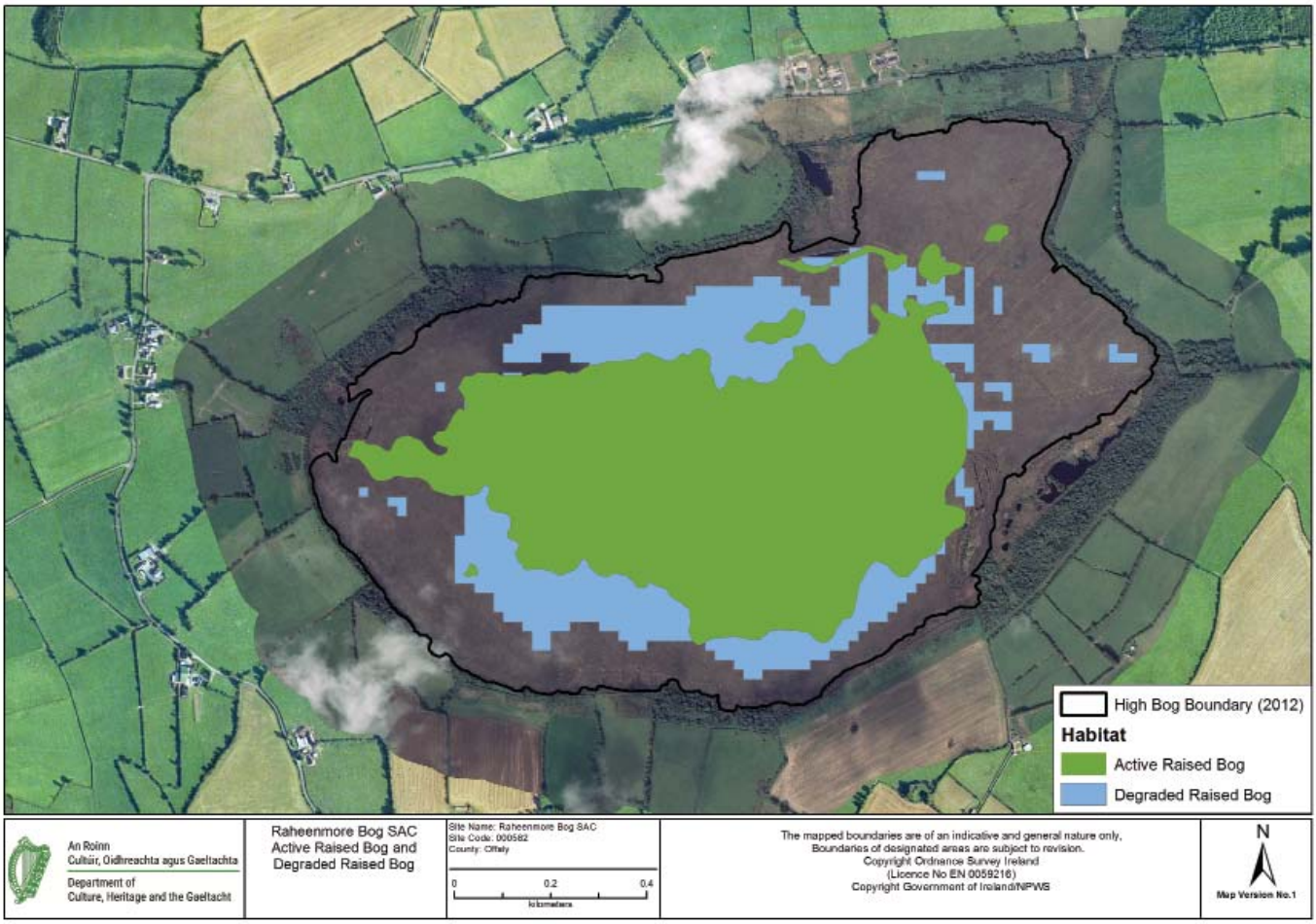
Site Statistics

Area of high bog in 1995 (ha):	130.8
Area of high bog in 2012 (ha):	130.5
Change in high bog (ha):	-0.3
Change in high bog (%):	-0.2%
Area of active raised bog in 1994 (ha) (Kelly et al. 1995)	60.5
Area of active raised bog in 2011 (ha) (Fernandez et al. 2012)	52.3
Change in active raised bog (ha):	-8.2
Change in active raised bog (%):	-13.6%
Area of degraded raised bog (ha):	16.4
Potential area bog peat-forming habitats (ha)	1.3

Composition of High Bog



- Active raised bog
- Degraded raised bog
- Potential supporting high bog habitat

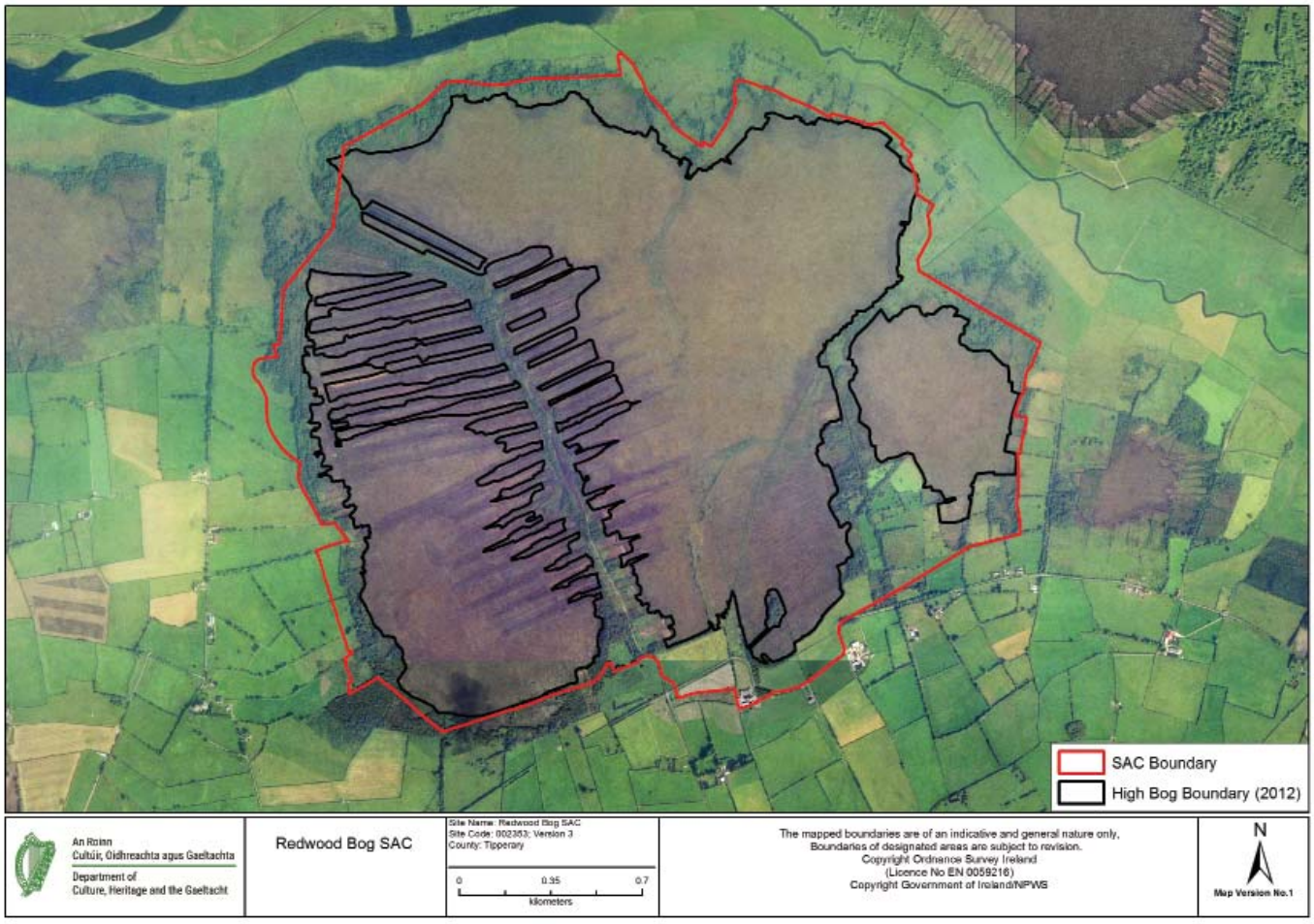


Redwood Bog SAC - Summary

Site Name:	Redwood Bog SAC
Site Code:	002353
Counties:	Tipperary
River Basin District:	Shannon
Sub-Catchment:	Shannon[Lower]_SC_060
Further Information:	http://www.npws.ie/protected-sites/sac/002353

Site Summary:

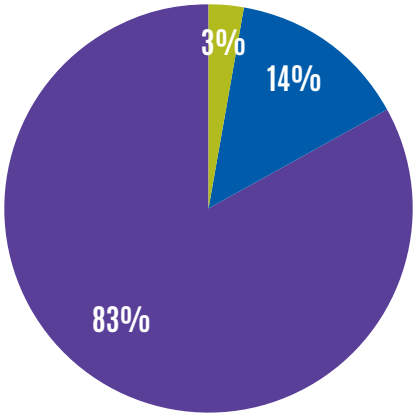
Redwood Bog is located 7 km south west of Banagher. Redwood Bog is of high conservation value due to the occurrence of a significant area of active raised bog. The site has traditionally been used by a flock of Greenland White-fronted Geese. There has been extensive historic peat-cutting in the western half of the site.



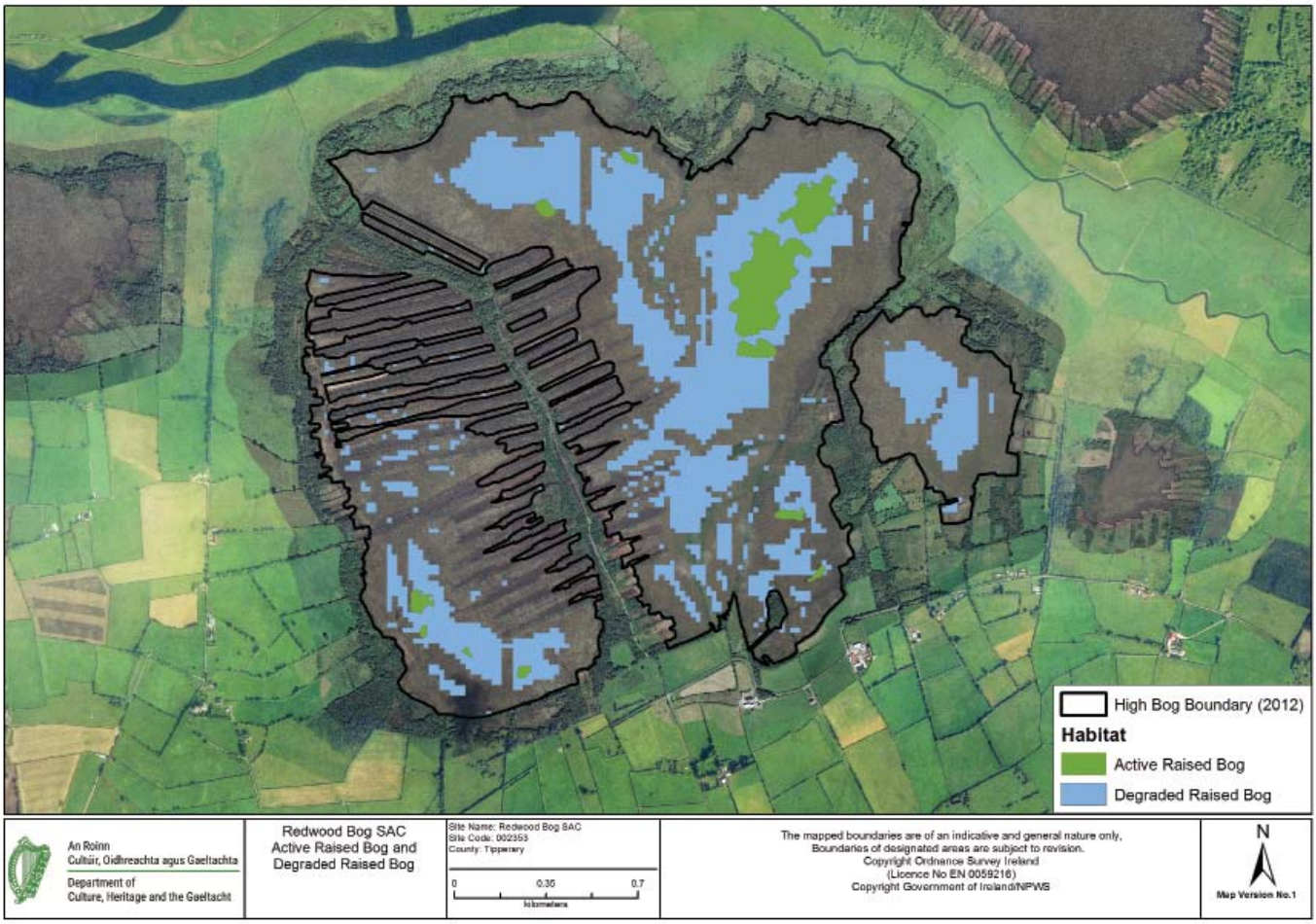
Site Statistics

Area of high bog in 1995 (ha):	379.6
Area of high bog in 2012 (ha):	366.0
Change in high bog (ha):	-13.6
Change in high bog (%):	-3.6%
Area of active raised bog in 1994 (ha) (Kelly et al. 1995)	42.3
Area of active raised bog in 2012 (ha) (Fernandez et al. 2014)	12.1
Change in active raised bog (ha):	-30.2
Change in active raised bog (%):	-71.4%
Area of degraded raised bog (ha):	51.8
Potential area bog peat-forming habitats (ha)	4.2

Composition of High Bog



- Active raised bog
- Degraded raised bog
- Potential supporting high bog habitat

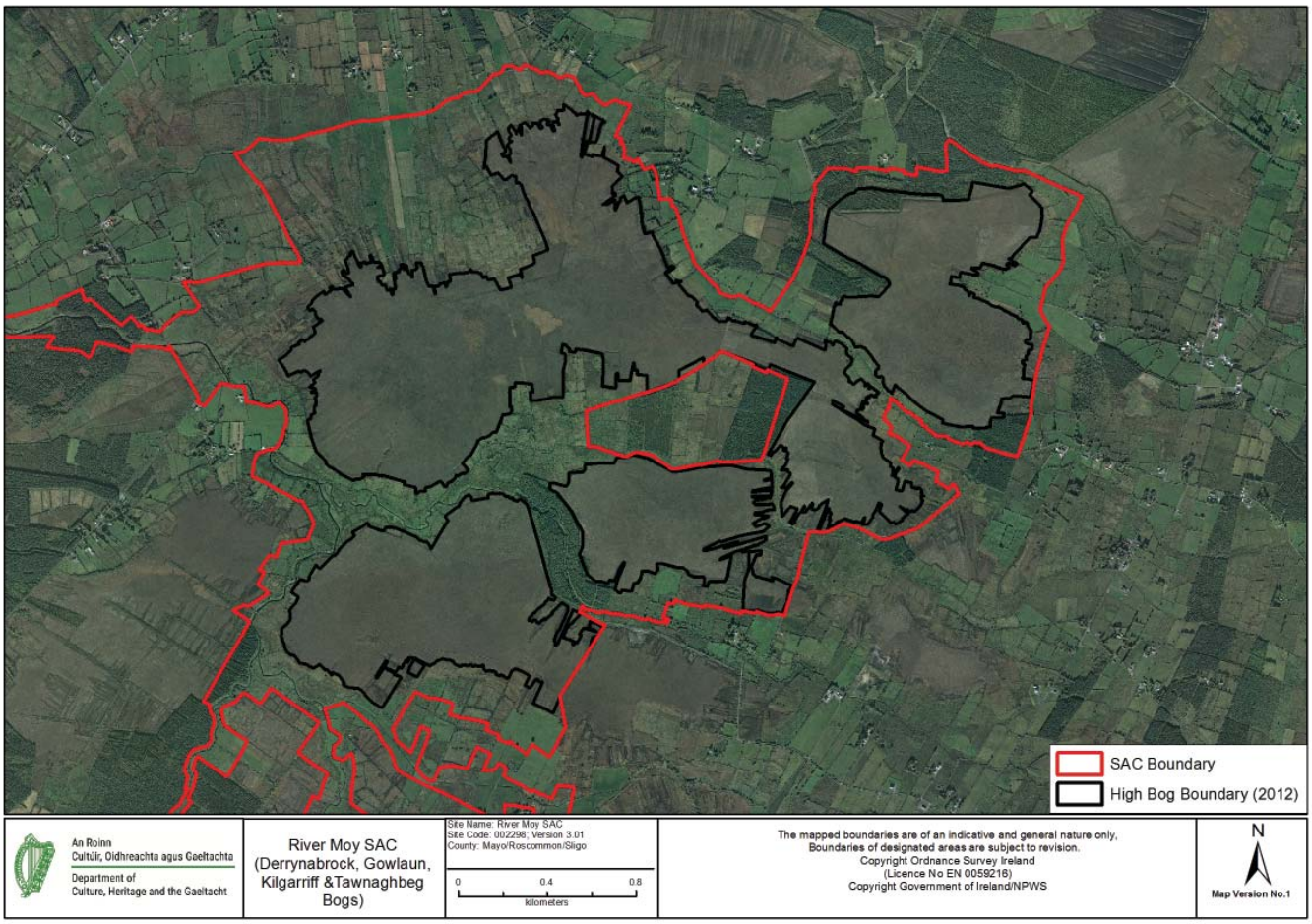


River Moy SAC - Summary

Site Name:	River Moy SAC
Site Code:	002298
Counties:	Mayo / Sligo
River Basin District:	Western
Sub-Catchment:	Moy_SC_030
Further Information:	http://www.npws.ie/protected-sites/sac/002298

Site Summary:

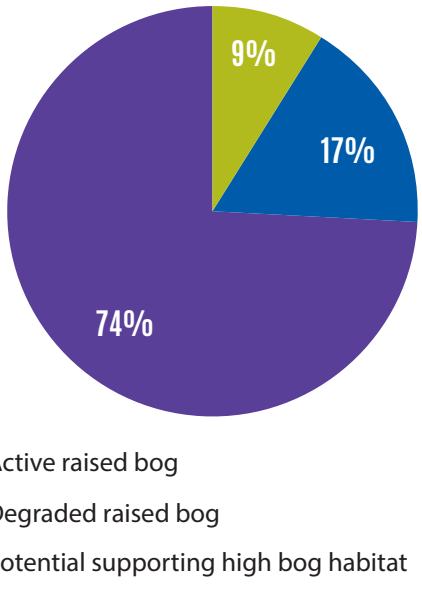
Most of the site is in Co. Mayo though parts are in west Sligo and north Roscommon. Within the River Moy SAC is a complex of five raised bogs including Kilgarriff, Gowlaun, Derrynabrock, Tawnaghbeg and Cloongoonagh. These are of high conservation value due to the occurrence of significant areas of active raised bog. The bogs represent the western raised bog type.

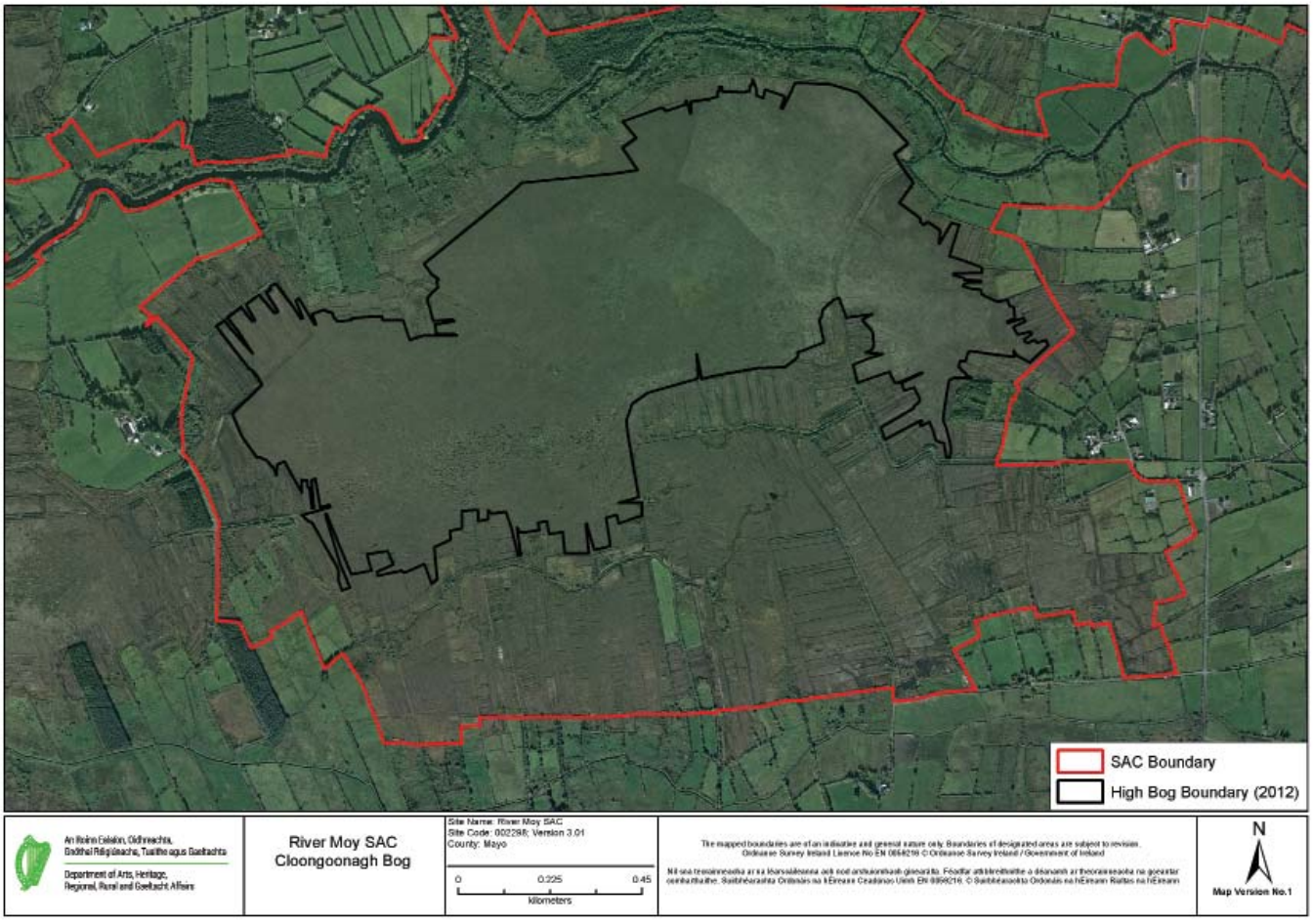


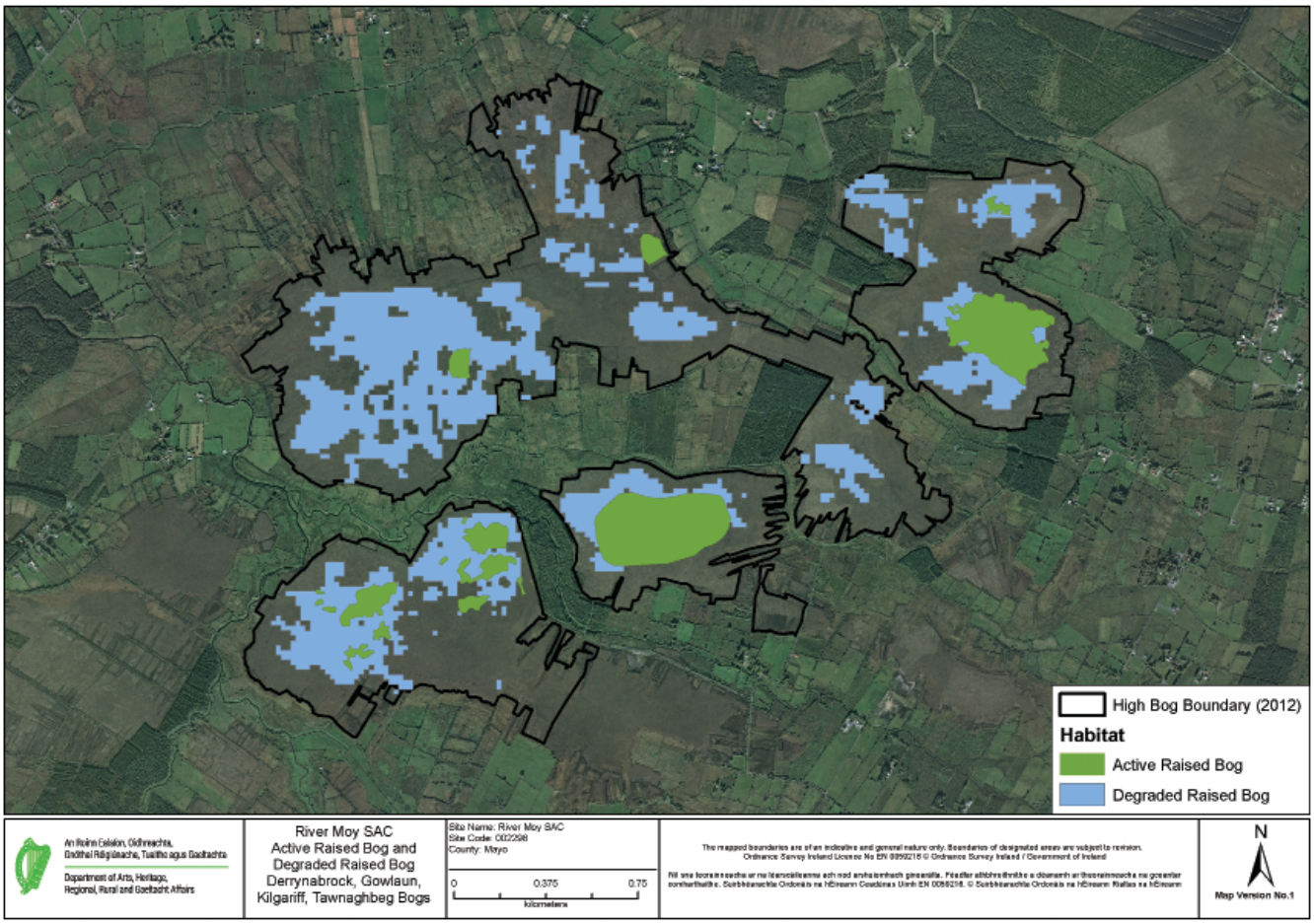
Site Statistics

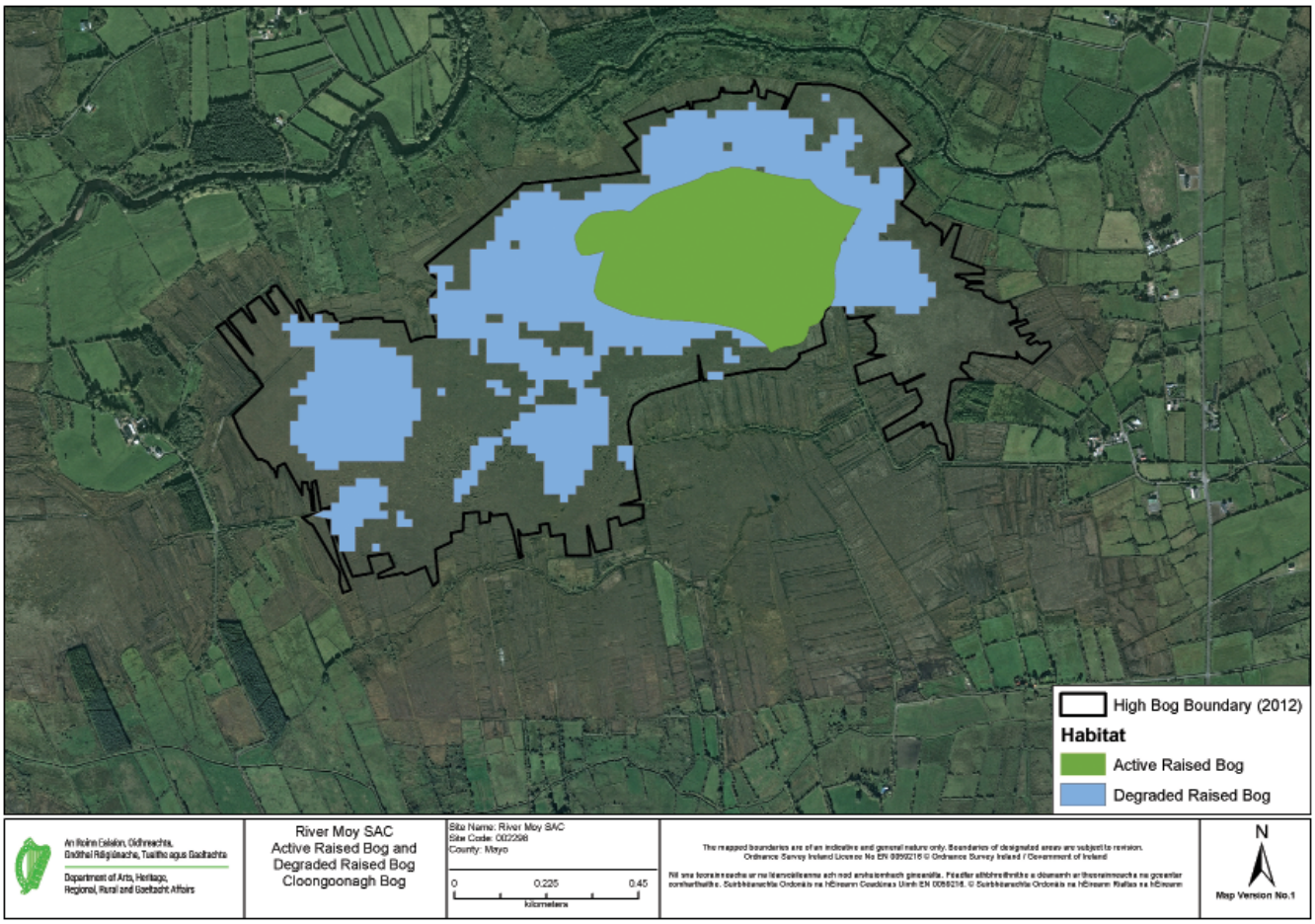
Area of high bog in 1995 (ha):	499.0
Area of high bog in 2012 (ha):	498.3
Change in high bog (ha):	-0.7
Change in high bog (%):	-0.1%
No earlier survey available that covered the entire site	N/A
Area of active raised bog in Kilgariff Bog in 1999 (ha) (Derwin & MacGowan, 2000*), Gowlaun Bog in 1999 (ha) (Derwin & MacGowan, 2000), Tawnaghbeg Bog & Derrynabrock Bog in 2012 (ha) (Fernandez et al. 2014) (*Revised by NPWS in 2014)	45.3
Change in active raised bog (ha):	N/A
Change in active raised bog (%):	N/A
Area of degraded raised bog (ha):	82.1
Potential area bog peat-forming habitats (ha)	5.0

Composition of High Bog






High Bog Boundary (2012)
Habitat
Active Raised Bog
Degraded Raised Bog
An Roinn Ealaíon, Oidhreachta, Gnóthaí Réigiúnacha, Tuaithe agus Gaeltachta
Department of Arts, Heritage, Regional, Rural and Gaeltacht Affairs
River Moy SAC
Active Raised Bog and Degraded Raised Bog
Derrynabrock, Gowlaun, Kilgariff, Tawnaghbeg Bogs
Site Name: River Moy SAC
Site Code: 002298
County: Mayo
0
0.375
0.75
kilometers
N
Map Version No.1

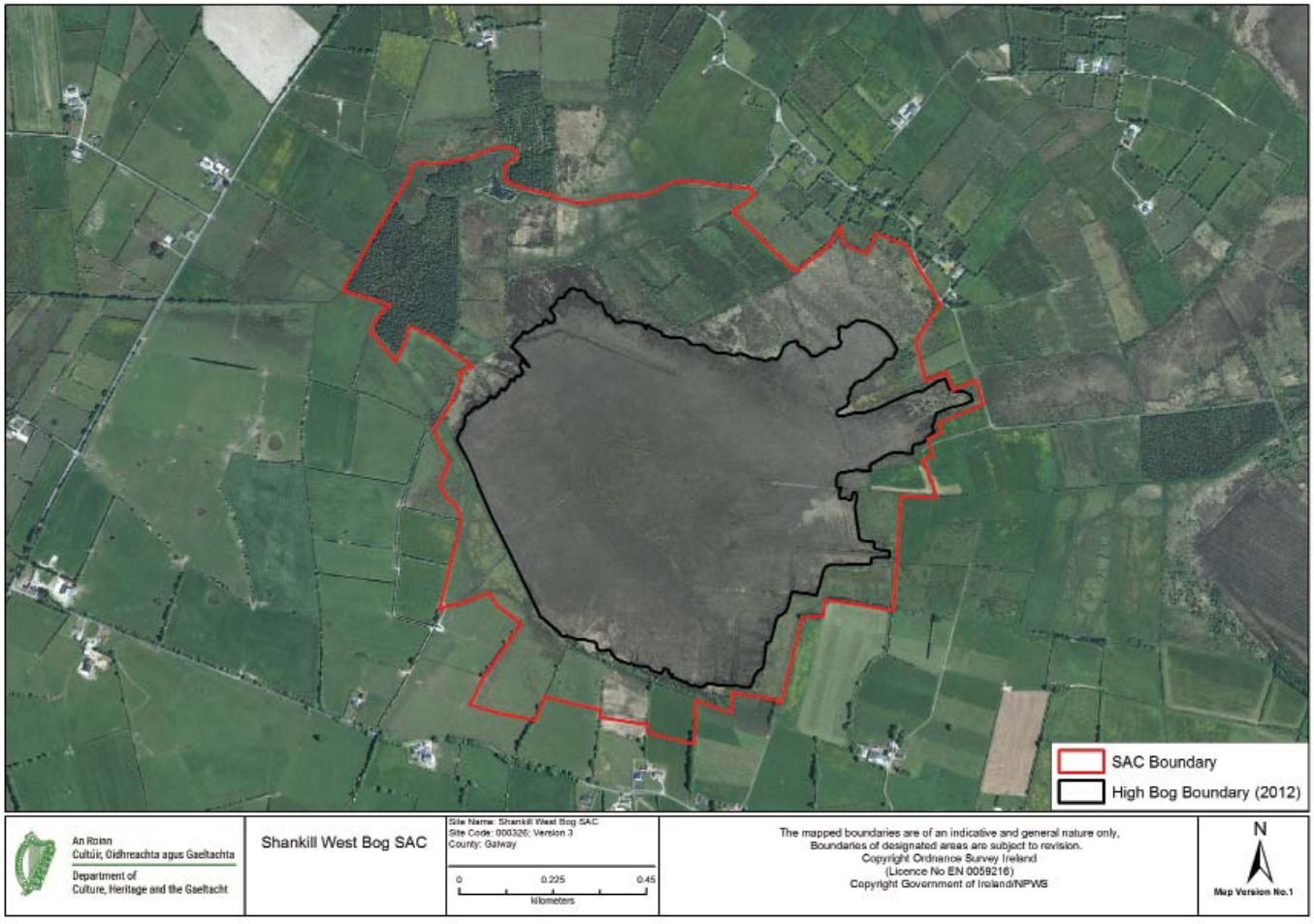

High Bog Boundary (2012)
Habitat
Active Raised Bog
Degraded Raised Bog
An Roinn Ealaíon, Oidhreachta, Gnóthaí Réigiúnacha, Tuaithe agus Gaeltachta
Department of Arts, Heritage, Regional, Rural and Gaeltacht Affairs
River Moy SAC
Active Raised Bog and
Degraded Raised Bog
Cloongoonagh Bog
Site Name: River Moy SAC
Site Code: 002298
County: Mayo
0
0.225
0.45
kilometers
N
Map Version No.1

Shankill West Bog SAC - Summary

Site Name:	Shankill West Bog SAC
Site Code:	000326
Counties:	Galway
River Basin District:	Shannon
Sub-Catchment:	Castlegar_SC_010
Further Information:	http://www.npws.ie/protected-sites/sac/000326

Site Summary:

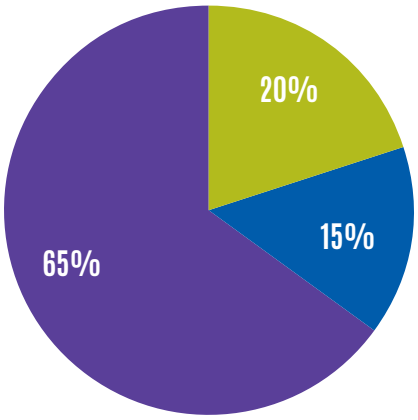
Shankill West Bog is a small raised bog with unusual topography and a largely intact dome, situated about 7 km north-west of Mount Bellew Bridge, Co. Galway. This site is of high conservation value due to the occurrence of high quality active raised bog vegetation with hummocks, hollows and pools. A natural transition from the bog to a lake and grasslands to the north is also of interest.



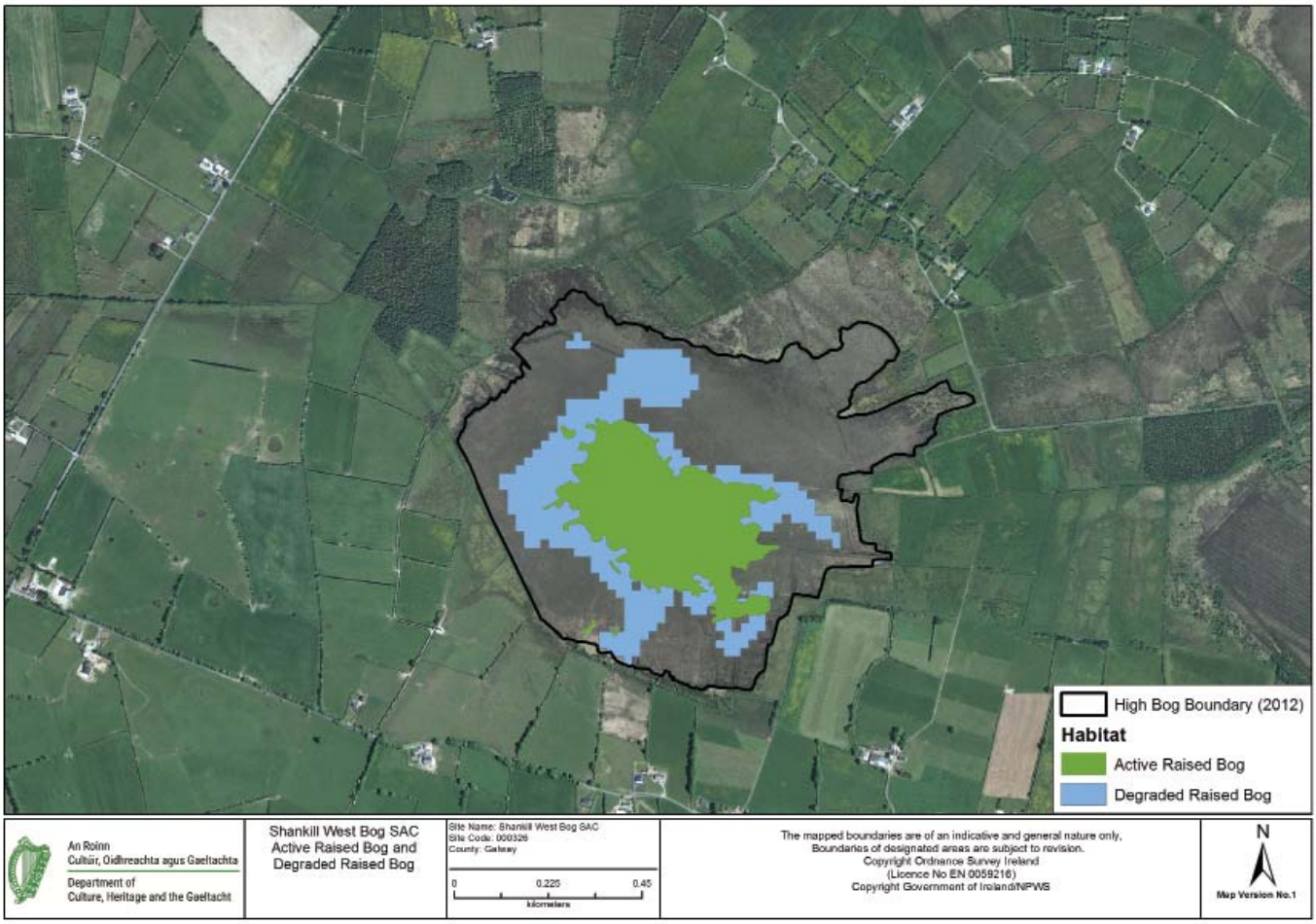
Site Statistics

Area of high bog in 1995 (ha):	67.6
Area of high bog in 2012 (ha):	67.4
Change in high bog (ha):	-0.2
Change in high bog (%):	-0.3%
Area of active raised bog in 1994 (ha) (Kelly et al. 1995)	14.1
Area of active raised bog in 2012 (ha) (Fernandez et al. 2014)	13.3
Change in active raised bog (ha):	-0.8
Change in active raised bog (%):	-5.7%
Area of degraded raised bog (ha):	10.1
Potential area bog peat-forming habitats (ha)	0.0

Composition of High Bog



- Active raised bog
- Degraded raised bog
- Potential supporting high bog habitat



An Roinn Cultúir, Oidhreachta agus Gaeltachta
Department of Culture, Heritage and the Gaeltacht

Shankill West Bog SAC
Active Raised Bog and Degraded Raised Bog

Site Name: Shankill West Bog SAC
Site Code: 000326
County: Galway

0 0.225 0.45
kilometers

The mapped boundaries are of an indicative and general nature only.
Boundaries of designated areas are subject to revision.
Copyright Ordnance Survey Ireland
(Licence No EN 0059216)
Copyright Government of Ireland/NPWS

N

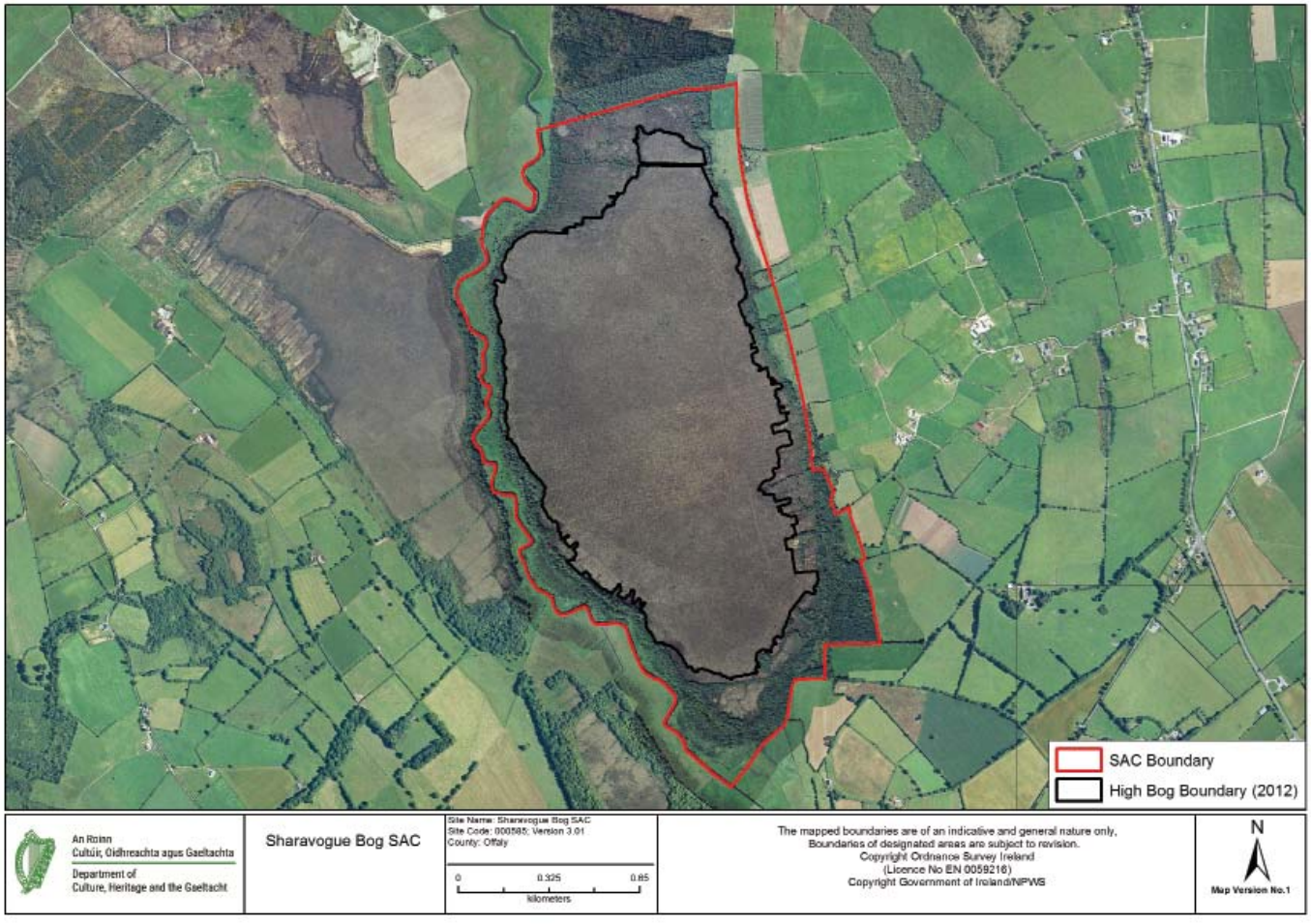
Map Version No.1

Sharavogue Bog SAC - Summary

Site Name:	Sharavogue Bog SAC
Site Code:	000585
Counties:	Offaly
River Basin District:	Shannon
Sub-Catchment:	LittleBrosna_SC_020
Further Information:	http://www.npws.ie/protected-sites/sac/000585

Site Summary:

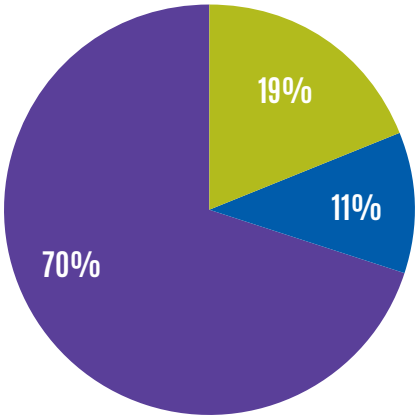
Sharavogue Bog is located about 8 km south of Birr, Co. Offaly, in the Little Brosna Valley. It is situated between the River Little Brosna and a ridge of high ground of Carboniferous limestone. Sharavogue Bog is of high conservation value due to the occurrence of an extensive area of active raised bog. On the western side the site grades from high bog, through fringing woodland to alluvial wet grassland by the Little Brosna River. A secondary lagg zone with fen vegetation occurs to the east of the bog. Restoration works in the form of drain blocking have been undertaken by NPWS.



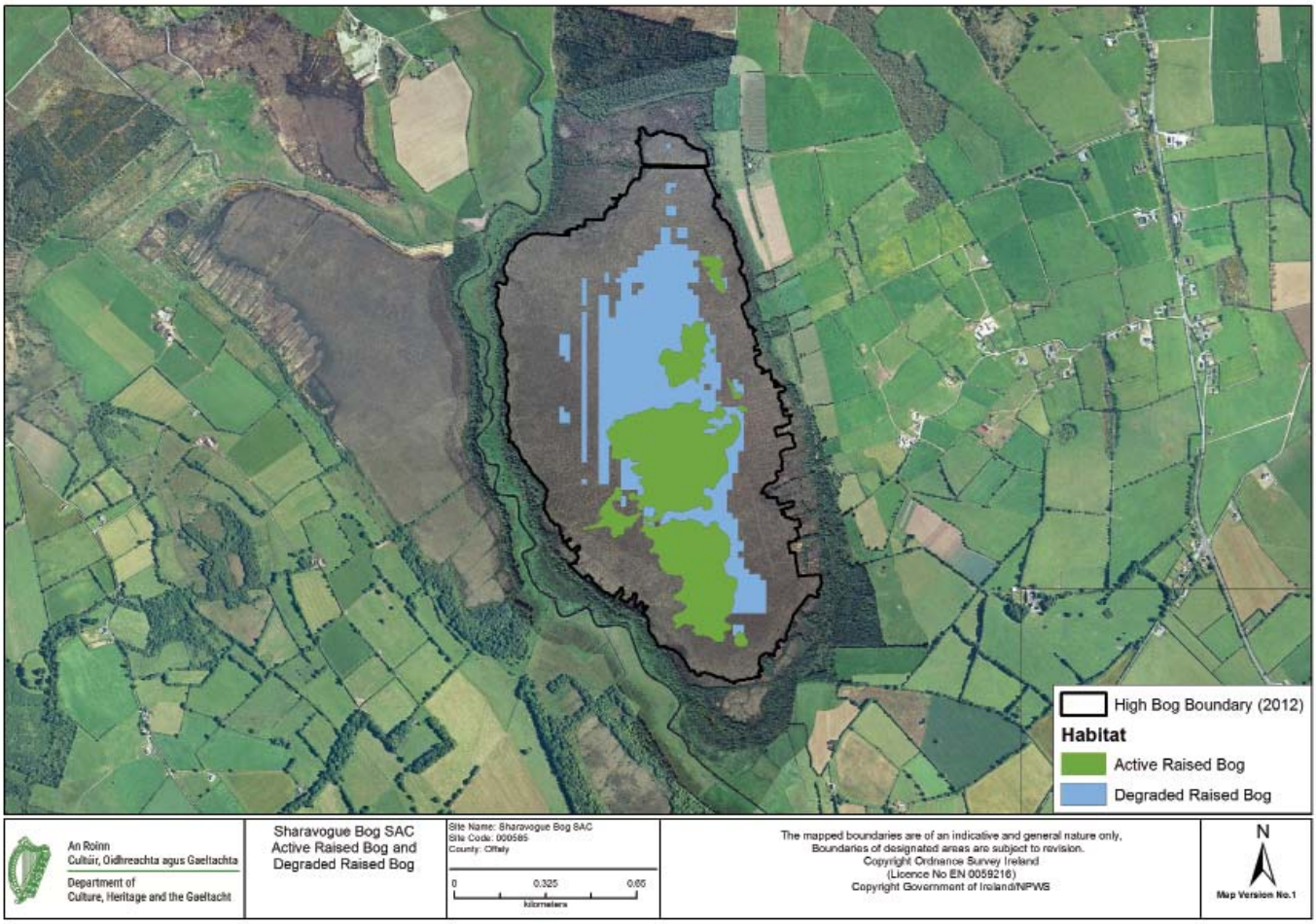
Site Statistics

Area of high bog in 1995 (ha):	137.2
Area of high bog in 2012 (ha):	137.0
Change in high bog (ha):	-0.2
Change in high bog (%):	-0.2%
Area of active raised bog in 1994 (ha) (Kelly et al. 1995)	23.6
Area of active raised bog in 2011 (ha) (Fernandez et al. 2012)	25.8
Change in active raised bog (ha):	2.2
Change in active raised bog (%):	9.3%
Area of degraded raised bog (ha):	14.7
Potential area bog peat-forming habitats (ha)	0.4

Composition of High Bog



- Active raised bog
- Degraded raised bog
- Potential supporting high bog habitat

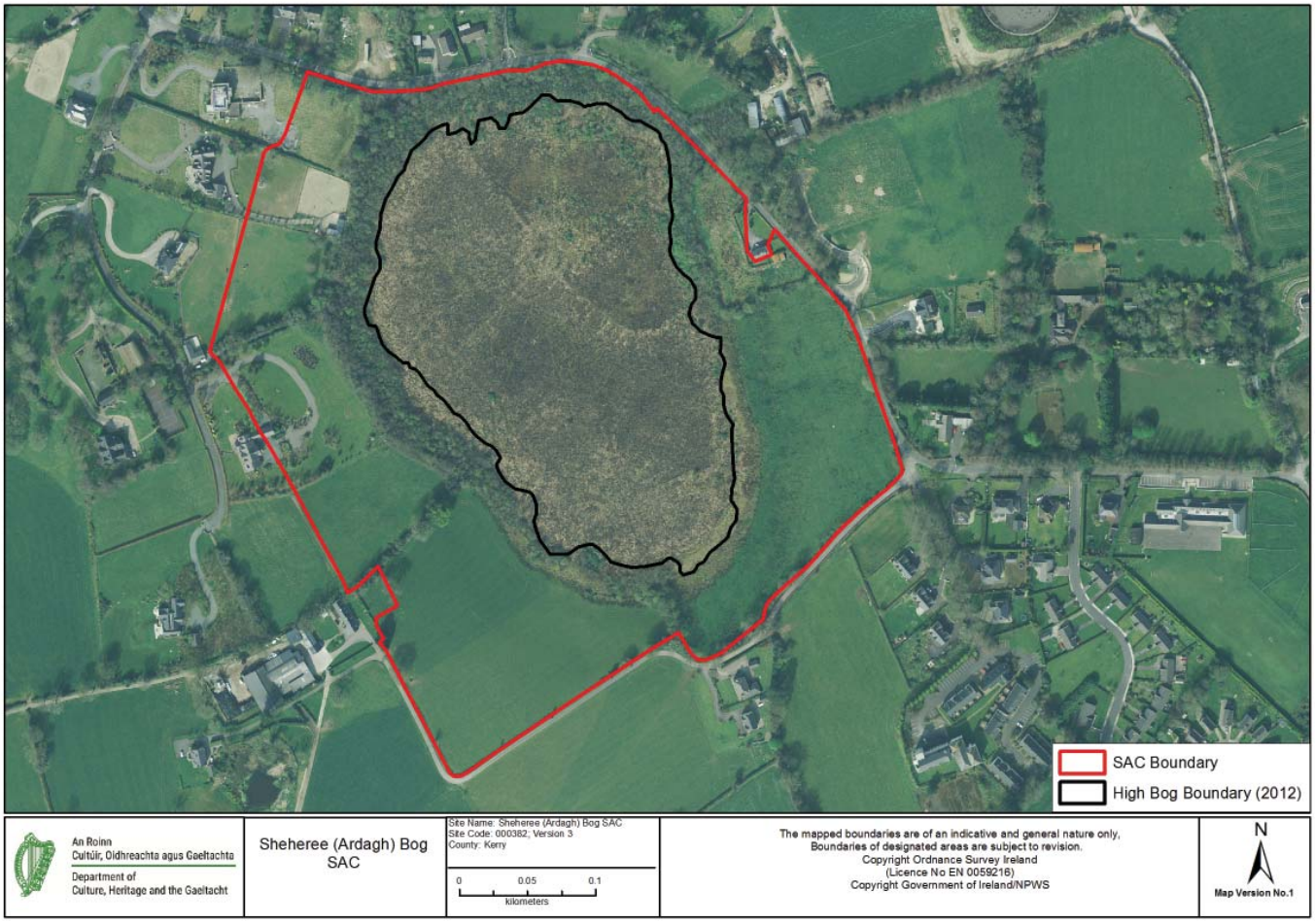


Sheheree (Ardagh) Bog SAC - Summary

Site Name:	Sheheree (Ardagh) Bog SAC
Site Code:	000382
Counties:	Kerry
River Basin District:	South Western
Sub-Catchment:	Laune_SC_010
Further Information:	http://www.npws.ie/protected-sites/sac/000382

Site Summary:

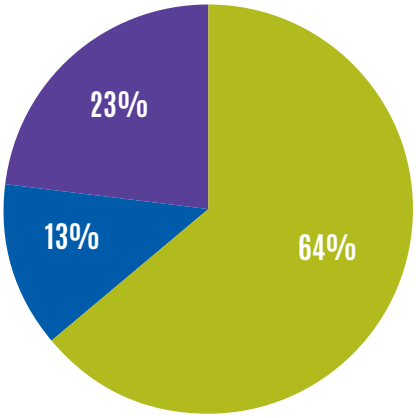
Sheheree Bog lies 2 km south-east of Killarney in a depression within a high ridge (103 m). It has developed by succession from a small lake to a ridge basin bog with similarities to a raised bog. Sheheree Bog is of high conservation value due to the occurrence of active raised bog, and has an intact margin. The bog is also of importance as it is located at the south western edge of the range and has an unusual vegetation type.

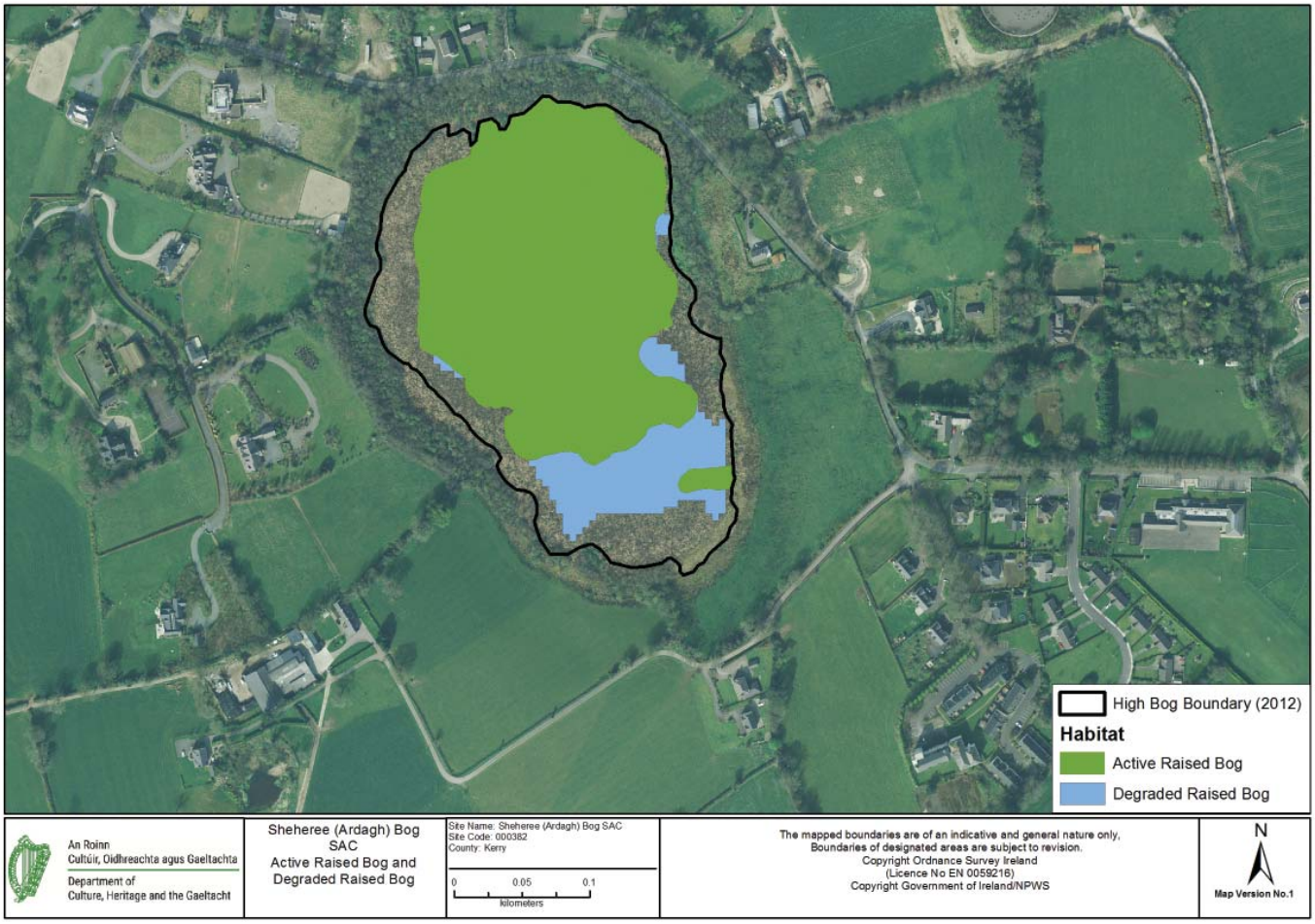


Site Statistics

Area of high bog in 1995 (ha):	6.4
Area of high bog in 2012 (ha):	6.4
Change in high bog (ha):	0.0
Change in high bog (%):	0.0%
Area of active raised bog in 1994 (ha) (Kelly et al. 1995*) (*Revised by NPWS in 2014)	4.1
Area of active raised bog in 2012 (ha) (Fernandez et al. 2014)	4.1
Change in active raised bog (ha):	0
Change in active raised bog (%):	0%
Area of degraded raised bog (ha):	0.8
Potential area bog peat-forming habitats (ha)	0.0

Composition of High Bog



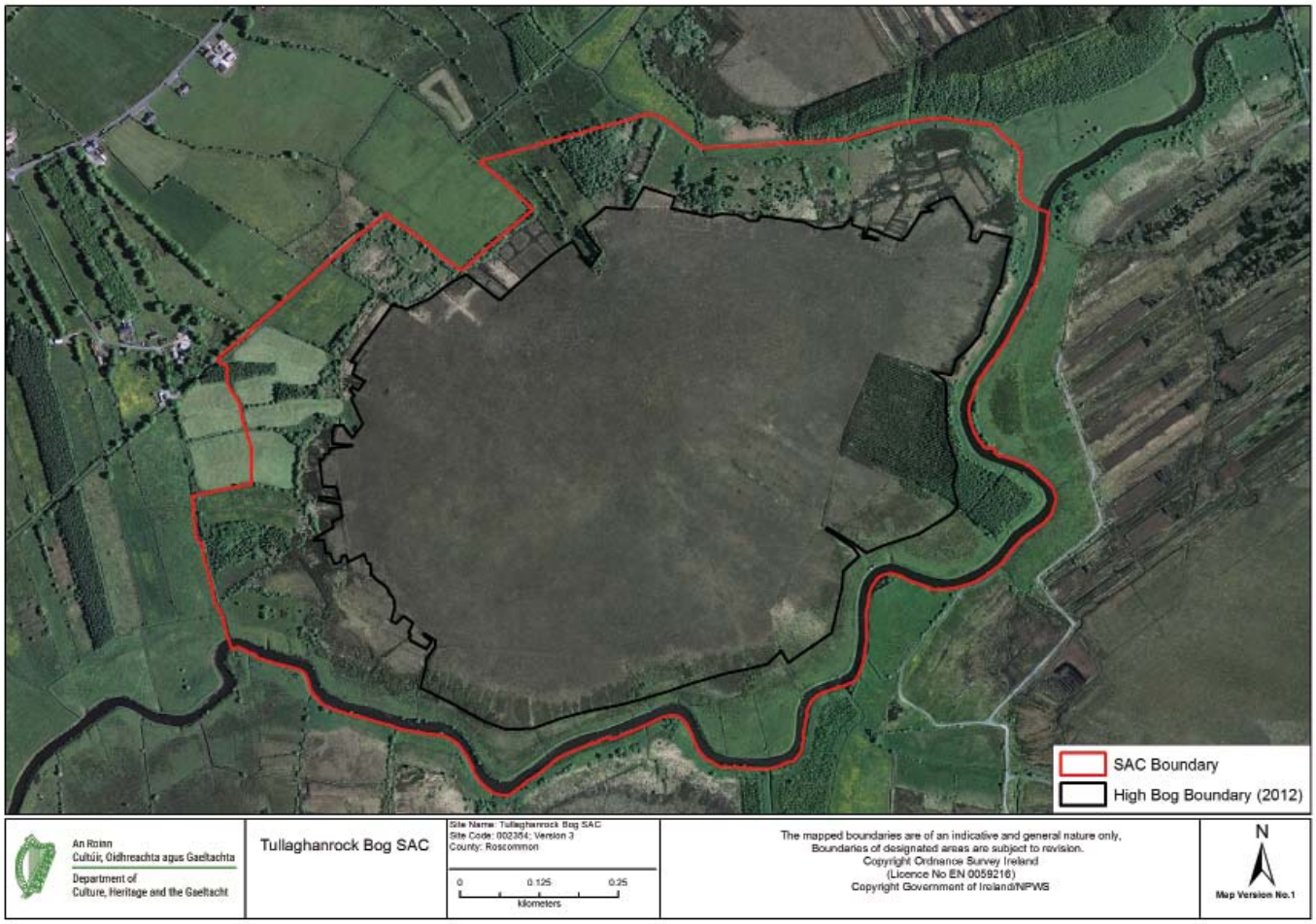


Tullaghanrock Bog SAC - Summary

Site Name:	Tullaghanrock Bog SAC
Site Code:	002354
Counties:	Roscommon
River Basin District:	Shannon
Sub-Catchment:	Lung_SC_020
Further Information:	http://www.npws.ie/protected-sites/sac/002354

Site Summary:

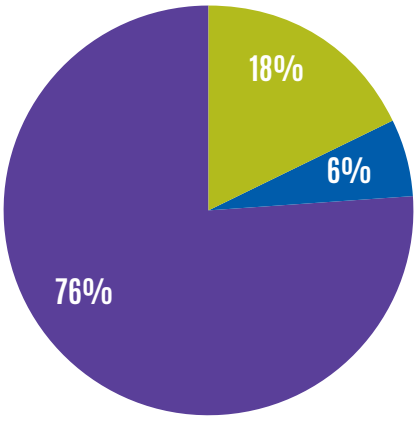
Tullaghanrock Bog is situated approximately 5 km east of Ballaghaderreen, Co Roscommon. The bog is of high conservation value due to the occurrence of a very extensive area of active raised bog. To the south and east there is a semi-natural margin between the high bog and the River Lung.



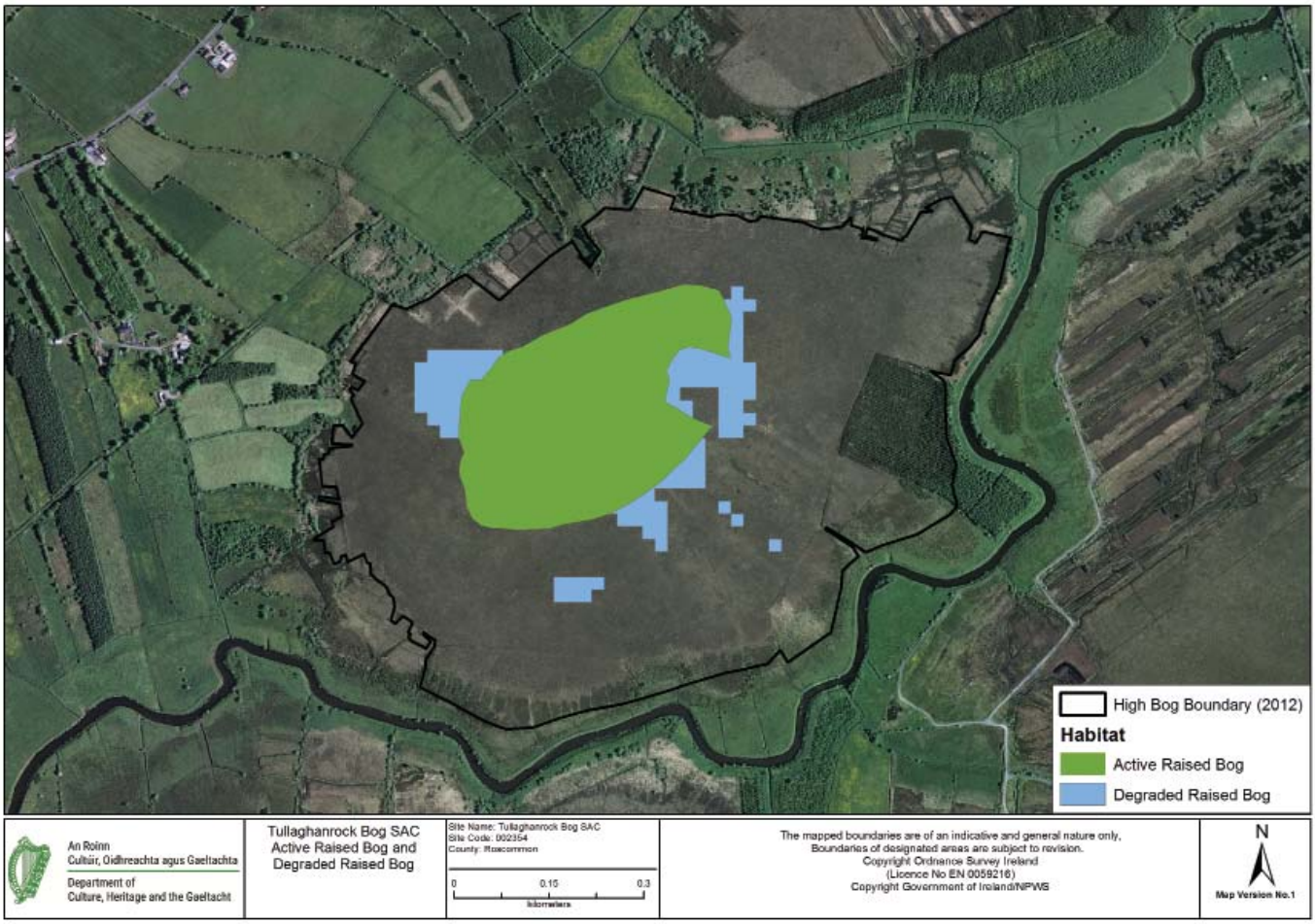
Site Statistics

Area of high bog in 1995 (ha):	62.8
Area of high bog in 2012 (ha):	62.8
Change in high bog (ha):	0.0
Change in high bog (%):	0.0%
No earlier survey available	N/A
Area of active raised bog in 1999 (ha) (Derwin & MacGowan, 2000).	11.0
Change in active raised bog (ha):	N/A
Change in active raised bog (%):	N/A
Area of degraded raised bog (ha):	3.9
Potential area bog peat-forming habitats (ha)	0.3

Composition of High Bog



- Active raised bog
- Degraded raised bog
- Potential supporting high bog habitat



An Roinn Cultúir, Oidhreachta agus Gaeltachta
Department of Culture, Heritage and the Gaeltacht

Tullaghanrock Bog SAC
Active Raised Bog and Degraded Raised Bog

Site Name: Tullaghanrock Bog SAC
Site Code: 002354
County: Roscommon

0 0.15 0.3
Kilometers

The mapped boundaries are of an indicative and general nature only.
Boundaries of designated areas are subject to revision.
Copyright Ordnance Survey Ireland
(Licence No EN 0059216)
Copyright Government of Ireland/NPWS

N

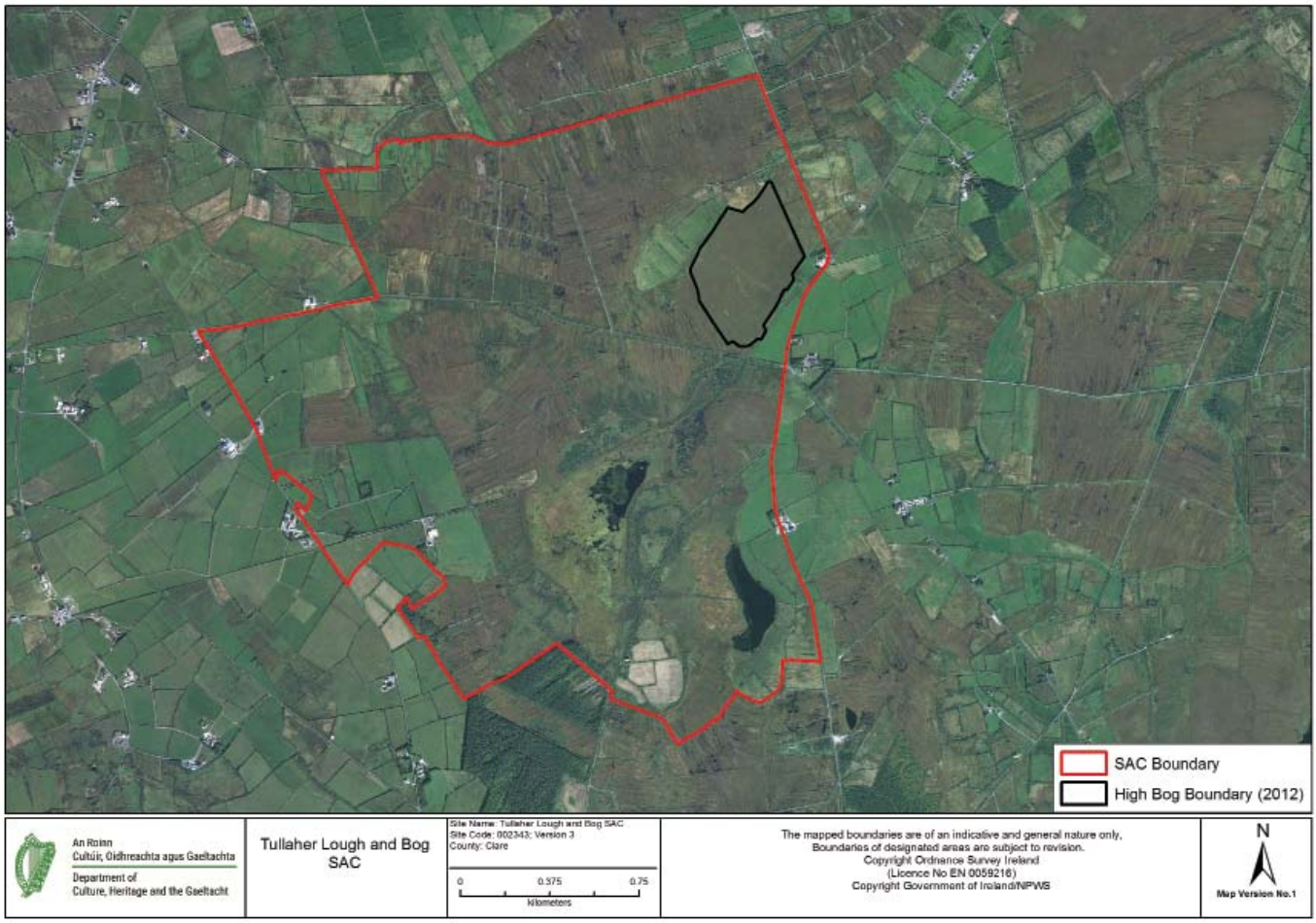
Map Version No.1

Tullaher Lough and Bog SAC - Summary

Site Name:	Tullaher Lough and Bog SAC
Site Code:	002343
Counties:	Clare
River Basin District:	Shannon
Sub-Catchment:	Doonbeg_SC_010
Further Information:	http://www.npws.ie/protected-sites/sac/002343

Site Summary:

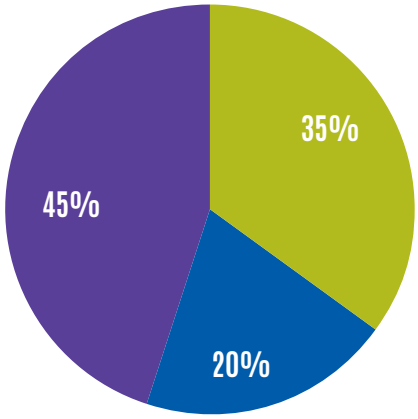
Tullagher Lough and Bog is located 4 km south-east of Doonbeg, Co Clare. This is a diverse site comprising raised bog, wet grassland, improved grassland, scrub woodland, alkaline fen and lake. The bog is of high conservation value due to the occurrence of a moderate area of active raised bog. The bog is also of importance as it is located at the western extent of the range.



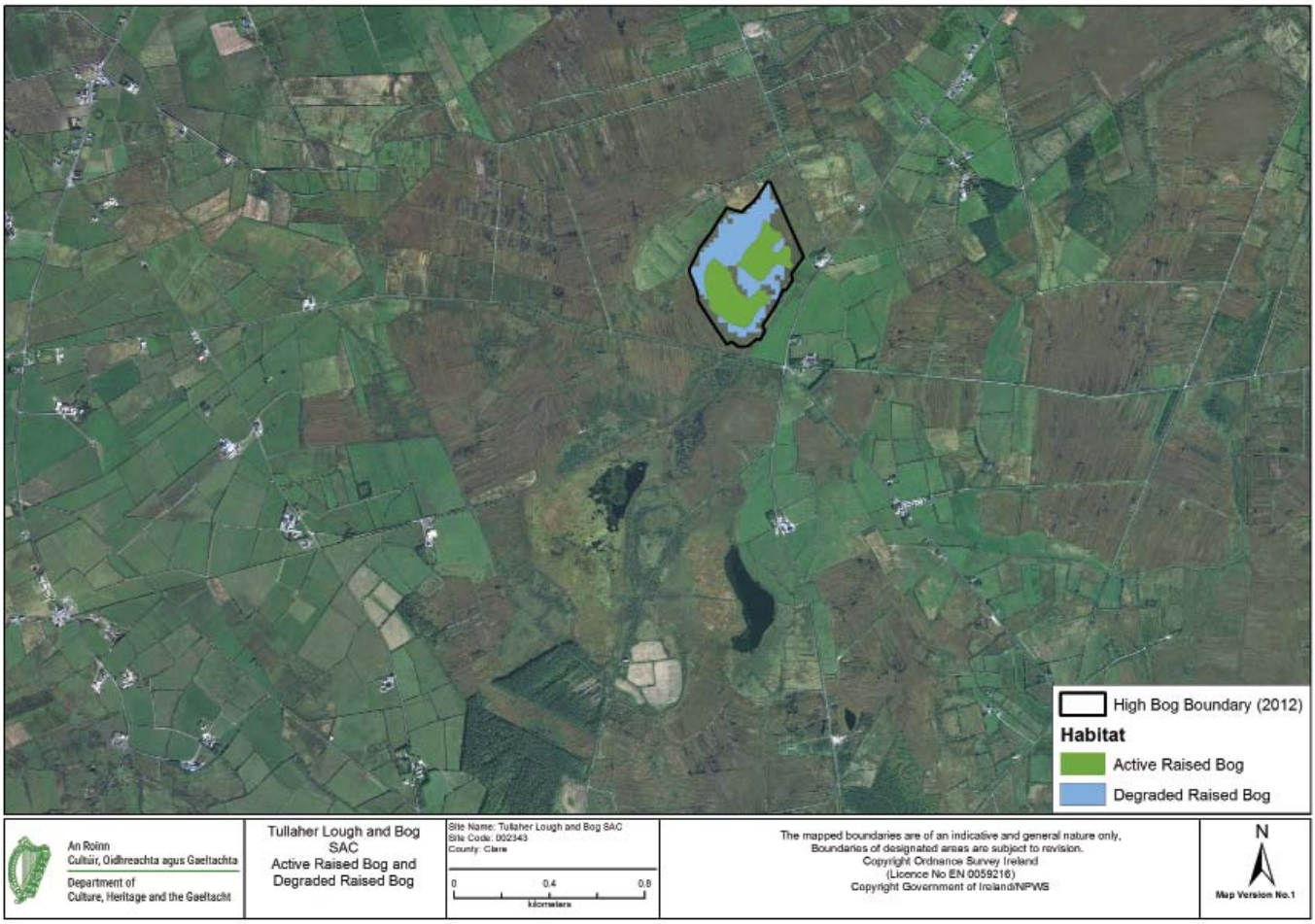
Site Statistics

Area of high bog in 1995 (ha):	19.6
Area of high bog in 2012 (ha):	19.6
Change in high bog (ha):	0.0
Change in high bog (%):	0.0%
No earlier survey available	N/A
Area of active raised bog in 1999 (ha) (Derwin & MacGowan, 2000)	6.8
Change in active raised bog (ha):	N/A
Change in active raised bog (%):	N/A
Area of degraded raised bog (ha):	4.0
Potential area bog peat-forming habitats (ha)	2.4

Composition of High Bog



- Active raised bog
- Degraded raised bog
- Potential supporting high bog habitat



Appendix 4

Article 6(3) Case Study - Lough Ree SAC, Co. Roscommon

Summary of Article 6.3 Case Study at Lough Ree SAC

Introduction

Fir Bog and Clooncraff Bog are located to the north-west and south-east of the complex of bogs known as 'Clooncraff and Cloonlarge Bogs' within Lough Ree SAC (000440) (Figure A4.1). Under Article 6(3) of the Habitats Directive turf-cutting can only continue within the SAC if it can be demonstrated that it will not impact, beyond any scientifically reasonable doubt, on the site-specific conservation objectives for Lough Ree SAC (or any other European site). This determination must be based on the best available scientific evidence.

This report describes the investigative approach and findings of a hydrological study completed on Lough Ree SAC in 2015. The study examined, inter alia whether continued turf-cutting at Fir Bog and Clooncraff Bog may pose a threat to the SAC's site-specific conservation objectives for ARB. More specifically, the study examined whether turf-cutting displayed potential to affect the extent of active raised bog (ARB), or areas capable of hosting ARB within 30 years following restoration measures (otherwise known as degraded raised bog (DRB)). The study considered the most extreme scenarios that could potentially impact ARB or DRB due to turf-cutting at Fir Bog and Clooncraff Bog.

This summary outlines the findings of hydrological investigations which were part of a wider process of undertaking Appropriate Assessment (AA) Screening and completion of a Natura Impact Statement. AA Screening also considered the potential for impacts on other qualifying interests of Lough Ree SAC as well as several other European sites in the surrounding areas with the potential to be impacted by the proposals for turf-cutting either alone, or in combination with other plans or projects.

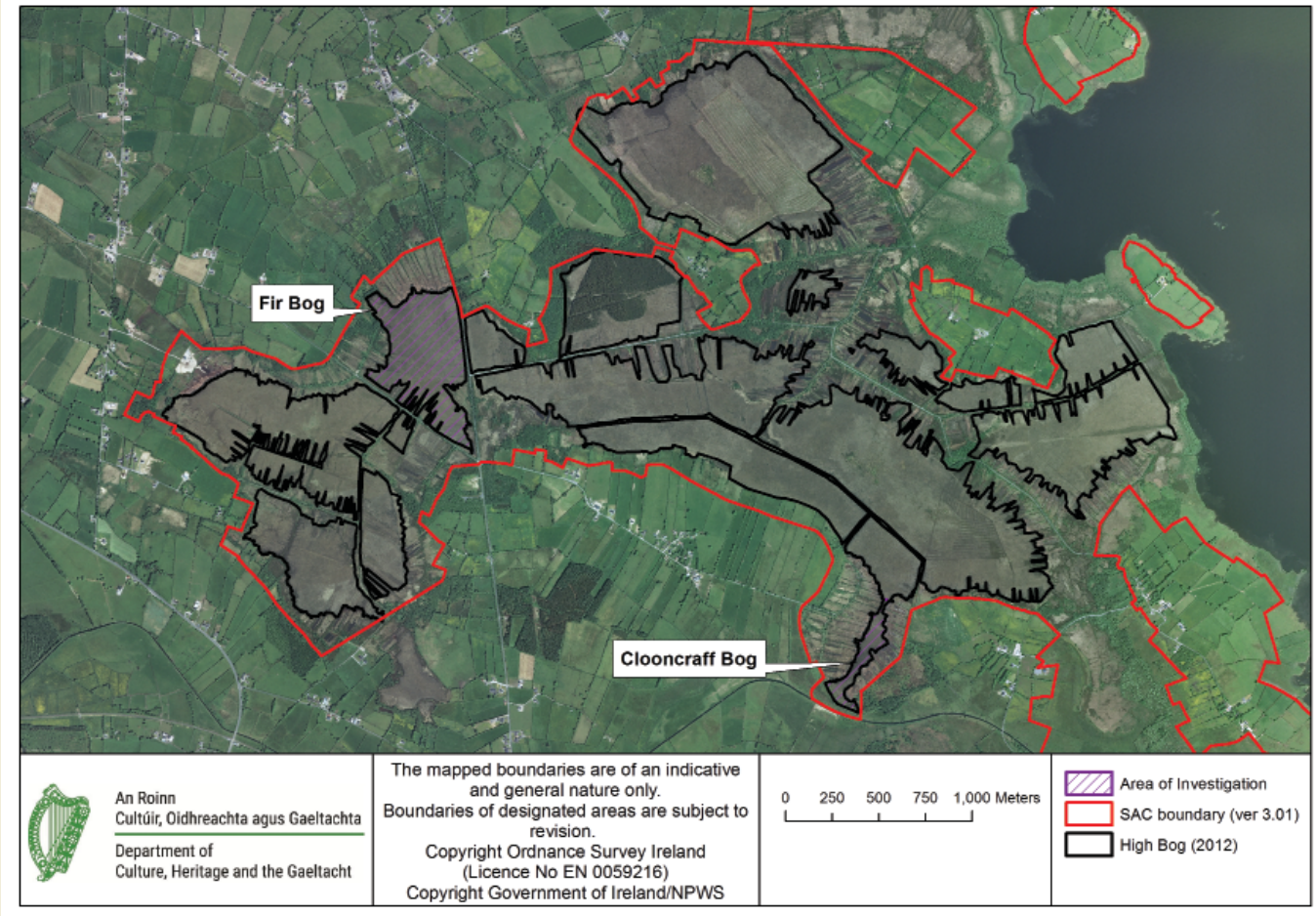


Figure A4.1: Location of Fir and Clooncraff Bog within Lough Ree SAC, Co. Roscommon.

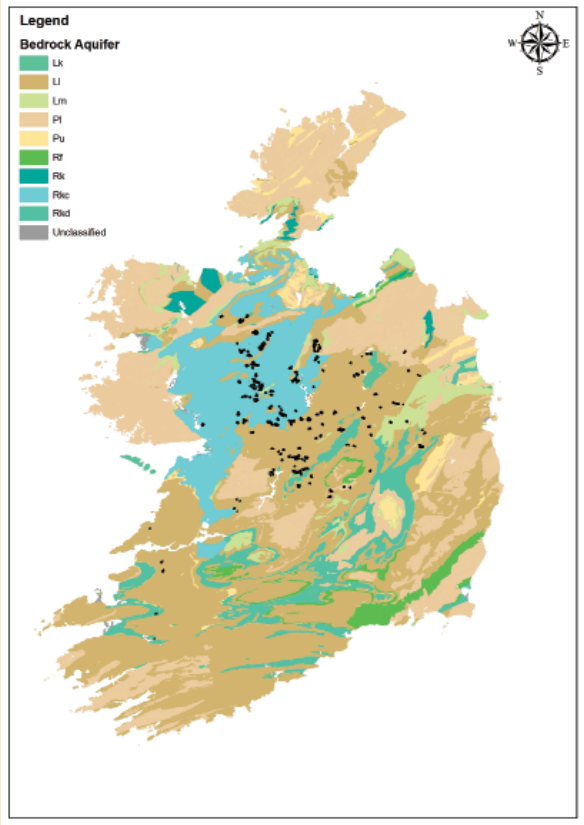
Investigation Methodology

A considerable body of knowledge has built up over the last 30 years concerning the eco-hydrology of Irish raised bogs. The Lough Ree SAC investigation has built on the concepts developed during these studies and, in conjunction with tried-and-tested investigative techniques, routinely employed in other forms of site investigation, was used to develop a state-of-the-art investigation protocol to assess the impact of proposed turf-cutting activity on the SAC's site-specific conservation objectives. An overview of critical elements of previous investigations provided below provides the background for the development of the investigation rationale employed.

Findings from previous investigations

Studies completed during the Irish-Dutch raised bog conservation study (see Schouten, 2002), and subsequent National Parks and Wildlife Service (NPWS) investigations, carried out in the early- to mid-1990s, demonstrated that ecological processes operating on Irish raised bogs differed from those published for many investigations completed elsewhere in Western Europe and North America. Many of these other areas were either in different climatic settings, or in areas where peat had been extensively impacted by drainage. By contrast, the high rainfall frequency and relatively undamaged nature of much of the peat investigated suggested different hydrological regimes operated on Irish raised bogs. Furthermore, work completed during the Irish-Dutch studies on Clara Bog SAC (Clara) and Raheenmore Bog SAC (Raheenmore), Co. Offaly, brought into question whether existing rules-of-thumb, developed during reclamation works (peat extraction and agricultural reclamation), carried out across Ireland in the 1960s and 1970s were valid for assessing the extent of impacts to peatland ecosystems from drainage; Irish-Dutch study findings had demonstrated that the impacts of drainage could extend into uncut bog considerably further than the 30m limit hitherto assumed. Indeed, measurements completed in detailed studies on Clara Bog and Raheenmore Bog revealed that distances where vegetation appeared to be impacted by marginal drainage associated with cutting could exceed 500m.

As part of the 2015 study, a desk-top survey of SACs and NHAs measured distances from peat cutting faces around bog margins (facebanks) to the nearest occurrence of ARB or DRB. This work provided a means of assessing whether findings from Clara and Raheenmore are representative of Irish bogs in general. Critically, the role of groundwater, hitherto considered negligible in most raised bog hydrological studies, was examined. Consequently, investigation data were subdivided according to the bedrock aquifer type underlying each site. The box and whisker plots Figure A4.2 summarise the results of this study.



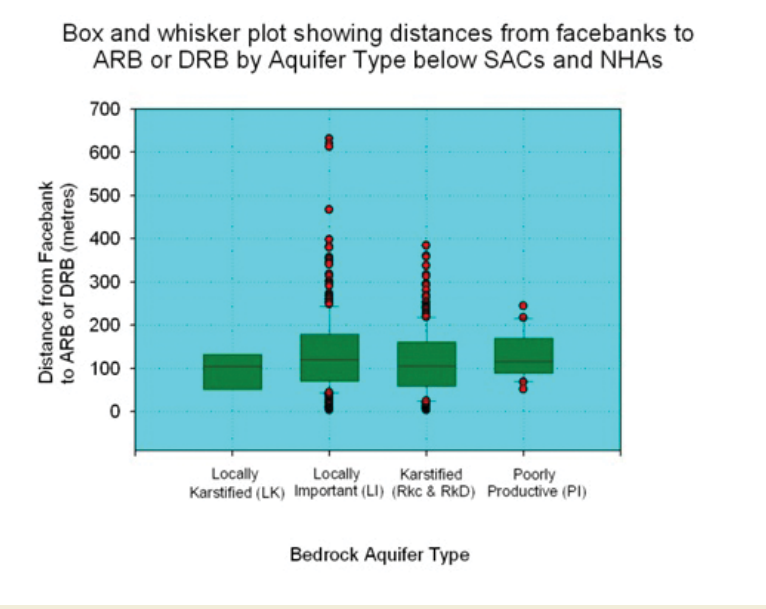


Figure A4.2: Left: Aquifer map of the Republic of Ireland showing the location of raised peat bogs considered in the survey of distance from marginal peat cutting faces (facebanks) to ARB or DRB. Right: Results of the survey classified by generic aquifer type.

Survey results revealed that distances between marginal turf-cutting faces (facebanks) and ARB/DRB varied substantially, with no significant differences apparent in the main body of the measurements between aquifer types; these ranged between 50m and 250m for all categories. However, it is apparent from Figure A4.2 that a significant number of outliers exist for those sites underlain by either locally important or karstified aquifers; these include measurements completed on Clara. Detailed investigations completed on Clara into the reason for such extensive impacts revealed that the site is underlain by a highly permeable Lower Carboniferous limestone aquifer that was subject to karstification (enlargements of water transmitting cracks in bedrock) (Flynn *et al.*, 2013). Declines in the water pressure (head) of this aquifer could extend over large areas; these changes have been shown to impact peatland hydrology for great distances. The locations where impacts occurred depended on geological conditions, with areas underlain by fine-grained low permeability deposits being less affected than sites where peat rests on top of coarser (more permeable) materials. Geophysical investigations carried out at Clara provided a means to examine the geological setting of the area of uncut bog in detail over significant distances from the nearest facebanks, without the need for extensive drilling/excavation.

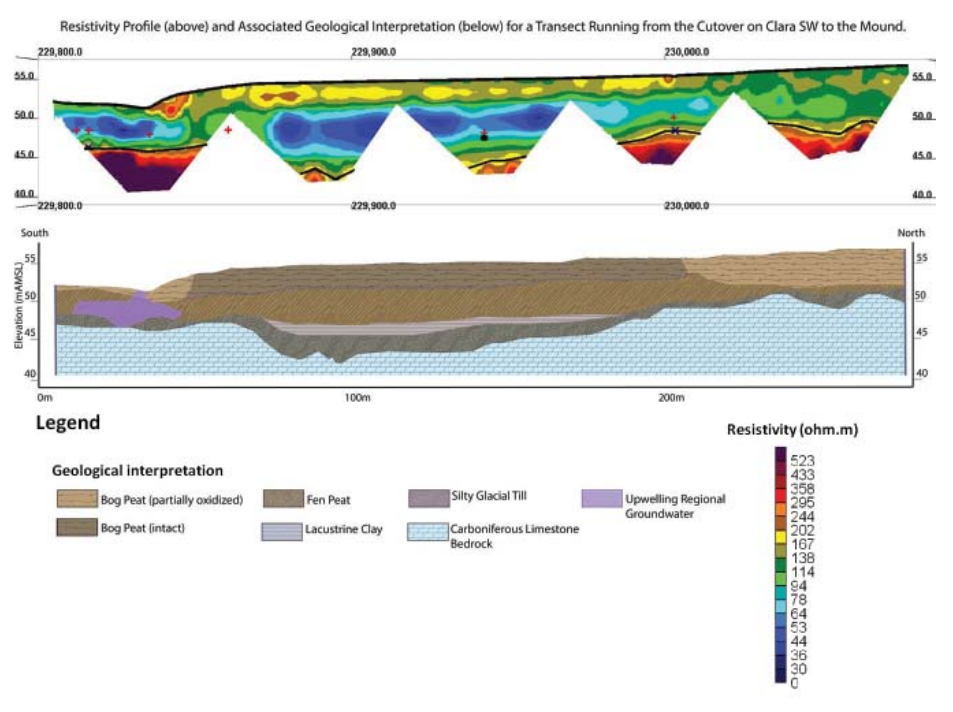


Figure A4.3: Geophysical survey results completed on south-western side of Clara Bog, Co. Offaly (above) and geological interpretation (below). Upwelling of deeper groundwater from bedrock is represented in purple. The upwelling water has generated significant alterations to peat topography, particularly in areas where fine-grained unconsolidated inorganic substrate materials are thin to absent below the peat. These changes have, in turn, altered the bog's eco-hydrology.

The results of the survey, when coupled with the findings of geological investigations and hydrochemical studies, revealed that cutting at a marginal drain, where peat substrate materials were thin to absent, permitted significant discharge of over-pressured groundwater from the underlying bedrock aquifer to discharge to the drain after peat ruptured under critical conditions (see Methods Box 2). This has generated a decline in the bedrock groundwater pressure (head) whose impact has, in the highly permeable bedrock, extended below the bog.

Geological and geophysical investigations at Clara also revealed the site's physical setting departs significantly from classical conditions associated with raised bog development, i.e. peat developing over lake sediments. Although these conditions exist below large areas of the site in many more locations, where the peat substrate is more elevated, they are absent; coring has shown glacial till with limestone clasts to be present immediately below the peat in many of these areas. Moreover, the presence of tree stumps below the peat on these deposits, (observed in outcrop), indicated that the material may have been subjected to sub aerial weathering, which can enhance its permeability. The permeability and thickness of the till can strongly influence its vertical connectivity with underlying aquifers and the capacity to allow deep groundwater to discharge and potentially affect a bog's hydrology at distance. According to the Clara geophysical surveys, the thickness of the till varies dramatically, and in some places is thin to absent, with peat below high bog occurring

in very close direct proximity to the bedrock aquifer. In the case of the results presented in Figure A4.3, these areas correspond to those zones where peat experienced significant subsidence.

By contrast, investigations completed over the central part of Clara showed drainage impacts to be largely associated with deeper drains cut into the peat (with no upwelling of deeper groundwater). Critically, measurements of hydrological and geotechnical properties in both areas demonstrated a significant contrast in properties and their trends. In those areas where no upwelling of deeper (regional) groundwater occurred, organic matter measurements demonstrated that peat compacted preferentially closer to the ground surface, while in settings such as that presented in Figure A4.3, where declines in groundwater level enhanced vertical losses of water from the bog, peat compacted preferentially at the base. In both cases subsidence caused a decline in peat hydraulic conductivity (ability to transmit water). In the case of the road bisecting Clara, the decline in hydraulic conductivity, coupled with roadside drainage has resulted in the generation of a hydraulic barrier that significantly restricts hydrogeological impacts on one side of the bog from propagating to the other.

Desk-Based Site Investigation

The highly heterogeneous conditions encountered at Clara are indicative of the variability of physical settings of Irish raised bogs, where geological conditions may vary dramatically over short distances. This investigation aimed to investigate whether the extreme impacts observed at sites like Clara could occur at Lough Ree SAC due to proposed turf-cutting at Fir Bog and Clooncraff Bog. Prior to undertaking detailed measurements in the field, a desk-based study was undertaken to optimise investigative effort and resources. Existing national geological and hydrological databases provided a basis for better understanding the physical setting of Lough Ree SAC and for identifying data gaps that needed to be addressed to provide a sufficiently thorough understanding of the site's eco-hydrology, along with the potential of ongoing peat cutting to impact it.

A review of historical topographic maps and subsequent aerial imagery, has shown that the area of uncut (or high) bog has declined substantially since the area was first surveyed in the early 1800s. Figure A4.4 presents losses experienced in the vicinity of Fir Bog, including losses between 1973 and 2012.

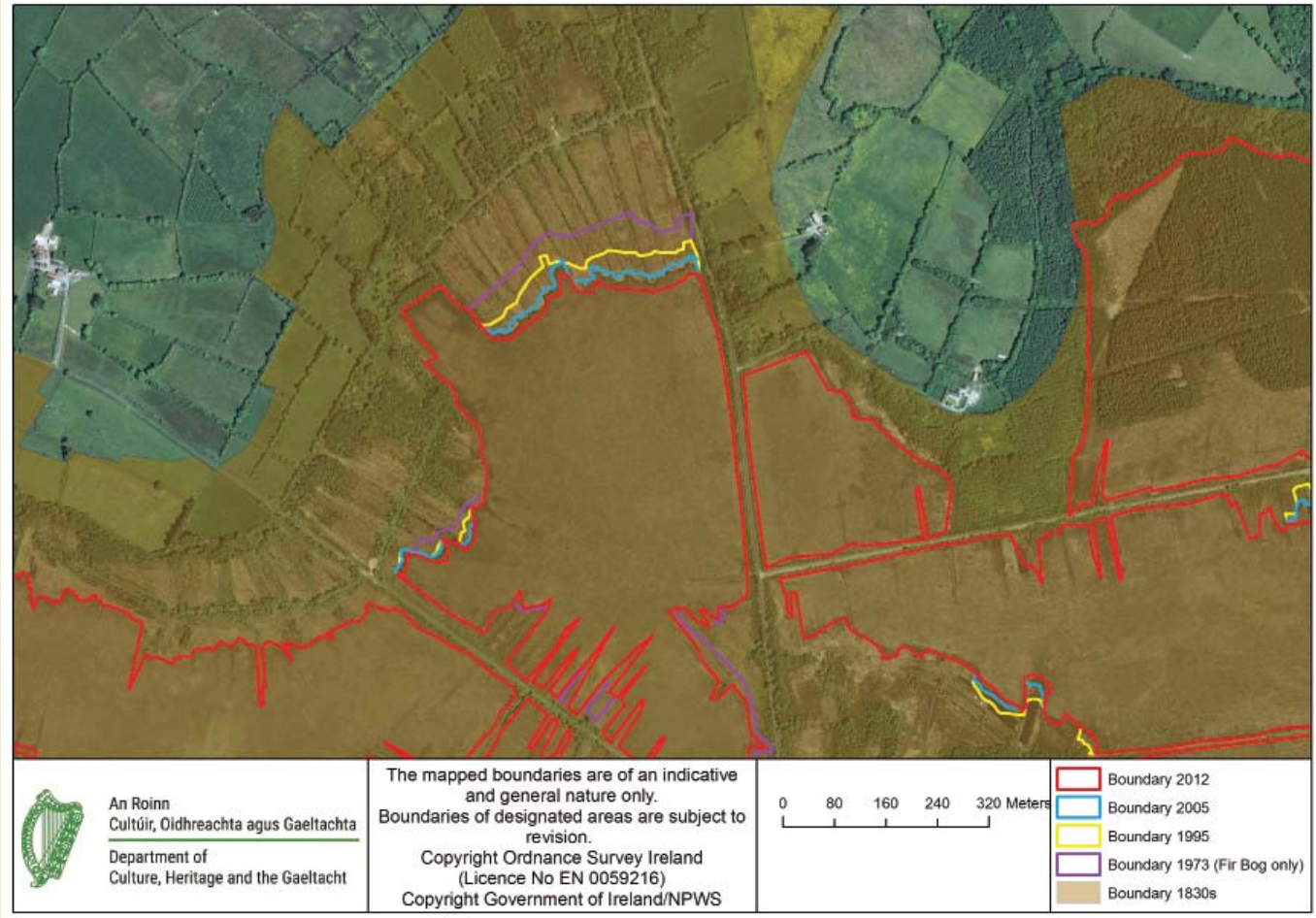


Figure A4.4: Uncut boundary of Fir Bog, as mapped by HM Ordnance Survey 1838 (shaded brown), superimposed on site boundaries for 1973, 1995, 2005 and 2012 (data from OSI and GSI).

Examination of geological data sets revealed the box complex to be underlain by locally important and regionally productive bedrock aquifer types (Figure A4.5). These categories underlie many of the sites where damage to ARB and DRB occurs at extended distances from facebanks, including those encountered in Clara. In a similar vein, subsoil maps generated for the area show peat interspersed with glacial till containing limestone clasts (Figure A4.6), again with similar to conditions encountered across much of Clara. The GSI groundwater viewer indicates low annual recharge rates from the peat to the underlying substrate of approximately 25mm/yr (typical range 1–50mm/yr).

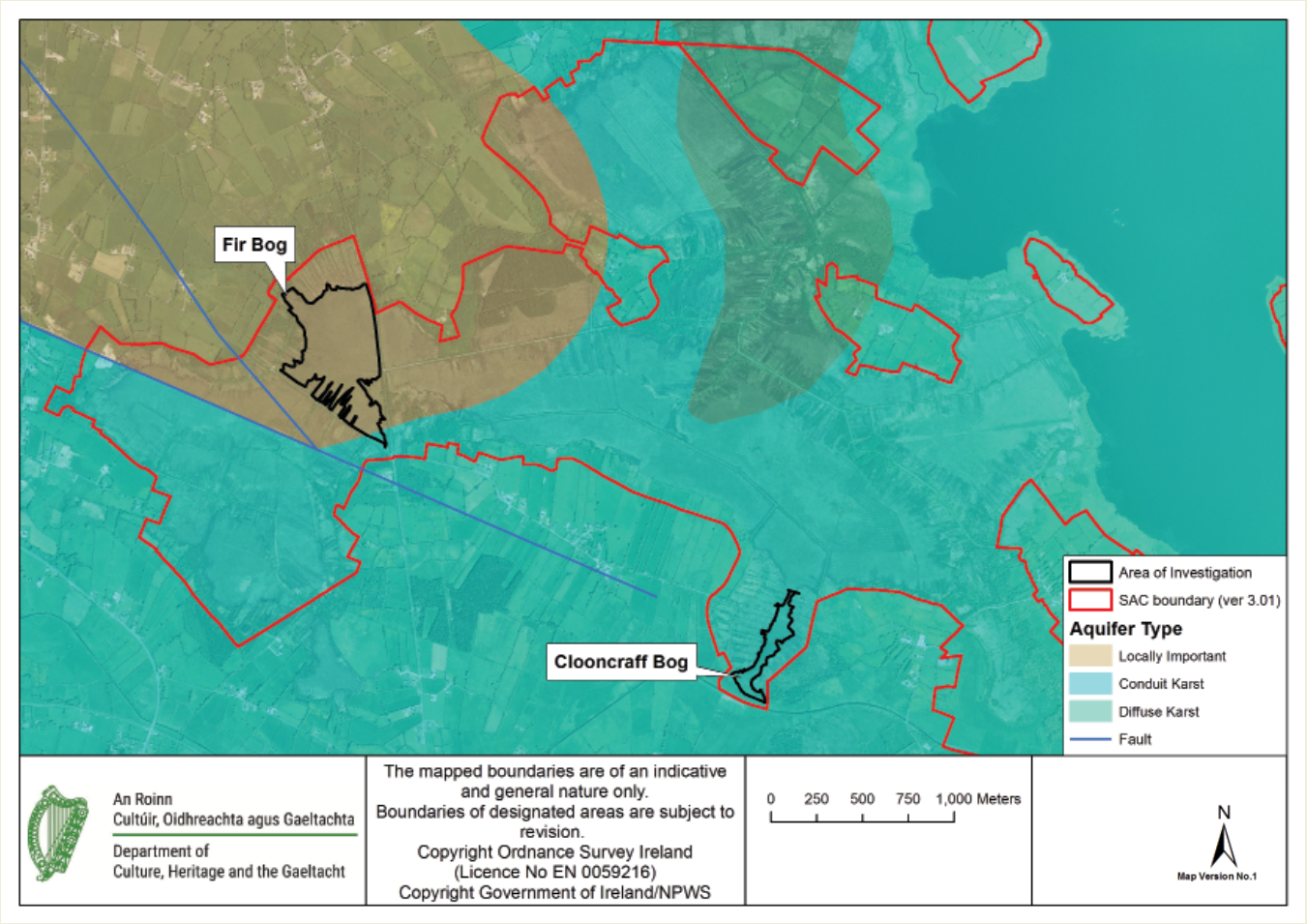


Figure A4.5: Bedrock aquifer map of Clooncraff and Cloonlarge Bog complex and its surroundings. Aquifer categories underlying the site correspond to those below Clara (data source: GSI).

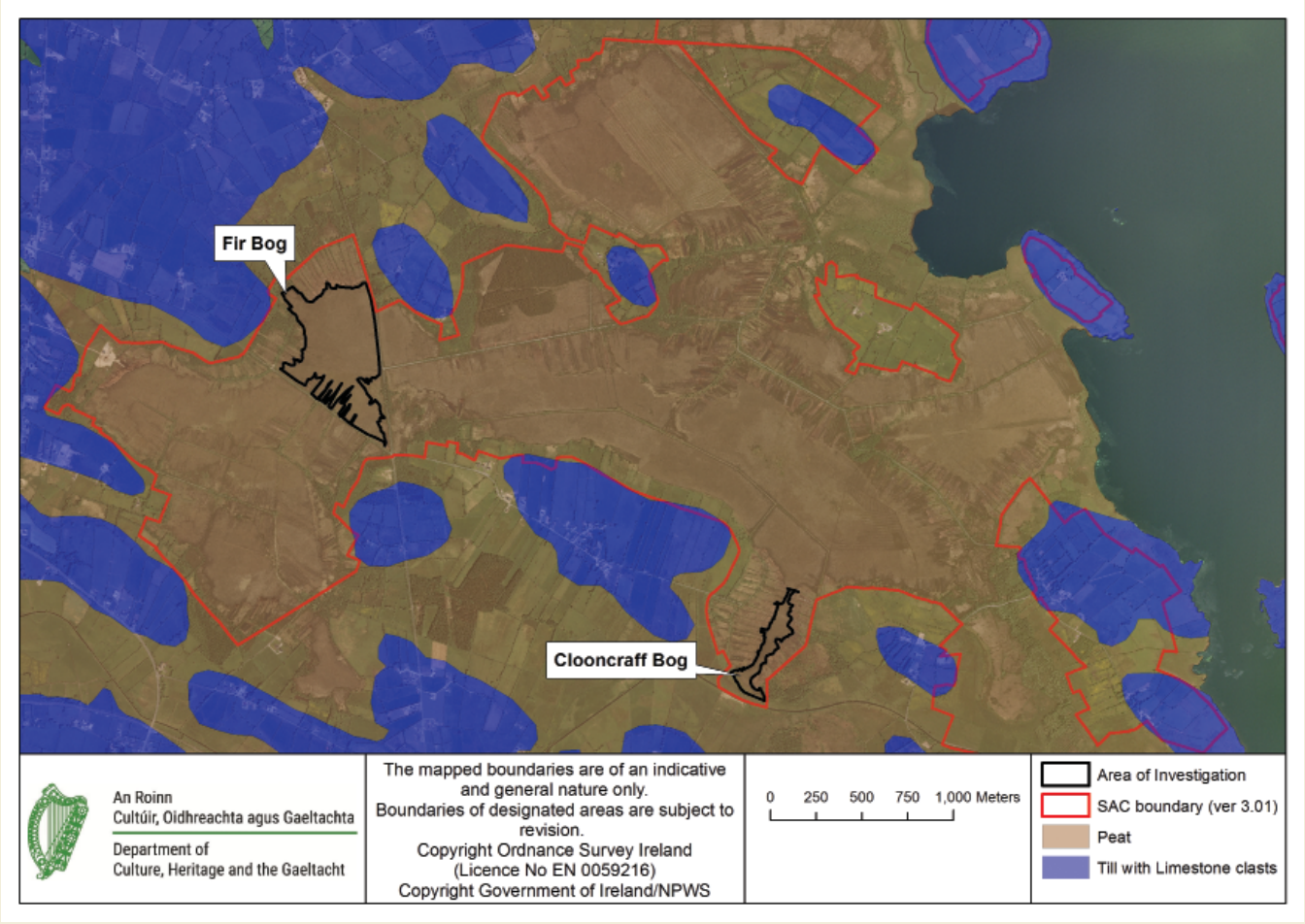


Figure A4.6: Quaternary (Subsoil) geological map of the unconsolidated deposits in the vicinity of Clooncraff and Cloonlarge Bog complex its surroundings. Conditions resemble those encountered below much of Clara. (Data source: GSI)

Ecotope mapping

Ecotopes across the high bog surface were mapped in 2003 as part of the turf-cutting impact assessment project by Fernandez *et al.*, (2006). In May 2015 a targeted ecotope survey was carried out to assess presence of ARB on specific sections of the high bog including the areas proposed for turf-cutting at Fir Bog and Clooncraff Bog. Evidence gathered from these investigations indicates that there has been further loss of ARB habitat from the high bog since the 2003 survey. No ARB was mapped on either area where turf-cutting is proposed.

Hydrological modelling of the site using LiDAR data, collected in 2012, has permitted identification of areas of DRB (see Appendix 2). These, when combined with the results of the most recent ecotope survey, have permitted definition of the distribution of ARB and DRB across the bog complex. This information, coupled with the extent of cutting proposed at Fir Bog and Clooncraff Bog, has allowed identification of the potential for ongoing cutting to impact remaining areas of ARB and DRB. Figure A4.7 presents the extent of these habitats in the vicinity of Fir Bog and shows that although DRB does not occur with 250m of the southernmost extent of projected cutting (the maximum distance for impacts on most bogs) it is encountered within a 650m radius.

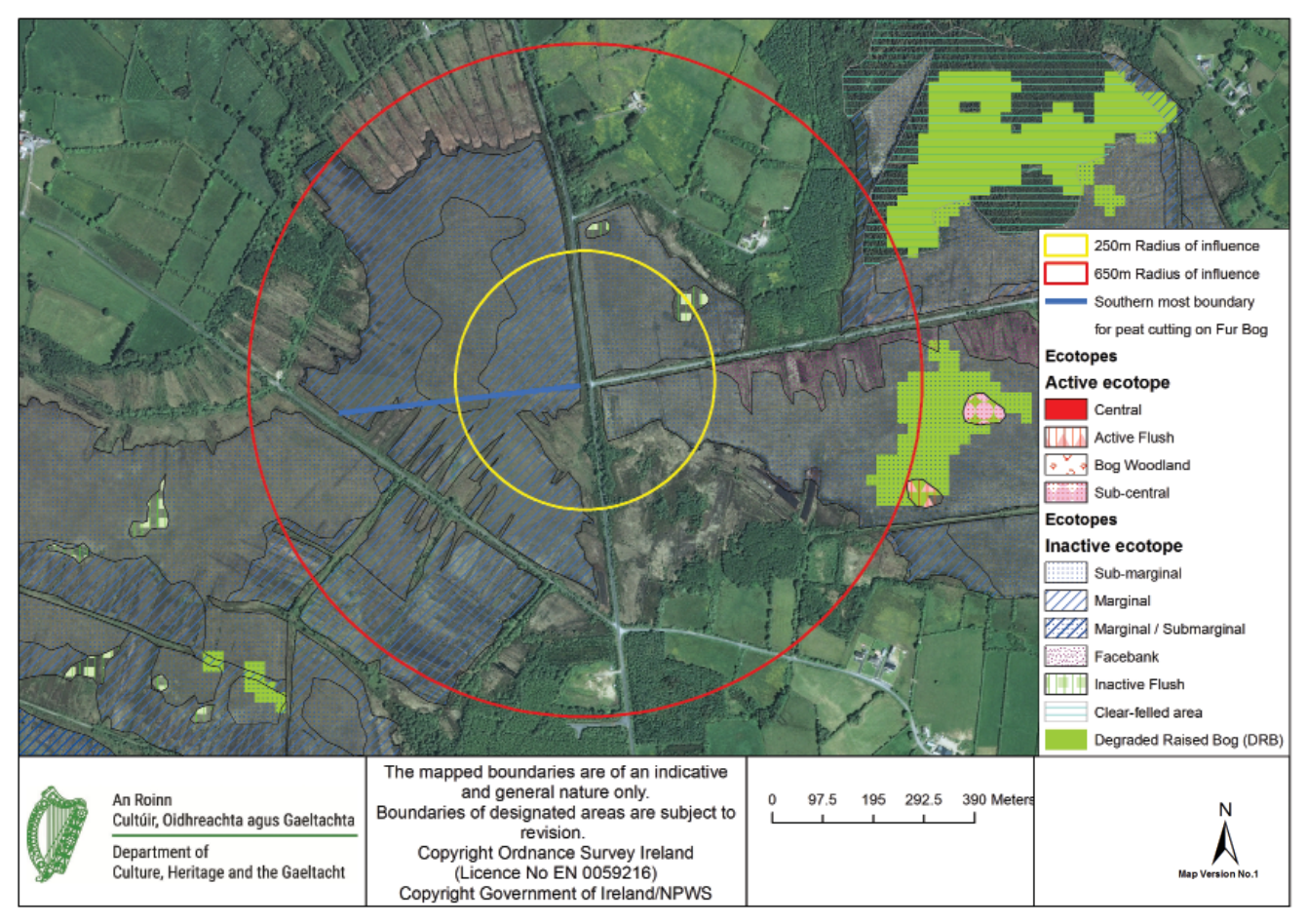


Figure A4.7: Map of Fir Bog, Lough Ree SAC, showing the southernmost extent of proposed turf-cutting. The 250m and 650m circles extending from the closest point where turf-cutting will take place along the east or Fir Bog to the nearest areas of ARB or DRB aim to reflect the typical extent of impacts from turf-cutting. Typically no impacts would be anticipated beyond approximately 250m if there are no impacts to underlying groundwater (depending on site-specific conditions), but impacts to DRB may be expected at up (or exceeding) to 650m if significant regional groundwater upwelling occurs with cutting.

In the case of Clooncraff Bog a similar review indicates that no ARB occurs within 250m of the area where turf-cutting is proposed. However, ARB (including an area of bog woodland) does occur within 650m of the area where turf-cutting is proposed. Given the karstified nature of the underlying bedrock, potential of impacts to these habitats, due to ongoing turf-cutting at Clooncraff, could not be eliminated (Figure A4.8).

The occurrence of ARB within the 650m radius of cutting implies that the possibility of detrimental impact to it cannot be eliminated based on the existing published data. To assess whether this may occur requires site-specific field-based investigations to more accurately characterise subsurface conditions below Fir Bog and Clooncraff Bog and the adjacent areas, approaching the ARB and DRB habitats. Based on analogies with the study completed at Clara, these investigations needed to establish with

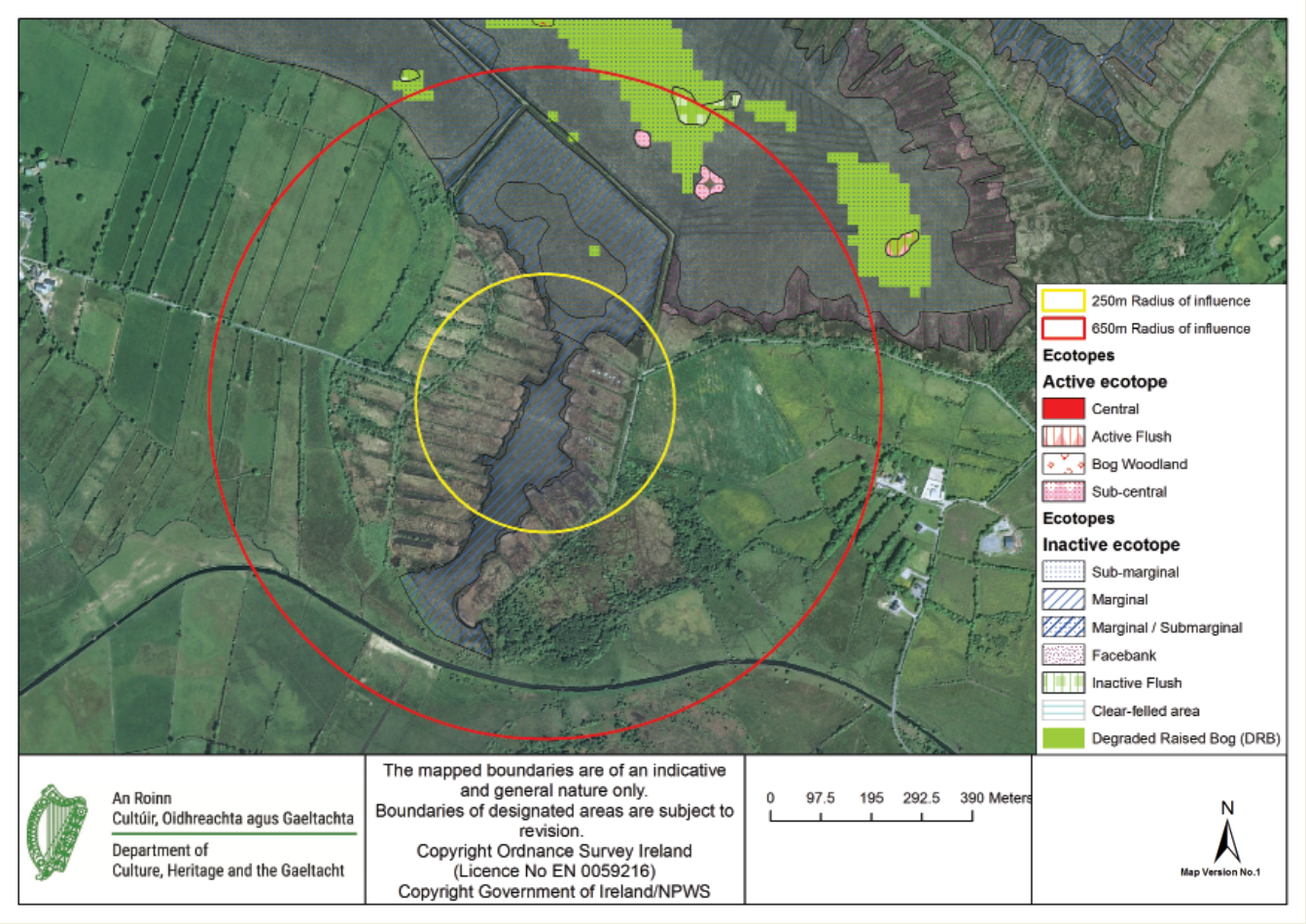


Figure A4.8: Clooncraff Bog, Lough Ree SAC. Although no ARB occurs within the 250m radius, ARB (including bog woodland) and DRB is found within the 650m interval, indicating significant potential for impacts if groundwater impacts cannot be ruled out.

confidence the predicted extent of impacts arising from peat cutting; this included a detailed assessment of the material below the site and whether, as at Clara, the road separating Fir Bog from the rest of the SAC acted as a hydraulic barrier, thus restricting the impacts of cutting.

Field Investigations

Field investigations, completed in the summer and autumn of 2015, aimed to improve understanding of the geological conditions at Lough Ree SAC, particularly below the high bog.

Two progressively more detailed phases of investigation aimed to characterise the inter relationship between the bog and its substrate.

Phase 1

The initial phase of field investigation carried out at Lough Ree SAC aimed to characterise the peat substrate across the entire bog complex. Results of 32 cores, including nine taken around Fir Bog and six taken around Clooncraff Bog, demonstrated the peat substrate to have a complex geometry and highly variable composition, ranging from shell marl to sandy gravels; some of these deposits are not presented on published subsoil maps, emphasising the need for further subsurface investigation to better characterise the site.

A survey of the specific electrical conductivity (SEC) of water flowing in marginal drains, completed during a prolonged dry period in late May 2015, examined the contribution of water upwelling from the peat substrate to drain flow. The survey noted SEC levels in drain water that ranged from 32µS/cm to 470µS/cm, reflecting bog water and upwelling deeper groundwater respectively. Critically, the chemistry of samples collected around Fir Bog were dominated by bog water with localised deeper groundwater upwelling only observed (a) approaching the northern boundary of the peat and mineral soil, and (b) in the vicinity of the cutting boundary on the southern part of the site. SEC levels varied more significantly in the vicinity of Clooncraff Bog, with elevated levels in the cutover again reflecting upwelling deeper (more mineralised) groundwater.

Based in the results of the investigation, further investigations were considered necessary on Fir Bog and Clooncraff Bog to assess impacts of continued cutting on site-specific conservation objectives.

Phase 2

A more detailed second phase of field investigation (Phase 2), initiated in late August 2015, aimed to provide a more comprehensive picture of the subsoil geological conditions underlying Fir Bog and Clooncraff Bog. The resulting data provided a scientific basis for understanding to what extent the high bog area at Fir Bog and Clooncraff Bog, proposed for turf-cutting, provided a supporting function for ARB and/or DRB habitat in other parts of the bog complex. This would therefore permit the impact of cutting on site eco-hydrology to be defined.

Specific activities consisted of the following:

a) Ground penetrating radar (GPR) survey: A programme of GPR surveying permitted the base of the peat to be mapped. Survey lines were run at a spacing and resolution greater than that used in state-of-the-art peat commercial resource assessment. Figure A4.9 presents the locations of lines on Fir Bog and its immediate surroundings. Six GPR lines were run from north to south across Fir Bog at spacings of between 50 and 100m, while a seventh line was run along the southern limit of proposed continued peat cutting. Further lines were run immediately to the east of the site, including a transect extending from the eastern boundary of Fir Bog to the closest area of DRB (Figure A4.9). In total 5,200m of GPR transects were run in this area. Hand probing was carried out along all transects at approximately 100m intervals, where peat coring data were not available. Peat depths, when combined with high resolution topographic (LiDAR) data, permitted the elevation of the peat substrate to be determined. Figure A4.10 presents the locations of GPR survey lines on Clooncraff Bog. GPR surveys at Clooncraff Bog (1,550m of transects) were completed at similar spacings to those at Fir Bog to ensure comparable resolution. Similarly, routine probing was carried out to assess the depth of substrate for device calibration.

b) Electrical resistivity tomography (ERT) survey: ERT was employed to determine the depth to bedrock across the areas targeted for investigation. Figure A4.9 presents ERT transect locations on Fir Bog. In total 1,800m of transects provided detailed survey data on bedrock conditions below Fir Bog. Figure A4.10 presents ERT transect locations on Clooncraff Bog, where a total of 500m of transects were completed. As with GPR, subtraction of depths to peat from high resolution topographic data along transect lines permitted a contour map, reflecting the bedrock surface, to be generated. Moreover, subtraction of peat substrate from bedrock surface has permitted a map of till thickness (till isopach) below uncut bog to be constructed. This latter element provided the basis for identifying intervals where unconsolidated peat substrate materials may be thin to absent and risk of upwelling deeper groundwater was greater.

c) Peat coring: Peat coring served a number of crucial functions in the characterisation of Fir Bog:
   (i) It permitted sampling of peat for laboratory analysis (loss on ignition and organic matter content);
   (ii) It allowed visual analysis of peat samples for genetic classification (bog peat/fen peat) and assessment of degree of humification (degree of decomposition);
   (iii) It provided further information on peat thickness to assist in GPR survey line calibration; and
   (iv) It allowed the composition of the bog substrate to be sampled and described.

Organic matter content in bogs can be highly variable. It ranged by a factor of three to four in previous investigations at Clara Bog, albeit in a systematic manner that reflected the influence of drainage. At other raised bogs, organic matter contents have been shown to vary in a similar manner, both in magnitude and degree of variation. Nonetheless, trends on Fir Bog could not be predicted based on findings from Clara alone, due to possible differences in undisturbed peat content between sites. In order to minimise ambiguity associated with the investigations at Lough Ree SAC, a detailed programme of site-specific peat sampling and analyses was undertaken at the locations shown in Figure A4.11 to evaluate its spatial variation (with distance from drains and with depth).

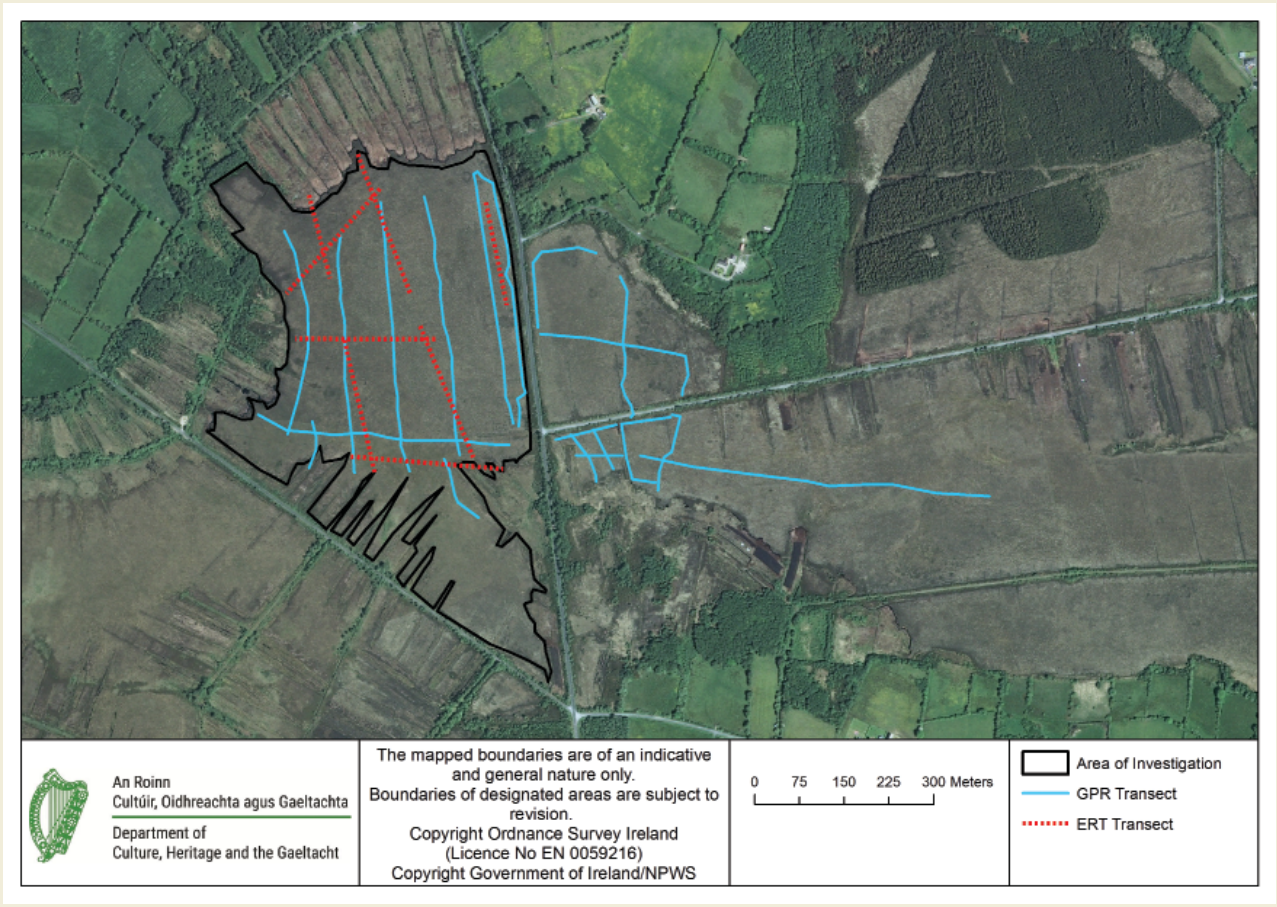


Figure A4.9: Location of GPR and ERT transects at Fir Bog and its immediate surroundings, Lough Ree SAC, Co. Roscommon.

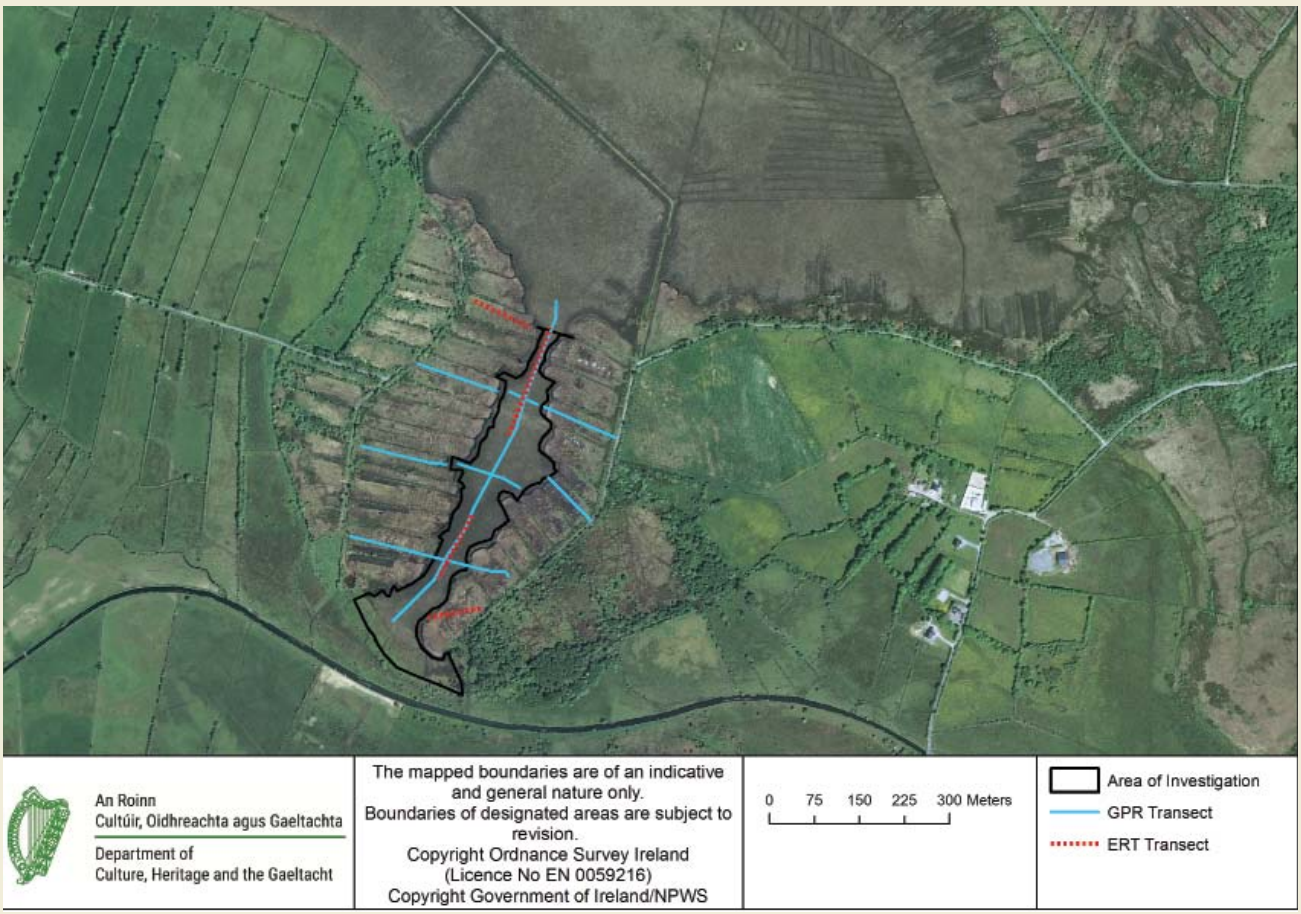


Figure A4.10: Location of GPR and ERT transects at Clooncraff Bog and its immediate surroundings, Lough Ree SAC, Co. Roscommon.

Overall, a total of 54 peat cores were sampled from the ground surface to the base of the peat, involving the collection of 1,372 samples (as illustrated in Figure A4.11). To maximise the quality of the samples collected, a stainless steel Eijkelkamp Russian auger collected 50mm diameter x 25cm long peat samples every 25cm from the ground surface to the base of the peat. Immediate sealing of samples in watertight aluminium containers following sampling prevented water loss from samples due to evaporation before weighing in the field. Subsequently, 1,372 samples were analysed for organic matter content by drying at 95 degrees until sample weights remained stable. Analysis of a subset of 127 samples for inorganic matter content (through loss on ignition) permitted quantification of loss of organic matter due to in situ oxidation. A further 30 samples of substrate material were also collected using this method to permit properties to be better characterised and compared with substrate samples collected at greater depth.

The results of peat analyses permitted resolution of a range of critical issues relevant to the objectives of the investigations. All focused on the degree of subsidence experienced/anticipated in the peat at various locations across the investigation area at Fir Bog and in the bog immediately to the east. The resulting data provided a basis for quantifying the impact of drainage on both surface and subsurface hydrological regimes. Through the principle of conservation of matter, comparison of organic matter content extending from the bog margins to an undisturbed central location allowed change in content to be linked with drainage and peat thickness. This may be expressed mathematically as follows (see Methods Box 1 for further details):

$$\frac{om_{DRAINED}}{om_{INTACT}} = \frac{z_{INTACT}}{z_{DRAINED}}$$

Consequently a given organic matter content and thickness at a drained site may be related to that at a reference location to determine the degree of subsidence experienced. Based on these observations, relationships between subsidence and drainage in space and, where age of cutting has been defined, in time, permit prediction of changes in peat thickness arising from cutting to be determined. Consequently, combining these data with peat thickness models of the site allows the impact of continued cutting on the topography of adjacent areas to be predicted. This in turn provides a means of stating whether cutting and associated drainage, at its maximum extent, will affect surface eco-hydrological processes.

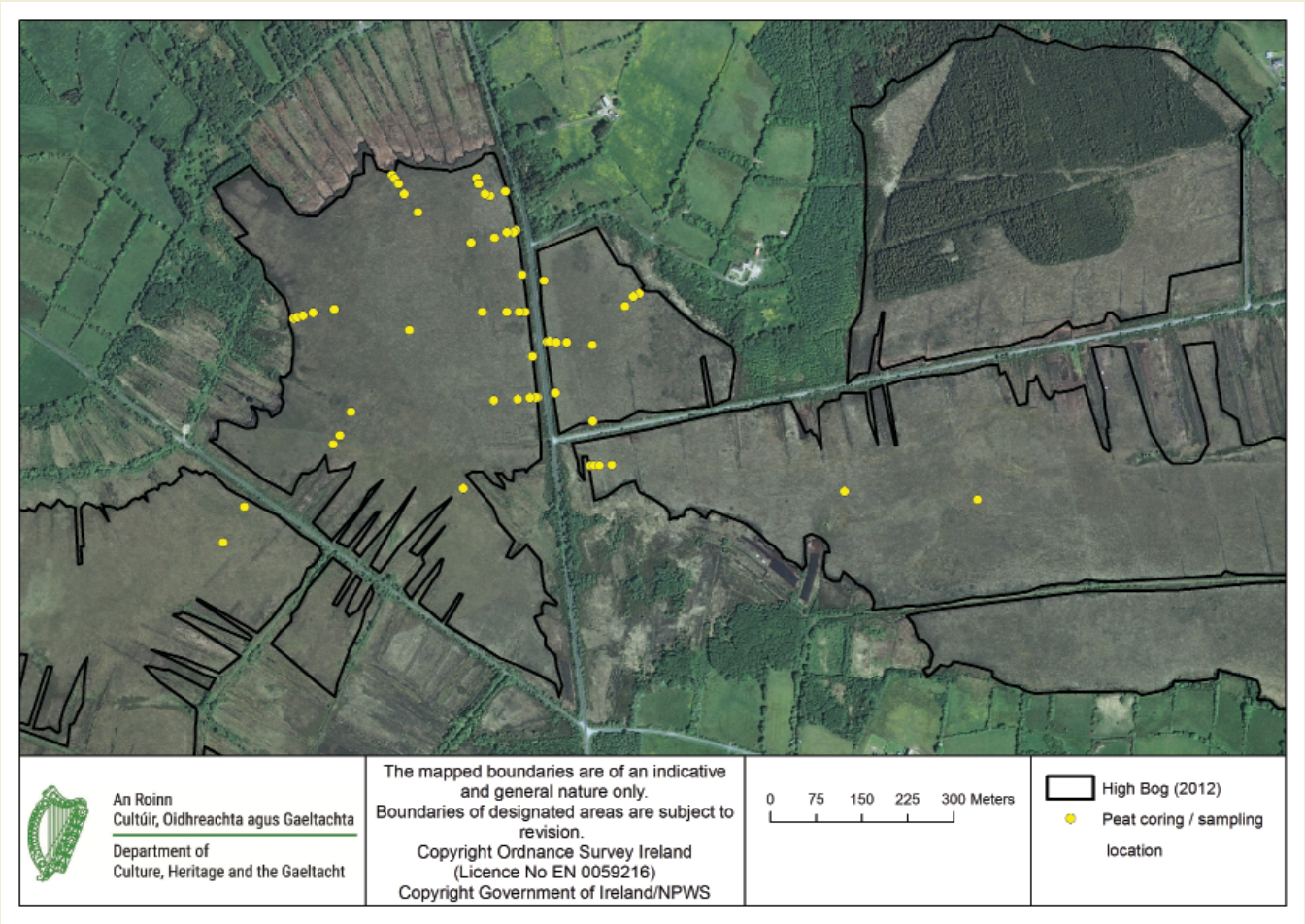


Figure A4.11: Location of peat sampling locations at Fir Bog and its immediate surroundings, Lough Ree SAC, Co. Roscommon

Due to the extent of turf-cutting at Clooncraff Bog that has taken place to date and the degree of settlement/ compaction that has already occurred in this area peat samples were not collected for analysis from this area. Additionally, Clooncraff is essentially isolated from the remaining section of intact high bog where its only connection is a narrow neck of peat less than 15m wide. It is therefore likely that the peat in this area has experienced its terminal impact from subsidence.

In addition to assessing impacts on surface hydrology, investigations at Clara revealed that drainage can influence groundwater flow in peat, with drainage causing a reduction in permeability, while also increasing the capacity of the peat to resist deformation arising from reduced water levels. These changes can allow physical features, such as roads, to act as effective barriers that can reduce and possibly limit the impact of cutting in adjacent uncut bog.

d) Piezometer installation: To assess the impact of drainage on peat properties 27 piezometers were installed at different depths at 17 locations on Fir Bog and the area immediately to the east (Figure A4.12). The 32mm ID HDPE piezometers with 50cm or 1m slotted intervals permitted measurement of water levels across the site to be assessed. Locations were concentrated around the road on the eastern boundary of Fir Bog to assess whether drainage in the area caused significant changes in the hydrogeological properties of the peat in more undisturbed areas. At the same time piezometer testing (rising head tests /falling head tests) completed using submersible data loggers allowed the hydraulic conductivity of the peat to be analysed using either Hvorslev (1951) or Bouwer & Rice (1976) methods (for fully saturated or partially saturated screened intervals respectively).

e) Substrate drilling/piezometers: Coring surveys data from both phases of investigation revealed Fir Bog's substrate to consist of fine-grained material (calcareous silts and clays) of variable stiffness. To better assess the nature (thickness and properties) of the peat substrate a programme of power auger drilling and substrate piezometer installation at five locations was carried out to investigate the properties of the materials underlying the peat at five locations. Continuous sample collection below the peat base allowed examination of how substrate properties varied with depth, while also permitting validation of the interpretation of geophysical survey data.

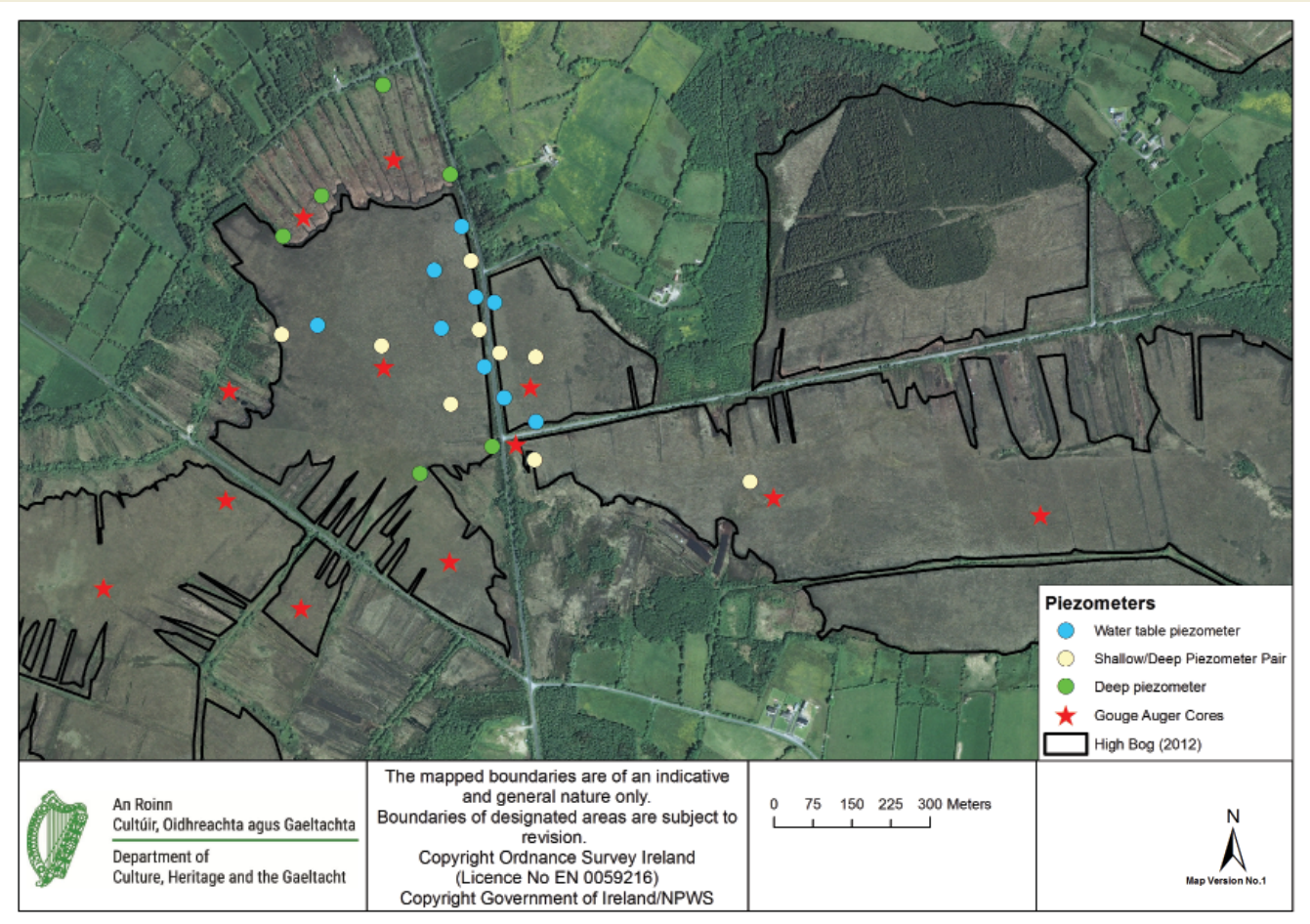


Figure A4.12: Location of piezometers and gouge auger sampling points at Fir Bog and its immediate surroundings, Lough Ree SAC

Investigation Results

GPR: Figure A4.13 presents the results of the GPR survey for Fir Bog. Results show the substrate on the western side of the site to be over 4m higher than the lowest intervals on the eastern side. Given the bog's relatively flat topography, this reflects a thinning of the peat in this area. By contrast, a prominent trough runs NW–SE below the road that separates the bog from the main body of the SAC. This reflects significantly greater thicknesses of peat in this area. Following the same approach with data collected from Clooncraff Bog revealed that the substrate, although dominated by shell marl in the uppermost layers, was underlain by unconsolidated deposits with comparable geophysical properties to that immediately underlying much of Fir Bog.

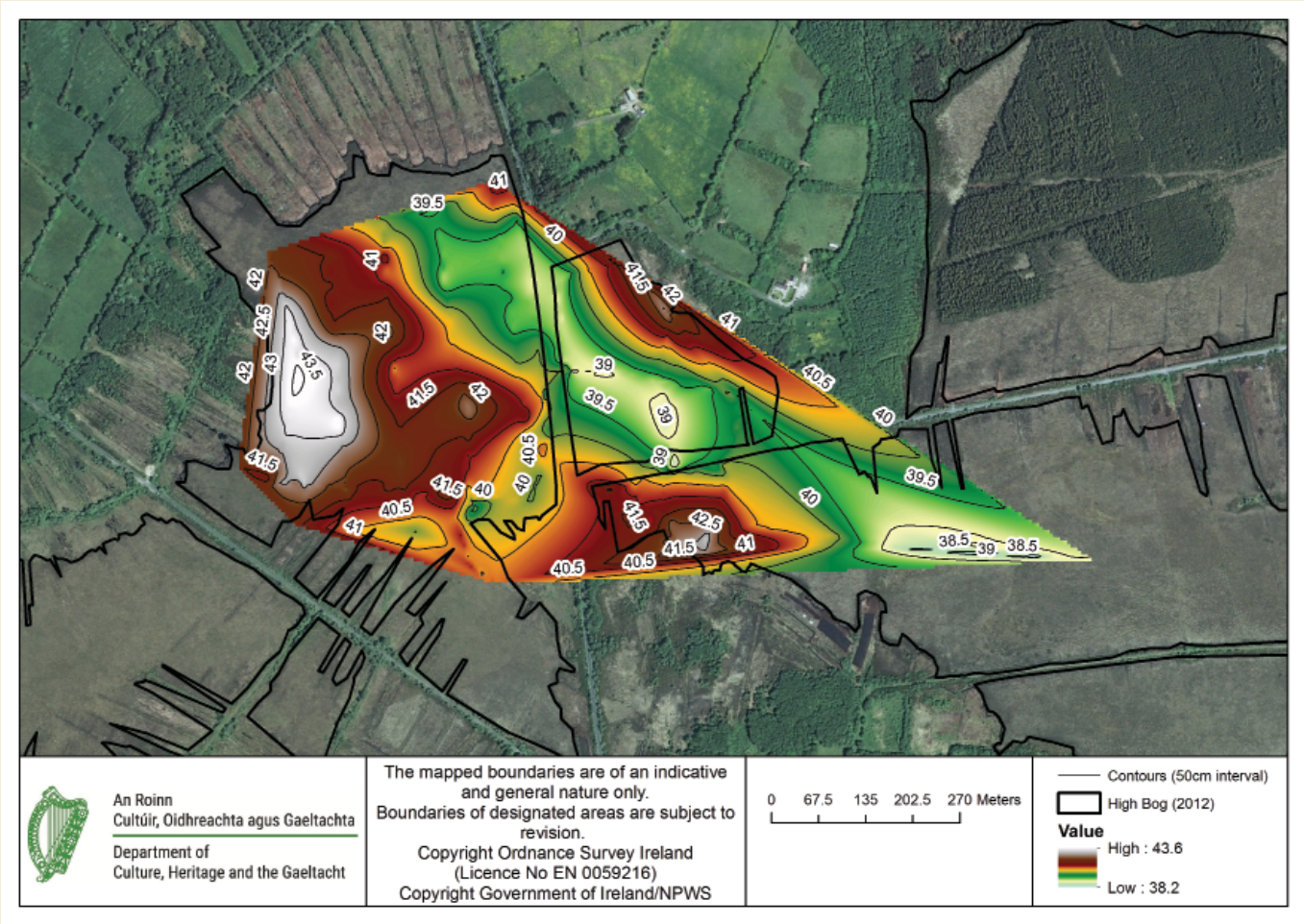


Figure A4.13: Peat substrate surface map of Fir Bog and its immediate vicinity to the east, approaching the nearest areas of DRB, Lough Ree SAC.

ERT survey: ERT survey results, when coupled with the results of peat substrate drilling demonstrated the method to be successful for detecting the base of unconsolidated material resting on bedrock. Figure A4.14, which compiles findings with results of coring, LiDAR and GPR surveys, provides a representative geological section across the site. Extension of this approach across Fir Bog and Clooncraff Bog has permitted (isopach) maps of substrate thickness to be generated. Figure A4.15 and Figure A4.16 present these maps and reveals that substrate thickness below Fir Bog ranges from between 3 and 4m in the centre to over 15m on the western side. Critically, findings show that substrate thins dramatically to the south of the southern boundary of projected cutting. This corresponds to a zone of minor groundwater upwelling, detected in a hydrochemical survey of the bog's marginal drains, completed in May 2015. This also corresponds to the area where greatest risk of development of critical conditions occurs (see Methods Box 2). The substrate isopach map of Clooncraff shows that unconsolidated peat substrate thickness is extremely thin (less than 1m) at the northern boundary of the target area. By contrast thicknesses in excess of 18m have been detected further south.

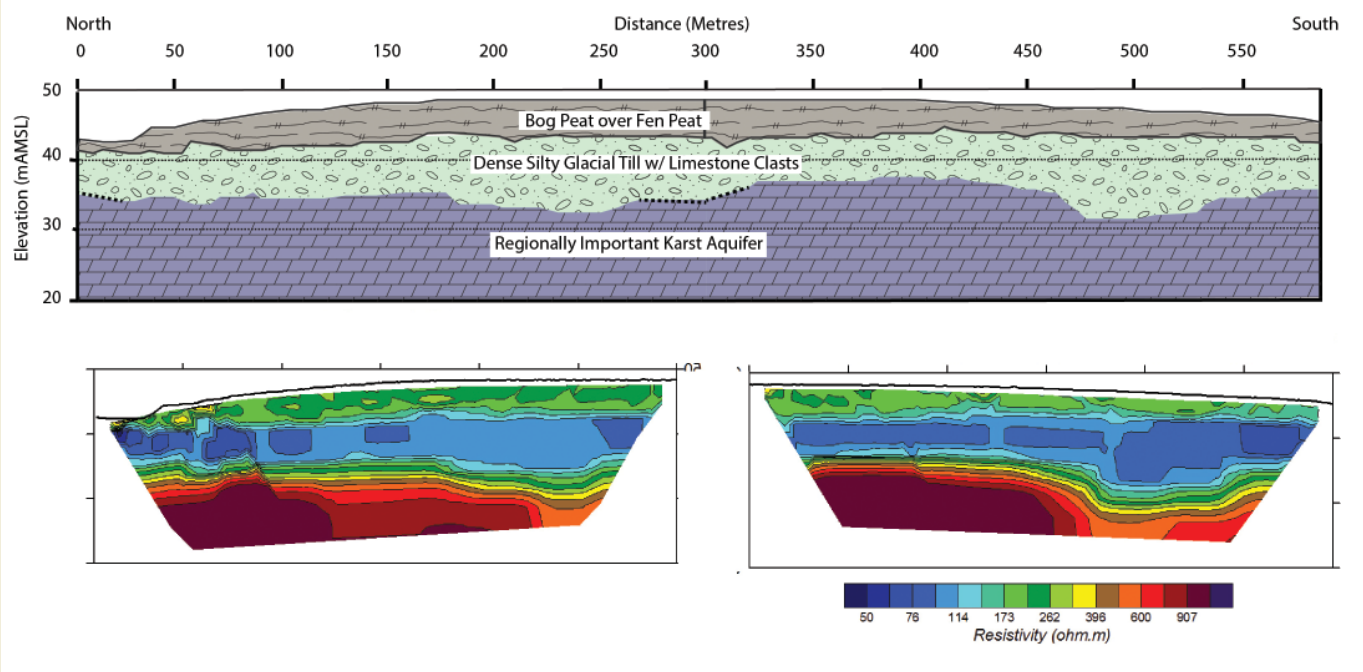


Figure A4.14: Geological cross section derived from geophysical and geological data along ERT transect R4 on Fir Bog; (Below) ERT Survey Results for the R4 transect, Fir Bog, Lough Ree SAC. Note the significant thickness of substrate material below the peat (dense glacial till with limestone clasts)

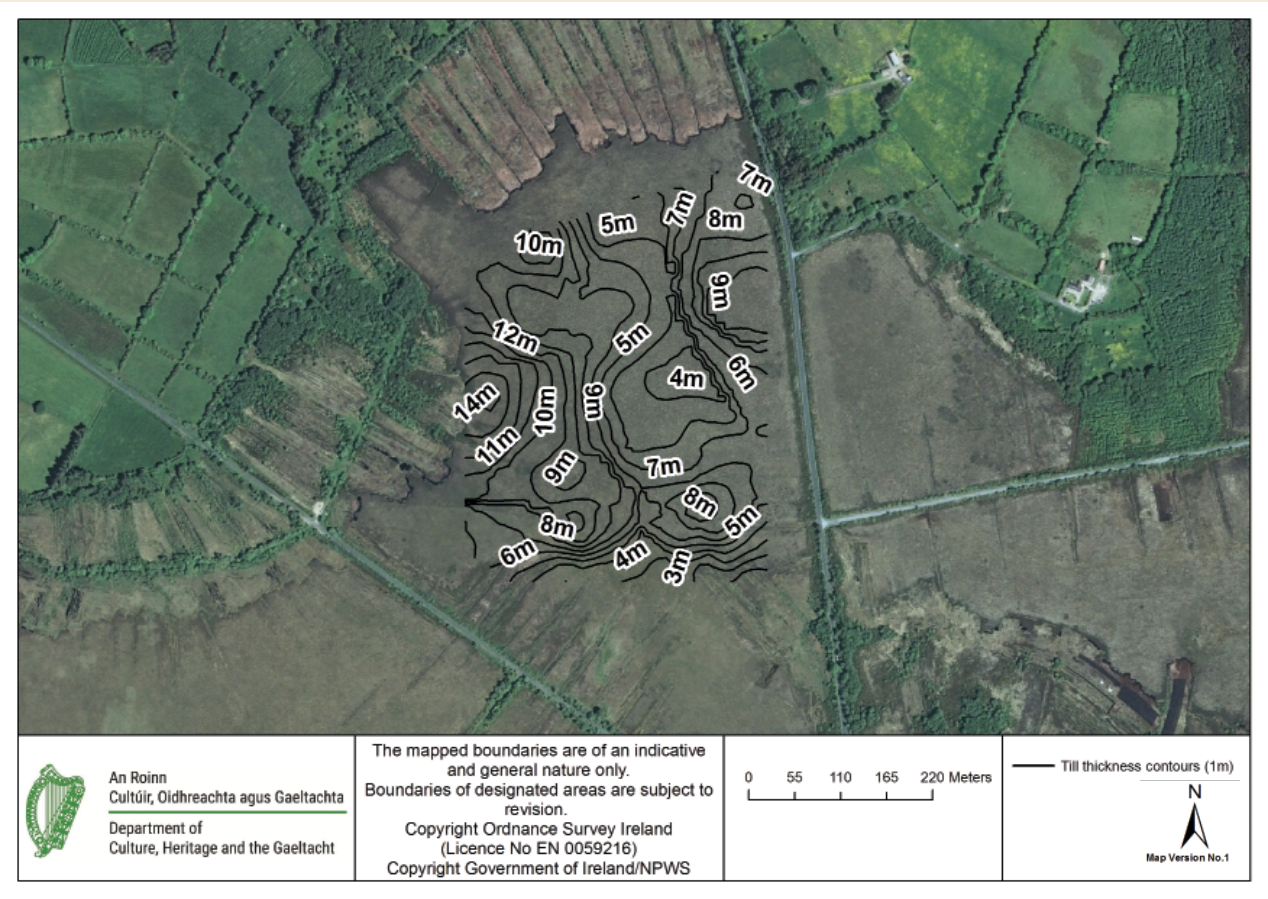


Figure A4.15: Till thickness contours at Fir Bog, Lough Ree SAC.

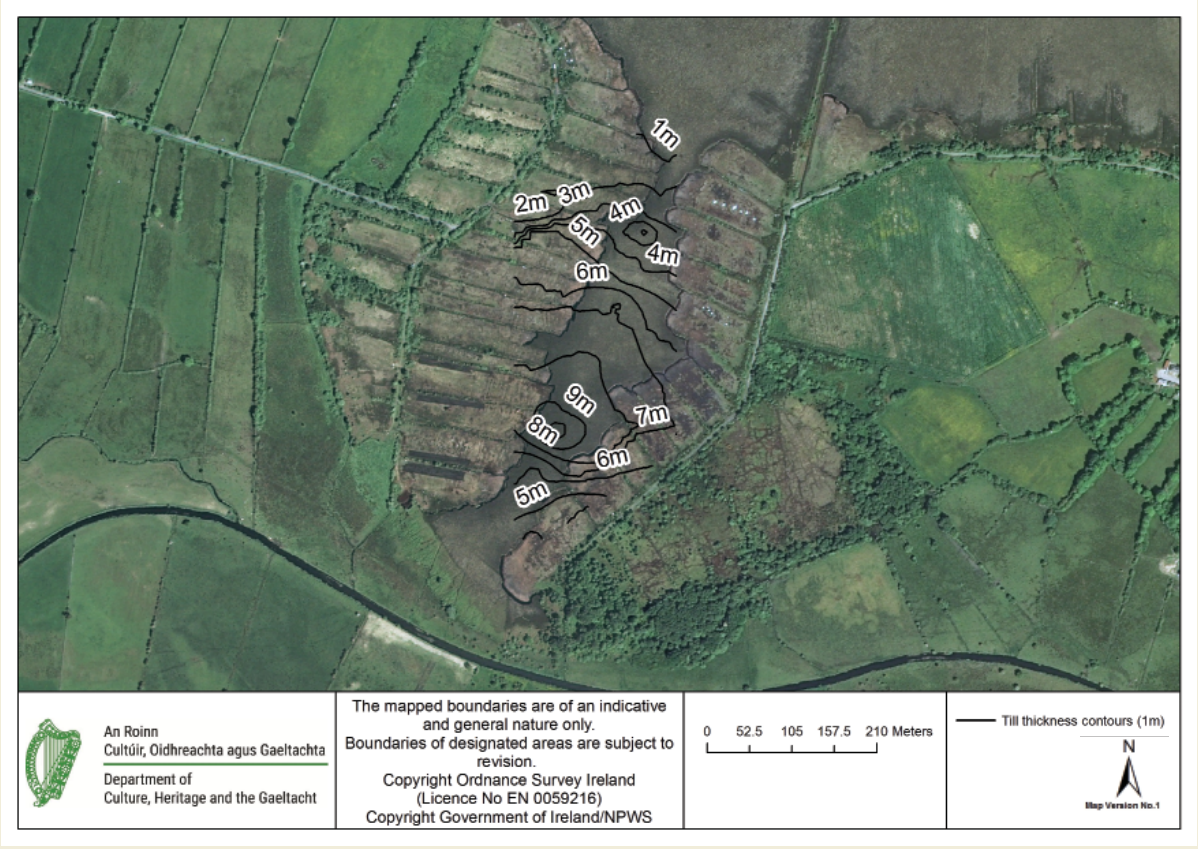


Figure A4.16: Till thickness contours at Clooncraff Bog, Lough Ree SAC.

Peat coring: The extensive programme of peat coring completed at Fir Bog displayed many similarities with conditions encountered in Clara. Overall organic matter content in uncut bog peat samples declined with distance away from drains. High levels encountered in samples collected near older deep drains contrasted with the lowest levels encountered in samples collected in those areas most removed from any influence of drainage. Critically, organic matter levels in cores collected from adjacent to the road separating Fir Bog from the rest of the SAC were significantly lower than on Clara where the roadside drains were significantly deeper.

Plotting depth averaged organic matter content for all coring locations with distance from drains revealed a wide scatter of points in samples collected close to drains. This variation declines with distance and eventually converges to levels resembling background contents at a distance of 232m from drains. The steepest decline occurs in samples collected from transects extending from older deep drains, notably those running in from the western side of the site where no cutting has occurred for at least the past 40 years.

Piezometer measurements: Water level measurement taken in piezometers installed across Fir Bog revealed the water table in the peat to lie consistently within 1m of the ground surface at more than 10m from all drains. Levels in transects extending in from roadside drains were typically less than 50cm below ground and rose closer to the ground surface with increasing distance. At those locations where paired piezometers were installed, hydraulic gradients always had a downward component. This, when combined with drain chemistry, reflects a vertical loss of water from the bog to the underlying substrate, albeit at low rates. By implication it also reveals that the groundwater level in uncut peat is higher than the level in substrate materials.

Results of hydraulic conductivity testing reveal elevated values for peat from tests carried out in all piezometers compared to those published for non-Irish raised bog peats. On the other hand the values obtained were typical of intact peats on many Irish raised bogs. Critically results show that peat permeability does not decline significantly approaching roadside drains, a trend also observed in the organic matter content of samples collected from peat cores in the same area. Elsewhere the capacity of the peat to transmit water, as reflected by hydraulic conductivity values, declines slightly with depth and indicates that it is more difficult for water to flow through deeper (fen) peat.

Peat substrate drilling/testing: Drilling through the substrate below uncut peat at Fir Bog consistently encountered calcareous silty glacial till with limestone clasts, comparable to samples encountered during hand coring. Testing of hand samples revealed those examined close to the interface with the overlying peat to have a soft to very firm consistency. Samples collected at depths greater than 1m below this level, although having similar composition, proved considerably stronger, being stiff to very stiff. Installation of piezometers (monitoring wells)

into this material revealed it to have a very low hydraulic conductivity, based on times taken for the wells to fill up with groundwater; this is typical of limestone glacial till deposits encountered across the Irish Midlands.

Synthesis

The results of field investigations completed at Lough Ree SAC have considerably improved the current understanding of physical geological setting and its influence on the eco-hydrology of Clooncraff and Cloonlarge Bogs, particularly in the vicinity of the area being considered for continued turf-cutting. Results have demonstrated that the bogs lie in a complex geological setting. Nonetheless, the detailed ecological, geophysical and hydrogeological investigations carried out have helped provide a scientific basis for understanding to what extent the high bog area at Fir Bog proposed for turf-cutting provides a supporting function to ARB and/or DRB habitat in other parts of the bog complex.

a) Fir Bog

Measurements carried out across Fir Bog have demonstrated a strong relationship between organic matter content and distance from marginal drains. The large degree of variation displayed in close proximity to the drains directly reflects the influence of drain depth and corresponding water level. In those samples collected at coring sites approaching facebanks, where deep drains have been installed in peat, organic matter levels prove significantly greater than in those where drains cut less deeply into the peat. This includes roadside drains separating Fir Bog from the rest of the SAC, where organic matter levels differ little from undisturbed peat at short distances from the road. The corresponding elevated hydraulic conductivities determined from piezometer testing in this area demonstrated that the road, although acting as an effective barrier to surface water flow, could not significantly limit groundwater flow should higher water level conditions (hydraulic gradient) favour flow from the adjacent SAC.

The change in organic matter levels observed in samples adjacent to aged facebanks suggests that ongoing cutting at Fir Bog will result in increases in organic matter content as peat cutting proceeds, not only on the bog itself but in peatlands immediately adjacent to it, i.e. on the other side of the road. This can be anticipated to impact both bog eco-hydrology in adjacent areas and the surface of the road, particularly in those areas of the bog where peat is thickest (as indicated by GPR). However, plots of organic matter content with distance from drains show that the impacts of drainage on organic matter content extend no further than 232m from any drain at the site as outlined within Methods Box 1. As Figure A4.7 shows, this distance is sufficiently far from the closest area of DRB that it will not affect its eco-hydrology.

b) Clooncraff Bog:

Survey results from Clooncraff Bog indicate that substantial thickness of unconsolidated deposits underlies much of the area proposed for further cutting. Moreover, geophysical data suggest that much of this material is dense glacial till resembling that encountered in boreholes drilled on Fir Bog. Where thick sequences of the till separate the bedrock aquifer from overlying peat, groundwater discharge that may affect ARB of DRB on the main body of the SAC is not anticipated. Nonetheless, as results of the surveys have shown, the unconsolidated peat substrate below northern part of the site reaches less than one metre. Risk of significant upwelling of groundwater that may arise due to continued peat cutting in the area cannot be discounted.

Methods Box 1
Determining the Distance of Drainage Impacts on Peat Properties

Long-term conservation of raised bogs requires an understanding of how peat behaves and how it influences bog eco-hydrology. Peat is an unusual geological material in that it is made up predominantly of water (typically 90–95% in Ireland) and it is highly compressible. This high compressibility makes peat makes very sensitive to changes in water level and water pressure (head). Declines in water level reduce the buoyancy effect that supports peat's internal structure, leading to it collapsing under its own weight. As the change in water level varies from one place to another, this can lead to changes in bog topography and associated changes in eco-hydrology that can lead to die-off of peat-accumulating plant communities (i.e. ARB).

Assessing how far a change in water level can extend varies substantially, both between bogs and within individual bogs. The principle of conservation of matter permits impacts to be quantified based on the idea that when peat settles under its own weight the change in volume occurs due to loss of water, i.e. the amount of organic matter remains constant. This can be used to calculate the change in the depth of peat (z) below a particular area due to drainage as follows:

(Equation 1)

$$\frac{om_{DRAINED}}{om_{INTACT}} = \frac{z_{INTACT}}{z_{DRAINED}}$$

where Z_{intact} and $Z_{drained}$ are the depths of intact and drained peat respectively.

Quantifying the impacts of marginal drains on peat structure proves particularly important for Irish raised bogs as one of the principal threats to their ecology comes from marginal drainage associated with peat cutting. Basic engineering calculations (using the Dupuit-Forcheimer solution for unconfined systems (Forchheimer, 1898)) show that changes in water levels in peat (and the changes they cause to its thickness) depend on how deep a drain has cut into the bog margin. The impact of these changes becomes progressively less moving away from the drain. Critically water levels change by a fixed proportion for each interval of distance. For example, if the water level reaches back to half its original level over 20m, it will be another quarter, or half of a half, over the next 20m etc. (Figure A4.17)

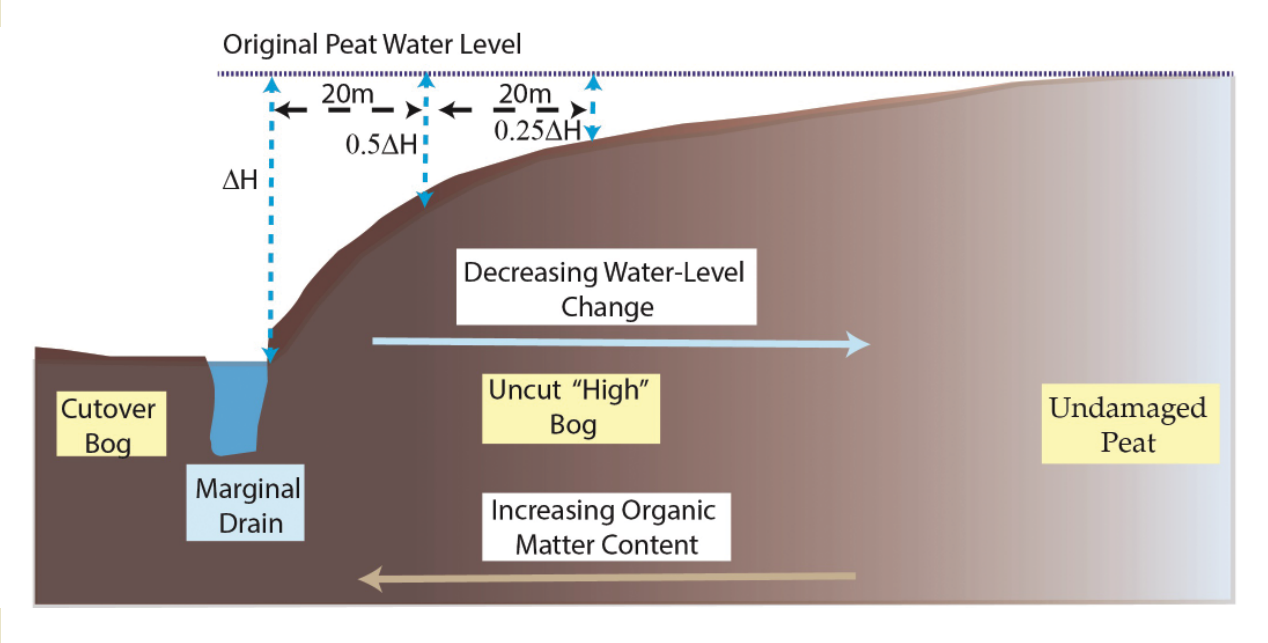


Figure A4.17: Schematic diagram illustrating the impact of peat drainage on water levels and organic matter content.

Since the main influence on the change in peat organic matter (OM) content is water level changes, the impact of drainage on peat can be expressed as

(Equation 2)

$$In\left(\frac{OMDrained}{OM\ Intact}\right) = -k.\ Distance$$

where k is an empirical constant reflecting the change in organic matter content with water level change. (Note: according to Equation (2) once the organic matter content reaches the same level as undrained peat it can decline no further.)

Plotting up the data collected for Fir Bog, part of Lough Ree SAC, using this approach revealed a wide scatter in organic matter content with distance from drains. This reflects the contrasting water level changes associated with the range of drains (and corresponding water level changes) encountered around the site. Nonetheless, it is clear from the plot that the model can be used to define a worst case scenario in which drainage has the most significant effect on organic matter content. Using the site-specific organic matter data with Equation (2), the maximum distance at which drainage can impact peat properties was determined from the model to be 232m from a drain (Figure A4.18).

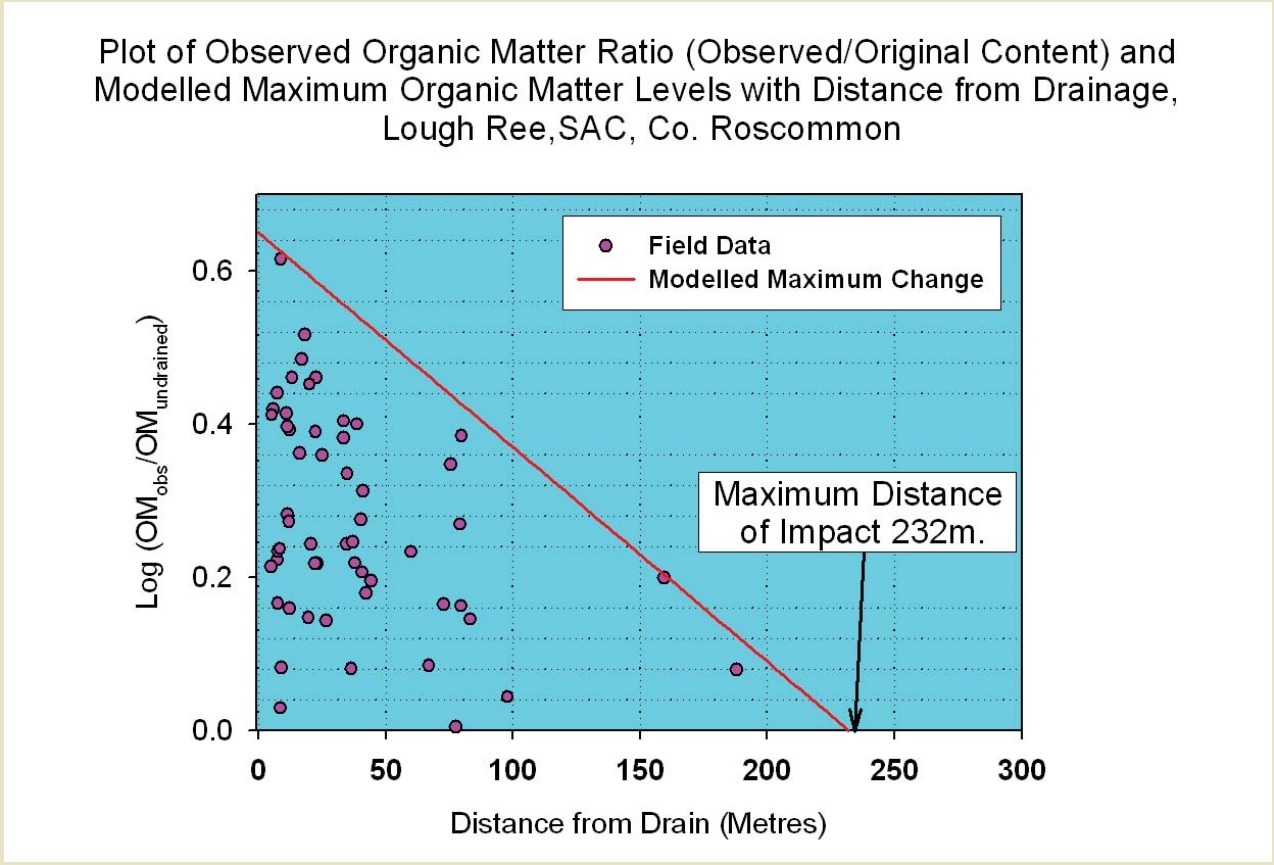


Figure A4.18: Plot of observed and modelled organic matter ratios with distance from a marginal drain, Lough Ree SAC, Co. Roscommon. (Model Equation: Log OMobs/OMundrained)=-0.0028xDistance+0.065).

Despite the findings outlined within Methods Box 1, the impacts to eco-hydrology, should deeper groundwater be impacted, need to be considered to ensure that drainage regimes resembling those on the south-western side of Clara do not arise on Clooncraff and Cloonlarge bogs in response to cutting. Geophysical measurements have permitted the geometry of the unconsolidated deposits underlying the site to be defined with high level of precision. Results of these data, when combined with findings from substrate boreholes revealed a thick sequence of dense stiff low permeability glacial till separates the base of the peat from the underlying bedrock aquifer. Over most of the site this deposit acts as a strong confining layer that effectively prevents groundwater from discharging to the ground surface. This applies particularly across the area of Fir Bog and Clooncraff Bog proposed for

further cutting. It is noteworthy that as the till layer thins dramatically in the area immediately to the south of Fir Bog and north of Clooncraff Bog; further cutting in these areas would present a risk of increased bedrock groundwater discharge that may affect bog eco-hydrology. Methods Box 2 provides further details of this process.

Methods Box 2

Critical Gradients and Groundwater Upwelling

The conventional view of raised bogs is as wetlands raised up above the landscape and largely isolated from surrounding hydrological processes. Fine-grained materials, often assumed to underlie bogs, can act as barriers limiting the amount of exchange between water in peat and the underlying substrate groundwater. However, in the Irish context, this view has frequently proven over-simplistic, with geological and geophysical observations often revealing peat to rest of more permeable materials, thus permitting greater exchange of water.

Groundwater levels in raised bogs occur close to the ground surface and typically have greater elevations (heads) than surrounding and underlying deposits. Where this occurs, water flows from peat into adjacent materials (including the substrate). This is reflected in a decline in groundwater level with depth in bogs. By contrast, when peat is cutaway and drained, the water level in the peat also reduces. Under these circumstances, water levels in the underlying materials may reach elevations greater than those in the overlying peat. In this case the groundwater from the underlying peat can flow up through the peat, depending on the nature of the intervening material. The gradient, or difference in water level between two units over a given separation, determines not only the direction of flow, but also influences how much water enters or leaves a bog. The other factors influencing this exchange include the hydraulic conductivity (or permeability) of the intervening material.

Where the hydraulic conductivity is low, this can limit groundwater flow. However, under high hydraulic gradients some soils and subsoils have insufficient strength to maintain their structure, leading to a loss of internal strength. Perhaps the example of this that most people may be familiar with is quicksand. However, it can also apply in other materials, including peat. Investigations carried out at Clara Bog revealed that where drains were cut into peat, close to the contact with underlying limestone bedrock, groundwater flowing from the bedrock destroyed the internal structure of the peat, leading to the formation of an extremely permeable peat sludge that permitted a dramatic increase in groundwater discharge from the bedrock into the overlying drain. The change in groundwater conditions in the aquifer resulted in widespread damage to the bog's eco-hydrology, covering a much larger area than would be anticipated by peat cutting alone.

Identifying potential areas where these conditions may arise forms a critical element of assessing whether continued peat cutting can affect a bog's conservation prospects. To do this requires a detailed understanding of a site's geology, notably the shape of the bog substrate, what the peat is in contact with, and what the hydraulic gradient between the bog and underlying deposits is like.

Whether the hydraulic gradient steeper than the minimum gradient needed to alter the internal structure of a soil, also known as the critical gradient icrit, depends on the specify gravity (or density relative to water) of the materials making up the soil, Gs, and the proportion of pores in the soil (known as the void ratio, e). These are related as follows:

Equation (1)

$$i_{crit} = \frac{G_s - 1}{1 + e}$$

Drilling and sampling of 30 peat substrate samples from below Fir Bog revealed them to consist of soft to very stiff silts with some sand and limestone clasts (glacial till). Compositionally they were dominated by calcium carbonate with lesser amounts on siliceous material, giving them a specific gravity of approximately 2.65.

Void ratios were calculated to range between 0.32 and 0.96, although most of these samples were collected from immediately below the peat interface where material was softer (and had a higher void ratio) than at depth. Critical gradients in this material thus need to exceed between 0.84 and 1.25 to begin to change its internal structure. This contrasts markedly with peat, having a typical specific gravity of approximately 1.35 and a void ratio of between 13 and 23; critical gradients thus range between 0.013 and 0.026. The significantly lower gradient is easily achievable in a range of natural settings. By contrast the steeper gradients required for the till would be more unusual. (Figure A4.19)

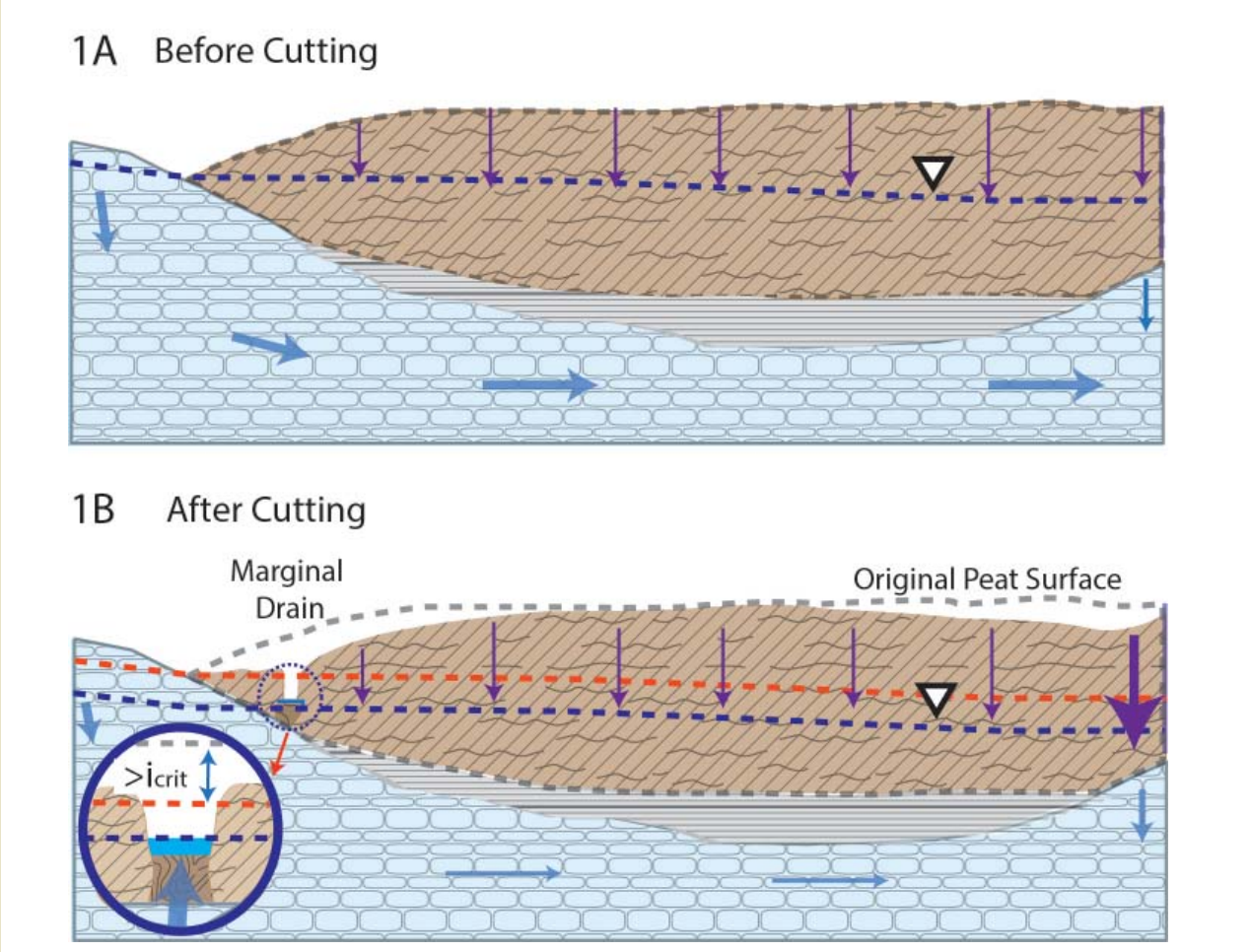


Figure A4.19: Schematic diagram illustrating (1a and 1b) the impact of critical gradients cause by marginal drainage can facilitate a dramatic loss in groundwater pressure in an aquifer underlying a bog, thereby altering its eco-hydrology at large distances from the drain. The width of the blue lines reflects the intensity (rate) of groundwater flow. The detail in the lower figure shows how exceeding the critical gradient leads to the development of highly permeable peat sludge that facilitates greater bedrock groundwater discharge than that through intact peat.

The critical gradients calculated for peat explain how blow out features develop where peat was very close to/in contact with bedrock. Examination of geological conditions at Fir Bog, by contrast reveal thick sequences of (glacial till) separating

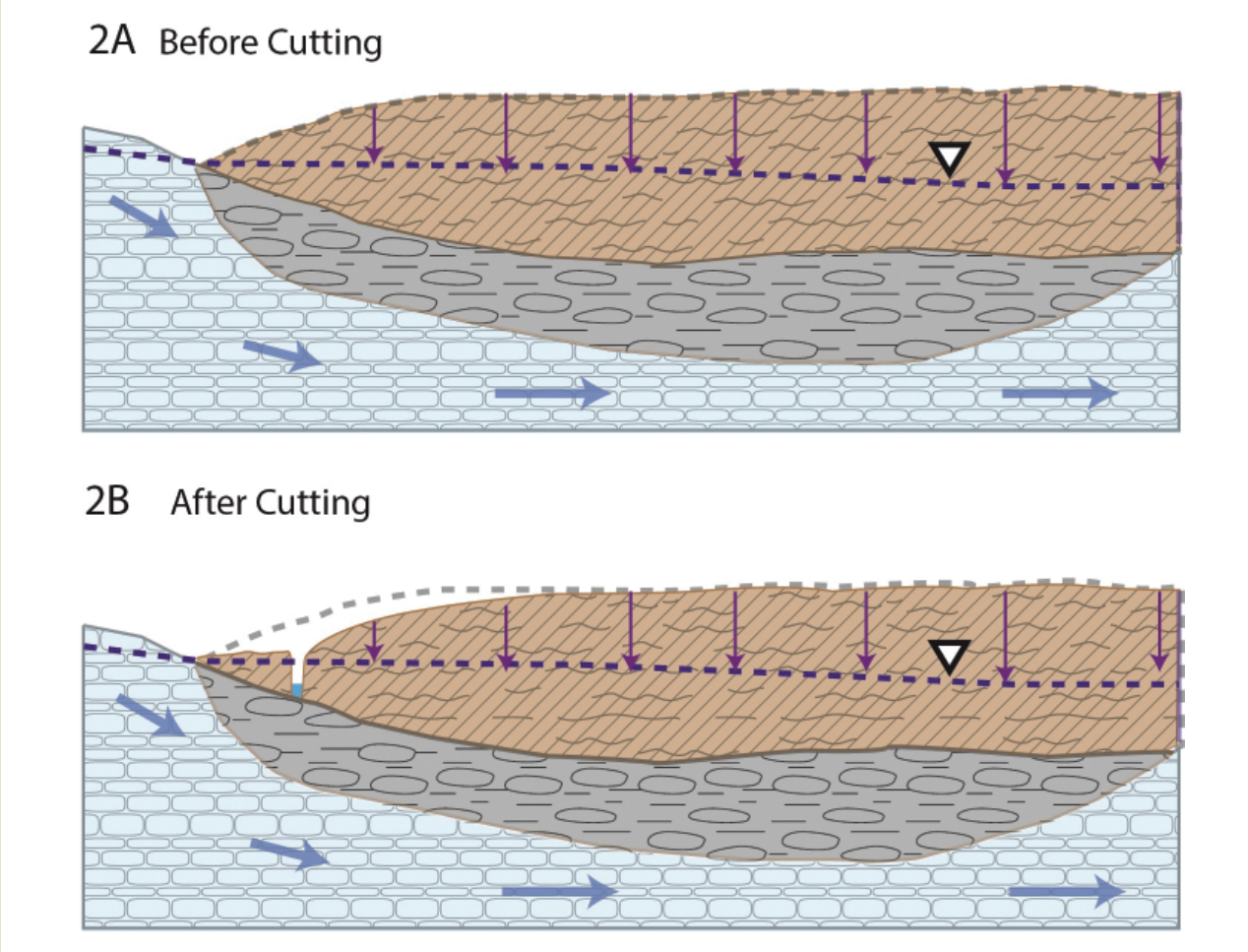


Figure A4.20: Illustration of how low permeability substrate (in dark grey) protects aquifers underlying peat bogs from the effects of marginal drainage. Eco-hydrological impacts to the bog extend over a smaller area, where the groundwater flow regime in the underlying aquifer is unaffected.

the peat from the underlying bedrock aquifer, such as that illustrated in Figure A4.20.

Hydrochemical measurements across Fir Bog revealed upwelling mineralised groundwater flows through the peat at the cutover on the south-eastern side of the site, where till was thin to absent; by contrast no evidence of upwelling was observed anywhere on the high bog. Results suggest the water level (head) in the bedrock is close to the elevation of the cutover on the northern site. Calculations of hydraulic gradient, assuming a worst case scenario where the water level in the peat is 2m below that of the groundwater level (head) in the bedrock, the critical gradient will not be exceeded anywhere where turf-cutting is proposed (Figure A4.21). It is noteworthy that the critical gradient is exceeded along the southern boundary which coincides with the area where turf-cutting has taken place in the past and upwelling groundwater was detected.

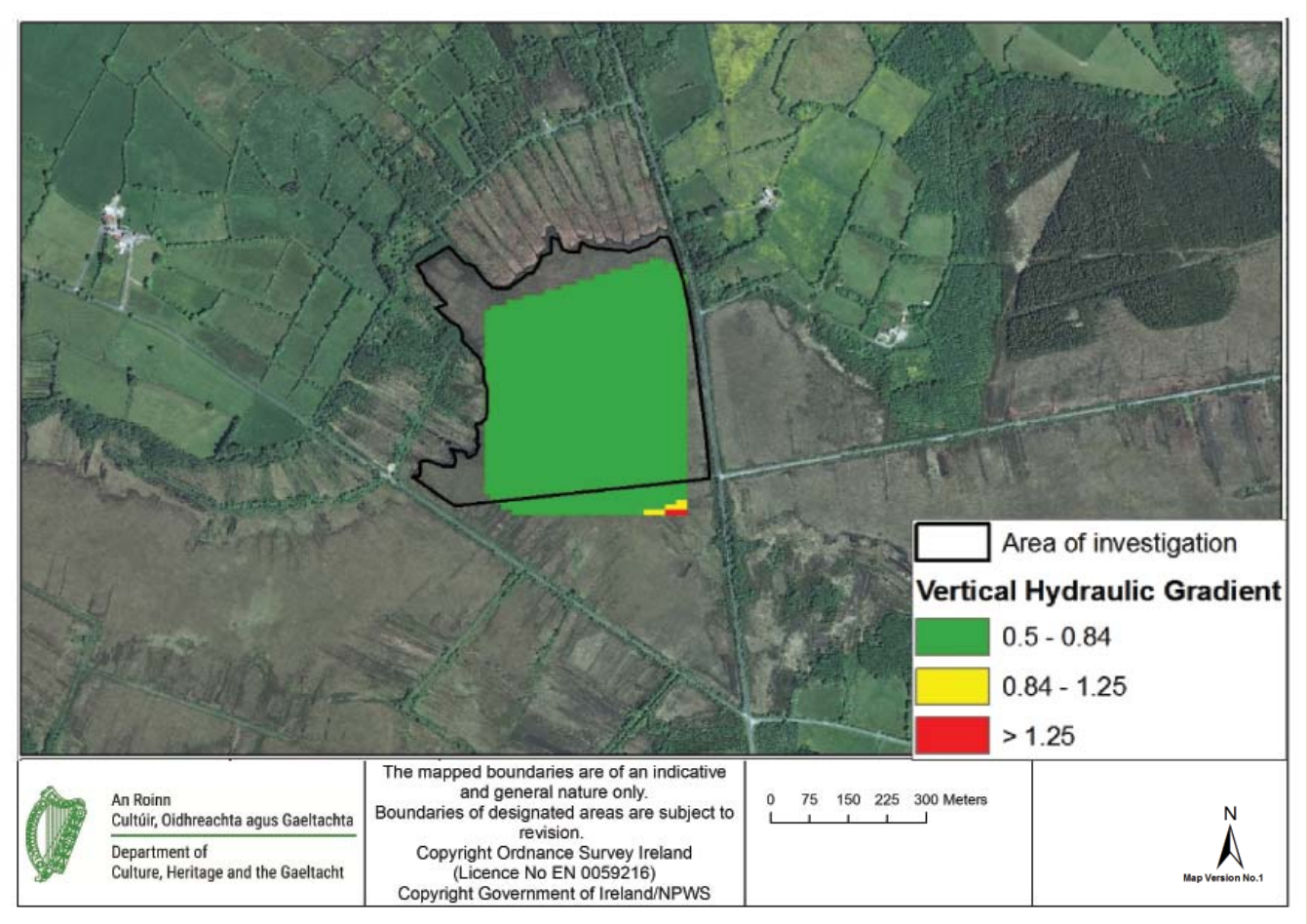


Figure A4.21: Map illustrating estimated vertical hydraulic gradients across Fir Bog. Critical gradients are only exceeded beyond the area where turf-cutting is proposed therefore hydrogeological impacts are not anticipated.

In the case of Clooncraff Bog geophysical data collected in the area have indicated that thick sequences of unconsolidated deposits, including stiff glacial till, underlie the southern end of the site. As a consequence, the impact of cutting on the site-specific conservation objectives for ARB is not considered significant for this part of the site. By contrast the very thin layer of cover separating peat from bedrock at the northern end of the site indicates that a significant risk of further groundwater upwelling could occur in this area, should cutting continue here. Consequently provided turf-cutting only takes place in those areas where a minimum of 3m of till substrate is present impacts to ARB and DRB are not anticipated.

Conclusions

Results of the desk-based investigations at Fir Bog and Clooncraff Bog show that geological units present below the site resemble those encountered at Clara Bog, where significant groundwater upwelling continues to impact on the site-specific conservation objectives for ARB.

Detailed field investigations at Fir Bog have demonstrated that, unlike at Clara Bog, the roads which cross the SAC do not act as effective hydrogeological barriers to disturbances and that continued cutting at the site can impact peatland topography and eco-hydrology in adjacent areas. Nonetheless, results of organic matter analyses (as outlined within Methods Box 1) have demonstrated that ARB and DRB habitats within the SAC are sufficiently far away from the proposed turf-cutting area at Fir Bog to not be impacted by this activity. This in turn implies that the high bog area in Fir Bog proposed for turf-cutting does not provide a supporting function to ARB and DRB habitat in other parts of the SAC.

Deeper geophysical investigations have demonstrated that geological conditions below the area of Fir Bog targeted for continued cutting provide sufficient protection against bedrock groundwater upwelling (as described in Methods Box 2). Consequently, no upwelling in the area of proposed cutting at Fir Bog is anticipated, should cutting proceed within the defined area presented in Figure A4.22.

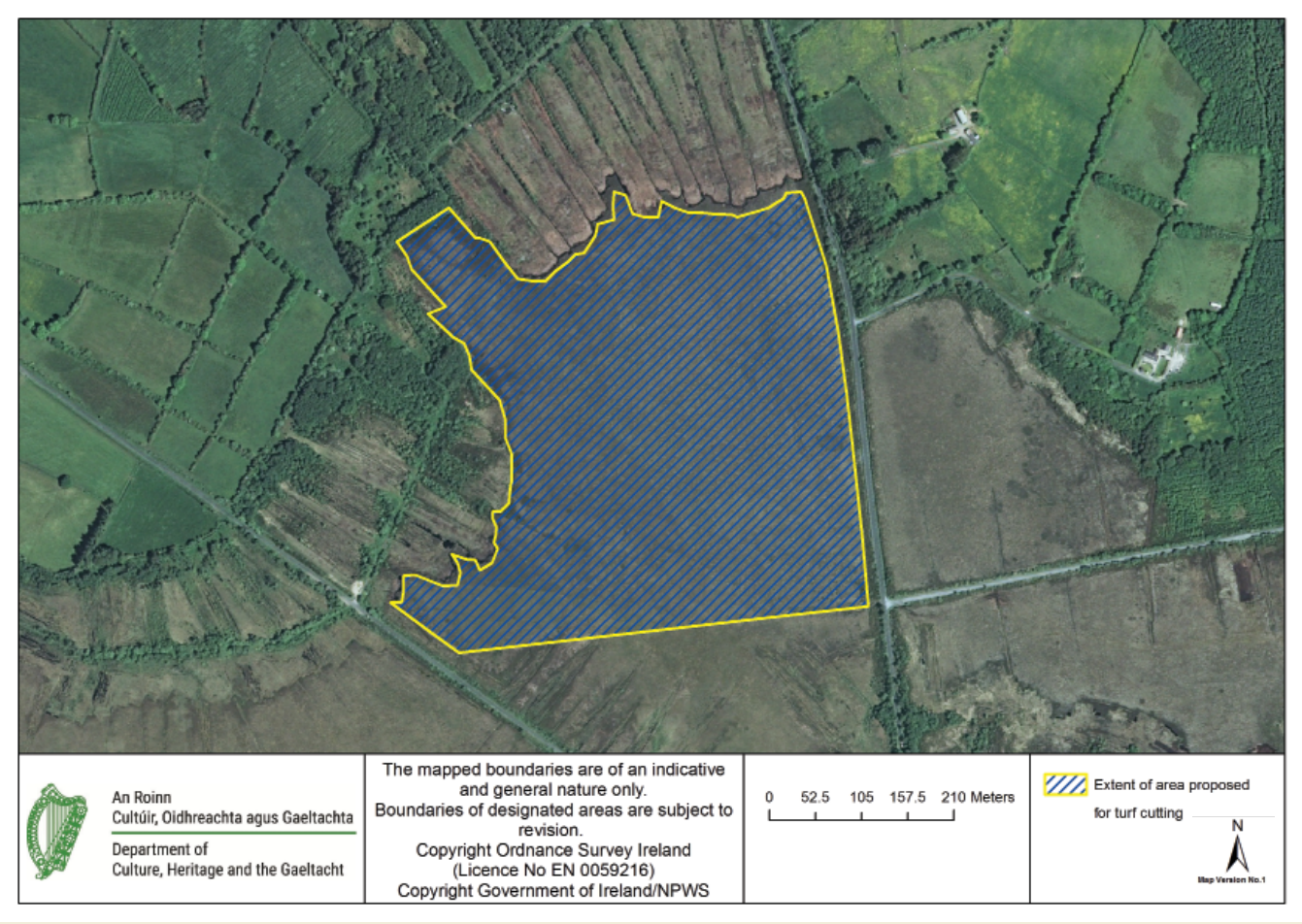


Figure A4.22: Extent of area of Fir Bog where turf-cutting can proceed without impacting on ARB or DRB within Lough Ree SAC

As the till unit thins rapidly to the south, the risk of upwelling associated with cutting increases markedly. If no further cutting is carried out in this area, further alteration to the hydrogeological regime of the underlying aquifer due to turf-cutting is not anticipated. Consequently the impacts of continued turf-cutting on Fir Bog to the north of the southern boundary, defined in Figure A4.22, are not anticipated to impact the ARB/DRB on the SAC, i.e. cutting must remain restricted to the area presented in Figure A4.22.

In the case of Clooncraff Bog, the risk of damage to ARB/DRB arising from turf-cutting lies primarily with losses resulting from upwelling groundwater discharging from bedrock. The extent of cutting that has taken place to date means that this area is effectively isolated from the main body of the bog. As a result direct impacts to raised bog topography further north on the main body of the bog are not anticipated.

Geophysical data collected in the area have indicated that thick sequences of unconsolidated deposits, including stiff glacial till, underlie the southern end of the site. As a consequence, the impact of cutting on the site-specific conservation objectives for ARB is not considered significant for this part of the site. By contrast the very thin layer of cover separating peat from bedrock at the northern end of the site indicates that a significant risk of further groundwater upwelling could occur in this area, should cutting continue here. Consequently continued cutting should be restricted to the southern end of the site where there is a minimum of 3m of till underlying the peat to avoid further impacts to ARB/DRB on the *SAC, i.e. cutting must remain restricted to the area presented in Figure A4.23.*

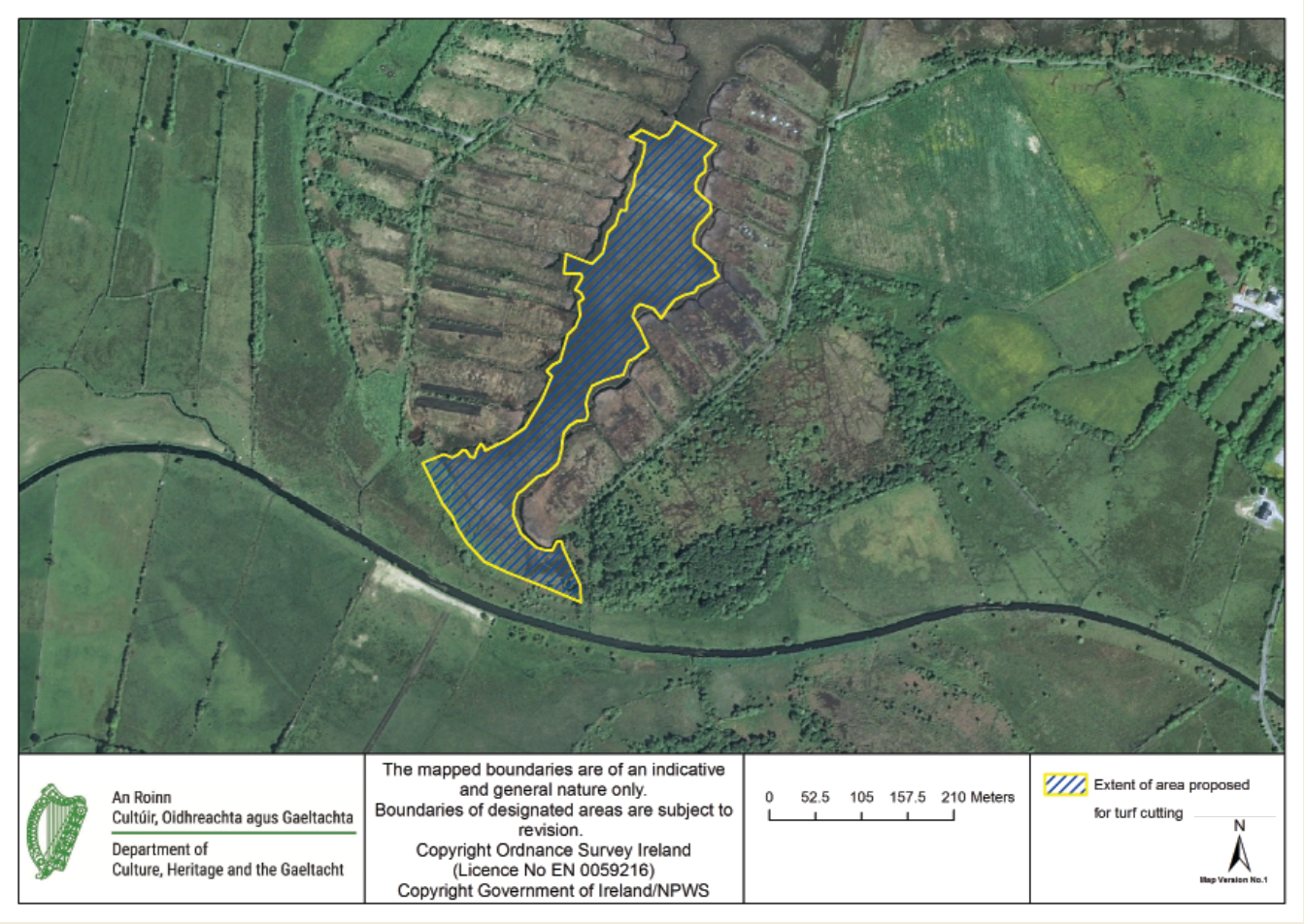


Figure A4.23: Extent of area of Clooncraff Bog where turf-cutting can proceed without impacting on ARB or DRB within Lough Ree SAC

Appendix 5

SAMPLE DRAINAGE MANAGEMENT PLAN CARROWNAGAPPUL SAC, CO. GALWAY

Background to Drainage Management Plan

Draft restoration plans have been produced to set out proposals for restoration of raised bog and associated habitats within each of the raised bog SACs. Technically feasible restoration measures for the various zones of the bog including the high bog, cutover bog and surrounding margins have been identified.

Sometimes, there are concerns from local communities living close to raised bogs that such restoration measures will result in, or exacerbate, flooding. However, it has been demonstrated at numerous bogs where restoration has been carried out that blocking high bog drains often slows the flow of water off the bog thus reducing the frequency and magnitude of flood events. Restoration works have been carried out at a large number of raised bogs in Ireland, which includes blocking of both high bog and cutover drains. High bog drain blocking has been carried out at Clara Bog (East), Co. Offaly, Raheenmore Bog, Co. Offaly, Carrownagappul Bog, Co. Galway, Lisnageeragh Bog, Co. Galway, as well as on several large Bord na Móna raised bog complexes. Blocking of cutover drains has been successfully carried out at a number of raised bogs including Ballykenny Bog, Co. Longford, and Killyconny Bog, Cos Cavan/Meath.

There are several examples of where peatland restoration is being carried out as a flood alleviation measure, particularly throughout the UK. Extensive peatland restoration work has been carried out in Exmoor National Park in Snowdonia, mainly in the form of drain blocking. The project team installed state-of-the-art equipment which relays data from over 200 monitoring points on the moorland every 15 minutes to record changes in water table levels alongside a number of sites to monitor water quality and greenhouse gas releases from the peat. Preliminary results suggest that the amount of storm water running off the moorland during heavy rainfall has reduced by up to one third. Additionally the storage capacity of the peat has increased by 260,000 cubic metres.

Nevertheless as this is a significant concern of many communities and one that is unlikely to be fully resolved until several years after restoration has been completed it is important that this issue is considered fully when undertaking restoration measures. In order to address this issue it is proposed that drainage management, beyond the raised bog boundary, is integrated into the restoration plan for each bog. This should be developed as part of the process of developing the restoration plan further in partnership with local communities.

A pilot drainage management plan has been developed for the main drainage channels surrounding Carrownagappul Bog SAC (001242) where localised incidents of flooding adjacent to the SAC have been reported. A summary of the process of developing the drainage management plan is outlined below.

Drainage Management Plan Development

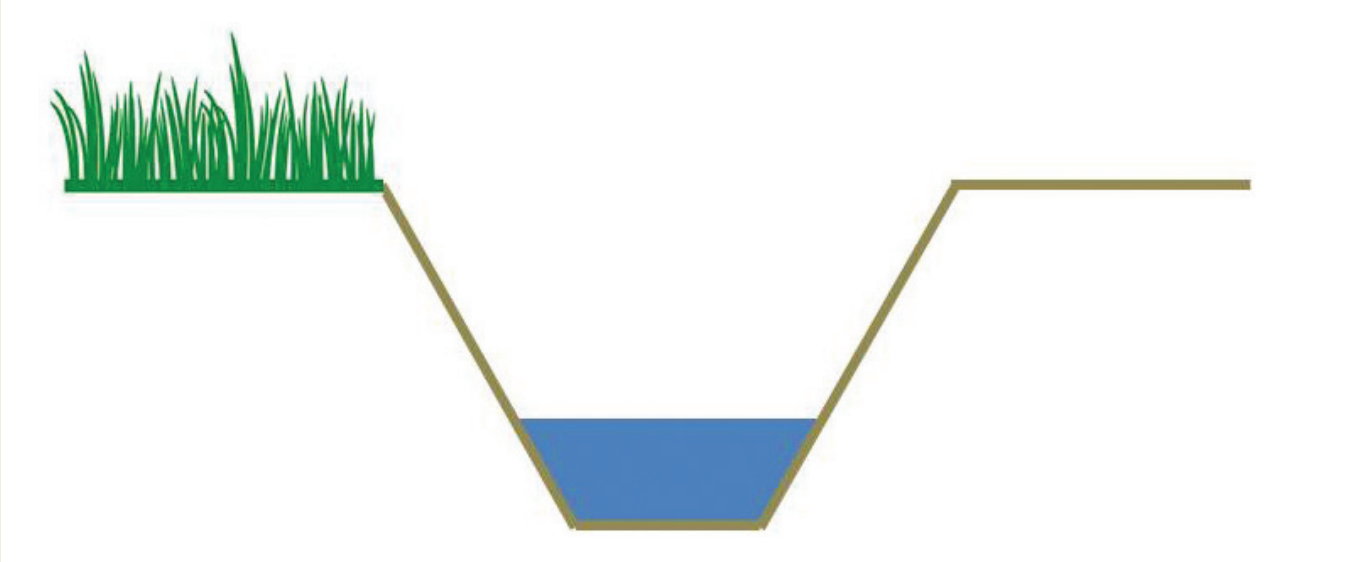
At Carrownagappul Bog, local knowledge indicated that there are have been regular flood events impacting on reclaimed agricultural land along some areas adjacent to Carrownagappul Bog. These flood events have been taking place for several years, in an area where no restoration measures have been carried out, therefore they are not related to restoration works at the bog. In order to complement the restoration of Carrownagappul Bog an assessment of the drainage network has been carried out to identify ways to further reduce the frequency and magnitude of out-of-channel flood events.

Any proposals to modify drainage channels must be assessed on a case-by-case basis to ensure that they will not result in adverse impacts on the conservation condition of Carrownagappul Bog SAC. This is because drains at the margins of the bog can have a significant influence on regional groundwater heads. If marginal drains are deepened into or close to mineral substrate underlying the peat, this can create an outlet for groundwater to discharge causing a decline in regional groundwater heads over a significant distance. This can lead to increased rates of vertical infiltration through the peat quite some distance from the area where the drainage has taken place, leading to widespread drying out of the raised bog habitat.

It is recommended that where the risk of groundwater impacts cannot be ruled out but it is necessary to increase channel dimensions to prevent flooding, an alternative channel design is implemented. The preferred approach would be to create a wider channel rather than a deeper channel, but this can lead to problems including ecological deterioration, sedimentation and excessive in-channel vegetation. Therefore it is recommended that where channel modifications are required a two-stage channel

should be created to both increase capacity during times of high flow but prevent ecological impacts of low flow spread across a wide channel as illustrated by Figure A5.1.

a) Typical uniform trapezoidal drainage channel



b) Two-stage drainage channel to offer additional capacity during times of high flow

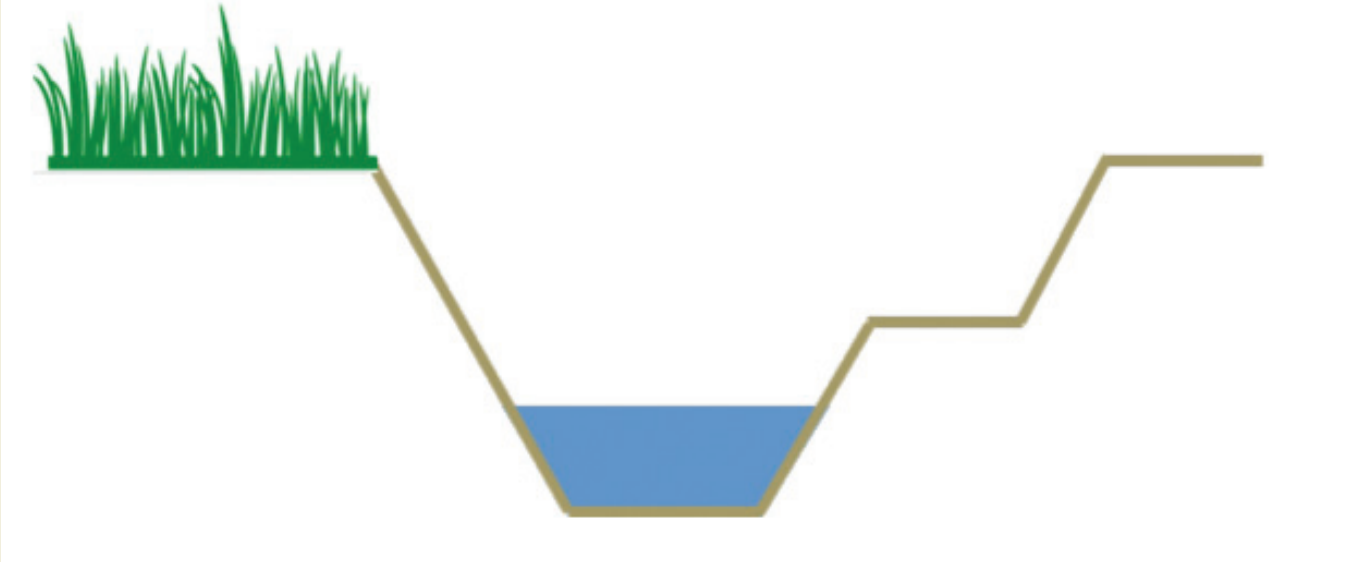


Figure A5.1 Schematic of typical drainage channel and a two-stage channel

Hydrological summary

Five key sub-catchments were identified as being under the influence of the bog (Figure A5.2). However, some of these sub-catchments drain only a small proportion of the bog. Local knowledge has indicated that flooding issues are only relevant to two of these sub-catchments (sub-catchment 1 and sub-catchment 2). There have been a number of flood events in the past number of years in each of the sub-catchments which have resulted in flooding of agricultural land. As a result these two sub-catchments were carried forward for further assessment to determine whether flood alleviation measures are required.

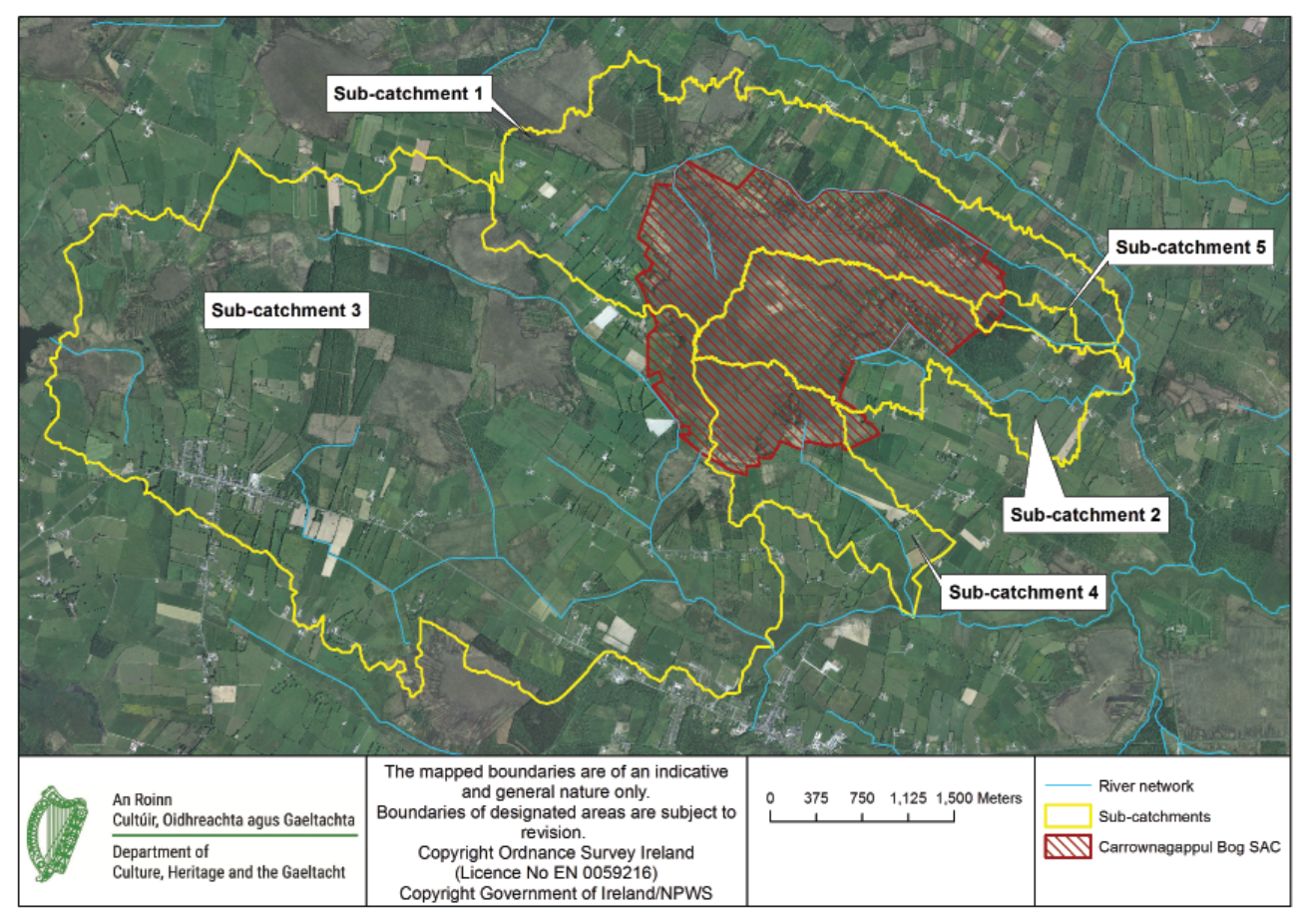


Figure A5.2 Main sub-catchments draining Carrownagappul Bog

Hydrological analysis

An estimation of typical flood flows was carried out by using a number of standard flood estimation techniques which are most suitable for use in small catchments. This includes:

- The Institute of Hydrology Report no 124 (IH 124) (Marshall & Bayliss, 1994)
- The Flood Estimation Handbook Statistical Method (Kjeldsen *et al.*, 2008)
- The Flood Studies Update 7 – variable equation (FSU 7 variable) (Murphy, 2009).

Each method was used to estimate Qmed (the median annual maximum flood with a return period of approximately two years) at the downstream outlet of each sub-catchment. This was followed by a survey of the channel and associated structures to determine channel capacity. The most conservative of the flood flow estimation approaches was then used to identify locations along the channel where channel capacity is likely to be too low to accept high frequency flood events.

This process led to identification of number of locations where channel structures are significantly under-sized; corresponding to locations where a local stakeholder has indicated that there have been flooding problems in recent years. It is therefore recommended that these structures are upgraded to increase the capacity of the channel. In addition it was apparent that channel dimensions are in general adequate to convey high frequency flood flows; however, in some cases there were obstructions including debris as well as deep rooted vegetation within the channel; these are features that are likely to impede flow

causing localised reduction in conveyance capacity. It has been recommended that this debris or rooted in-channel vegetation is removed along both main channels to increase flow capacity. In areas where there is significant shading of the channel it is recommended that selective tree removal is carried out to prevent tunnelling along the channels. Where there is significant vegetation on the banks that is likely to reduce capacity during times of high flow this should be managed. A summary of proposed drainage management measures is illustrated in Figure A5.3.

These works should be carried out in accordance with the Office of Public Works (OPW) Arterial Drainage Maintenance Service Environmental Management Protocols and Standard Operating Procedures[1]. Changes to the quantity and quality of water through drainage management may have direct impacts on animal life in the water bodies. Therefore, it is proposed to consult with Inland Fisheries Ireland, particularly on larger channels in order to conserve and protect the inland fisheries resource.

In summary the proposed maintenance works consist of:

- Replacement of under-designed culverts;
- Upgrading of culvert bank protection where this is a risk of blockage during flood events;
- Selective removal of trees where significant shading (tunnelling) occurs;
- Removal of rooted in-stream vegetation and debris; and
- Management of bank vegetation where it is likely to reduce flow capacity.

It is important to note that this approach is intended to reduce the risk of very regular flood occurrences. Future flood events will occur as it is not possible to design for no risk; however, the frequency and magnitude of flood events will be reduced considerably through these drainage management measures.

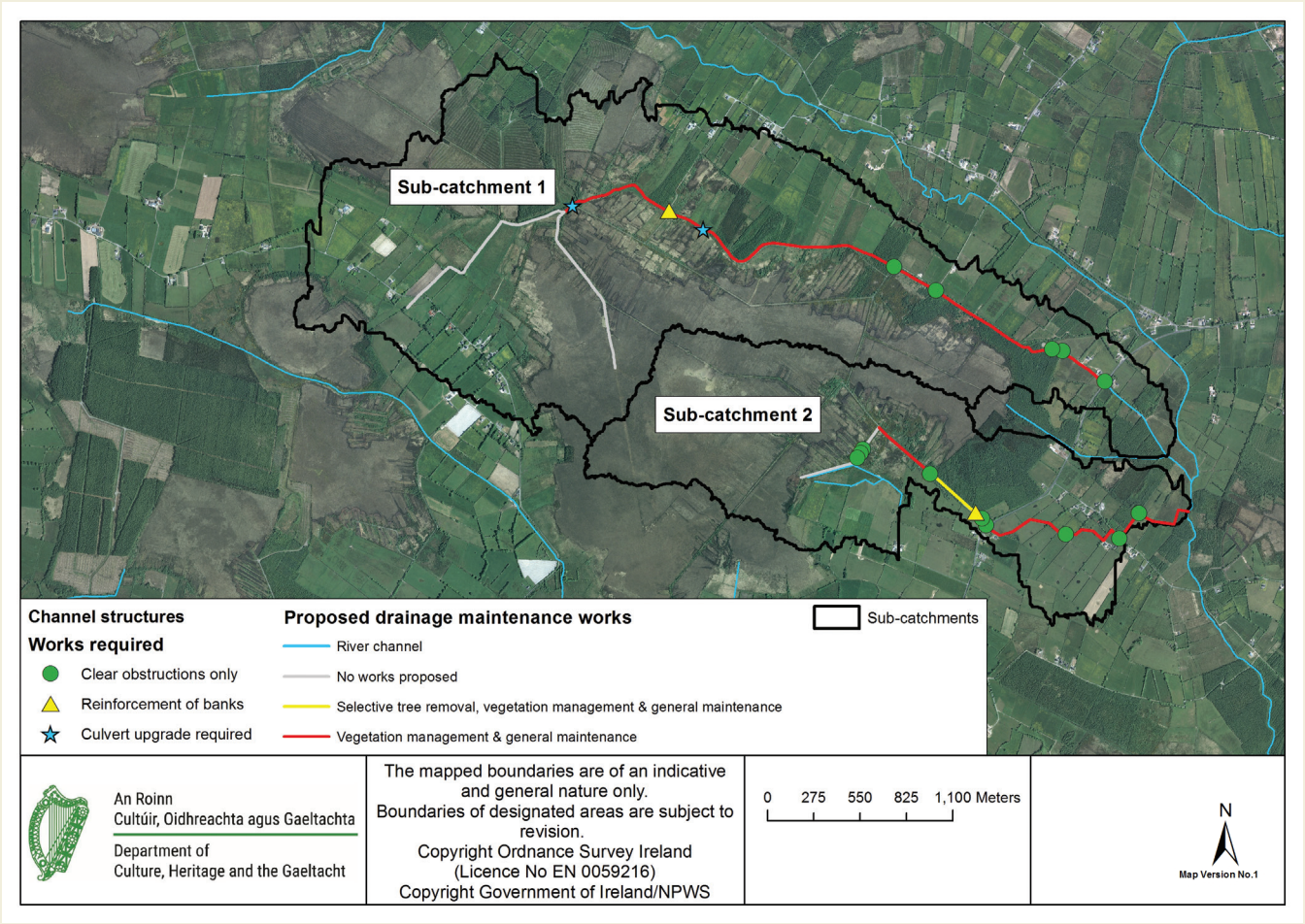


Figure A5.3 Map outlining the proposed drainage management measures required at Carrownagappul Bog SAC

1. http://www.opw.ie/en/media/environmental-management-protocols-and-sop-april-2011.pdf

Next steps and long-term drainage management

It is proposed that NPWS discuss the possibility of developing a Memorandum of Understanding with the OPW and/or Galway County Council to undertake the proposed drainage management works. Both of these bodies have extensive experience and technical capability of carrying out such works and are likely to ensure that all works are carried out to an appropriate standard. After the proposed drainage maintenance works have been carried out, a walkover survey of channel function should be carried out on an annual basis while bog restoration works are being carried out and annually for five years after restoration works have been completed to ensure the risk of flooding is minimised. The channel should then be inspected every five years to identify any build-up of debris or vegetation that may lead to issues of flooding in future.

Appendix 6

Summary Draft Hydrological Restoration Plan- Ardagullion Bog SAC, Co Longford

Ardagullion Bog SAC - Summary

Site Name:	Ardagullion Bog SAC
Site Code:	002341
Counties:	Longford
River Basin District:	Shannon
Sub-Catchment:	Inny[Shannon]_SC_020, Inny[Shannon]_SC_050, Camlin_SC_010
Further Information:	http://www.npws.ie/protected-sites/sac/002341

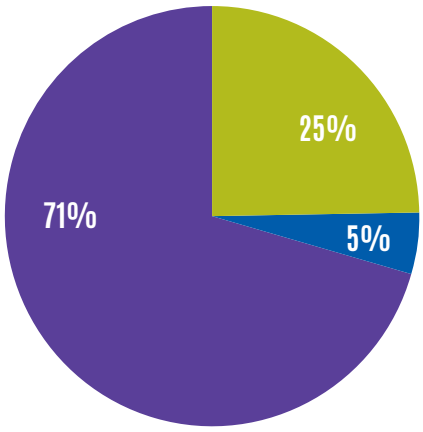
Site Summary:

Ardaguillion Bog is located 5 km north-east of Edgeworthstown, mainly in the townlands of Cloonshannagh and Ardaguillon in Co. Longford. The bog is of high conservation value due to the occurrence of a significant area of active raised bog. Although the site is relatively small and represents a remnant of a much more extensive raised bog, it retains a good example of active raised bog vegetation with hummocks and frequent pools.

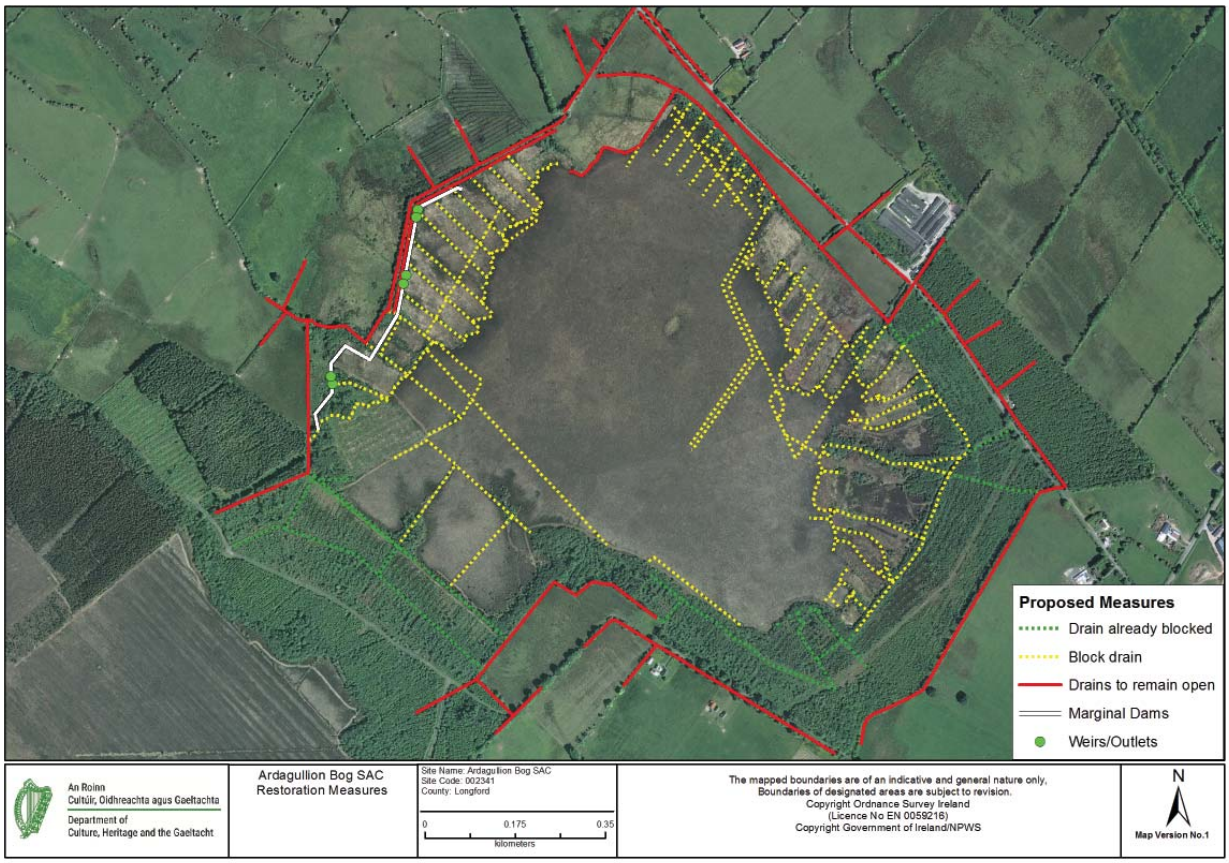
Site Statistics

Area of high bog in 1995 (ha):	57.9
Area of high bog in 2012 (ha):	56.9
Change in high bog (ha):	-1.0
Change in high bog (%):	-1.7%
No earlier survey available	N/A
Area of active raised bog in 1999 (ha) (Derwin & MacGowan, 2000*) (*Revised by NPWS in 2014)	14.0
Change in active raised bog (ha):	N/A
Change in active raised bog (%):	N/A
Area of degraded raised bog (ha):	2.7
Potential area bog peat-forming habitats (ha):	6.3

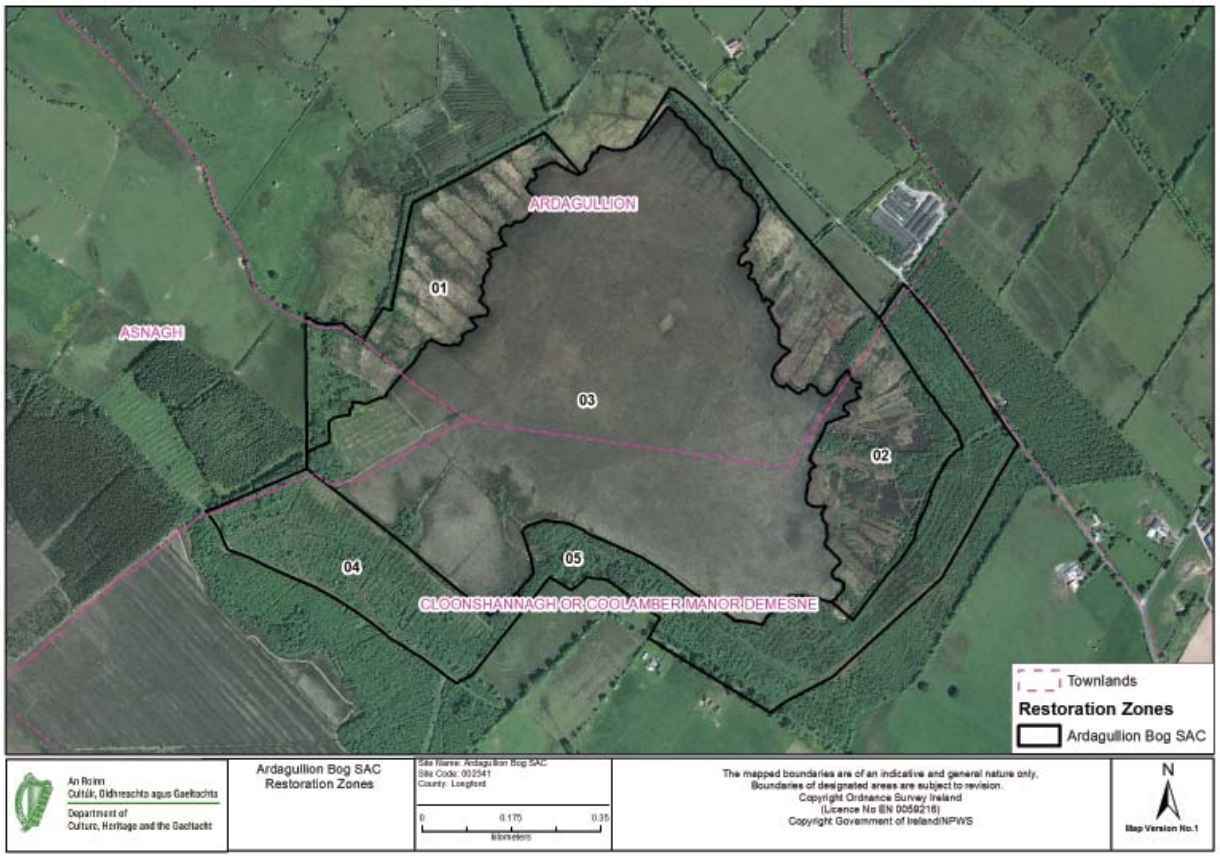
Composition of High Bog



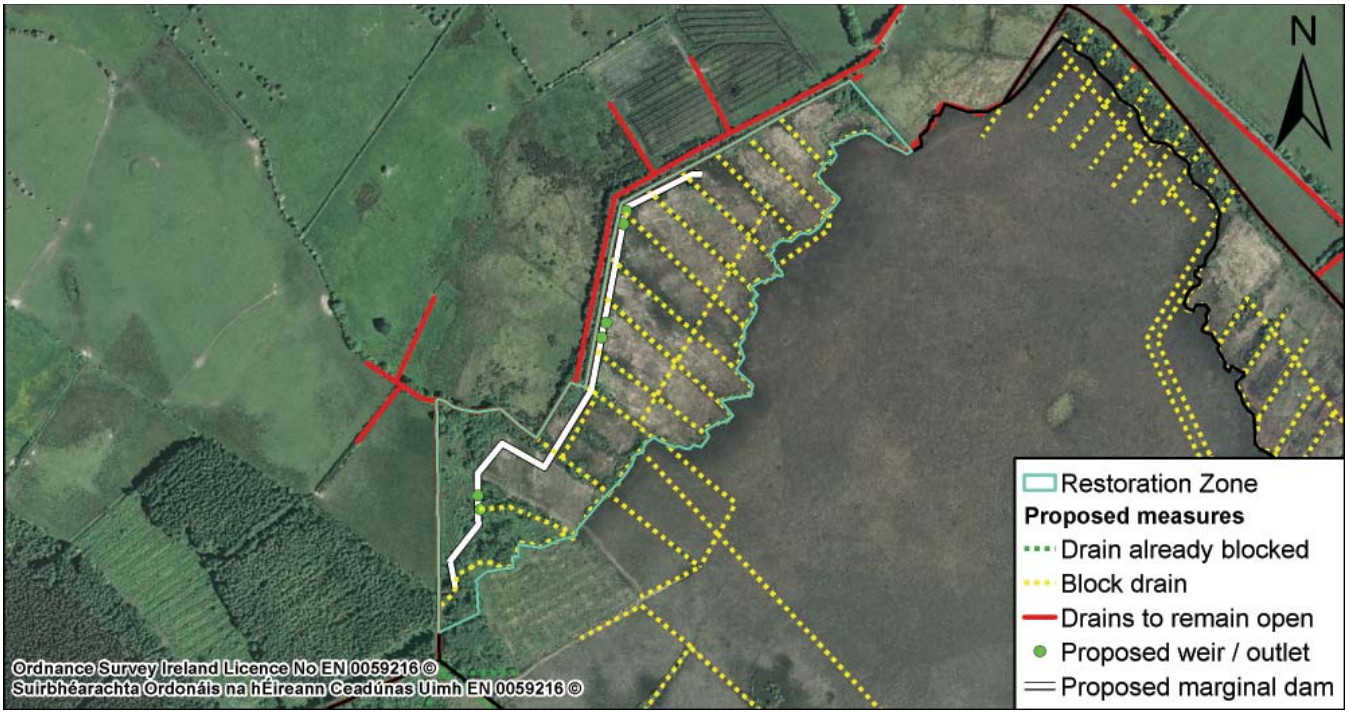
Ardagullion Bog SAC - Proposed Restoration Measures Overview



Ardagullion Bog SAC - Proposed Restoration Zones



Restoration Zone:			Ardagullion_01
Townlands:			Ardagullion, Asnagh
Priority:	2	**Justification for measures:**	Peat-forming habitats - Bog
Area of Degraded Raised Bog (DRB) (ha):			0
Potential area of peat-forming habitats (ha):			4.7



Measures Proposed

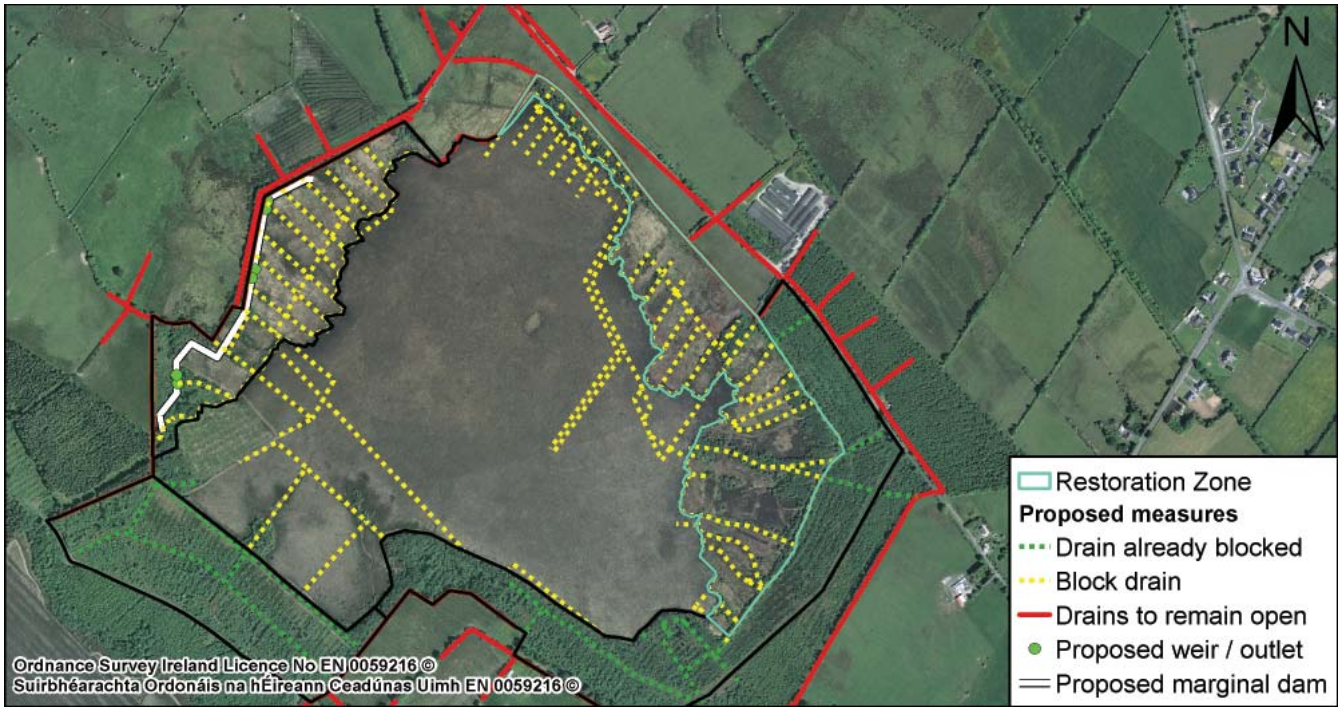
Measure 1:	Measure 2:	Measure 3:
Block 2.99 km of drains	Create 650m long marginal dam	Create 6 weirs/outlets

Are restoration measures likely to benefit the high bog?	Yes - it will reduce the gradient between the water table in the high bog and the water table in the margins
Current habitat:	Cutover bog, scrub
Co-dependency:	N/A

Measures Summary

Peat dams required	Plastic dams required	Forestry area to clear (ha)	Length marginal dam (m)	No. Weirs/outlets	Length infill drains (m)
221	22	0	650	6	0

Restoration Zone:	Ardagullion_02
Townlands:	Ardagullion, Cloonshannagh Or Coolamber Manor Demesne
Priority: 2 **Justification for measures:**	Peat-forming habitats - Bog
Area of Degraded Raised Bog (DRB) (ha):	0
Potential area of peat-forming habitats (ha):	1.6



Measures Proposed

Measure 1:	Measure 2:	Measure 3:
Block 4.85 km of drains	N/A	N/A

Are restoration measures likely to benefit the high bog?	Yes - it will reduce the gradient between the water table in the high bog and the water table in the margins
Current habitat:	Cutover bog, scrub, bog woodland
Co-dependency:	N/A

Measures Summary

Peat dams required	Plastic dams required	Forestry area to clear (ha)	Length marginal dam (m)	No. Weirs/outlets	Length infill drains (m)
444	39	0	0	0	0

Restoration Zone:	Ardagullion_03
Townlands:	Ardagullion, Asnagh, Cloonshannagh Or Coolamber Manor Demesne
Priority: 1 **Justification for measures:**	Increase the area of active raised bog (ARB)
Area of Degraded Raised Bog (DRB) (ha):	2.68
Potential area of peat-forming habitats (ha):	0

Measures Proposed

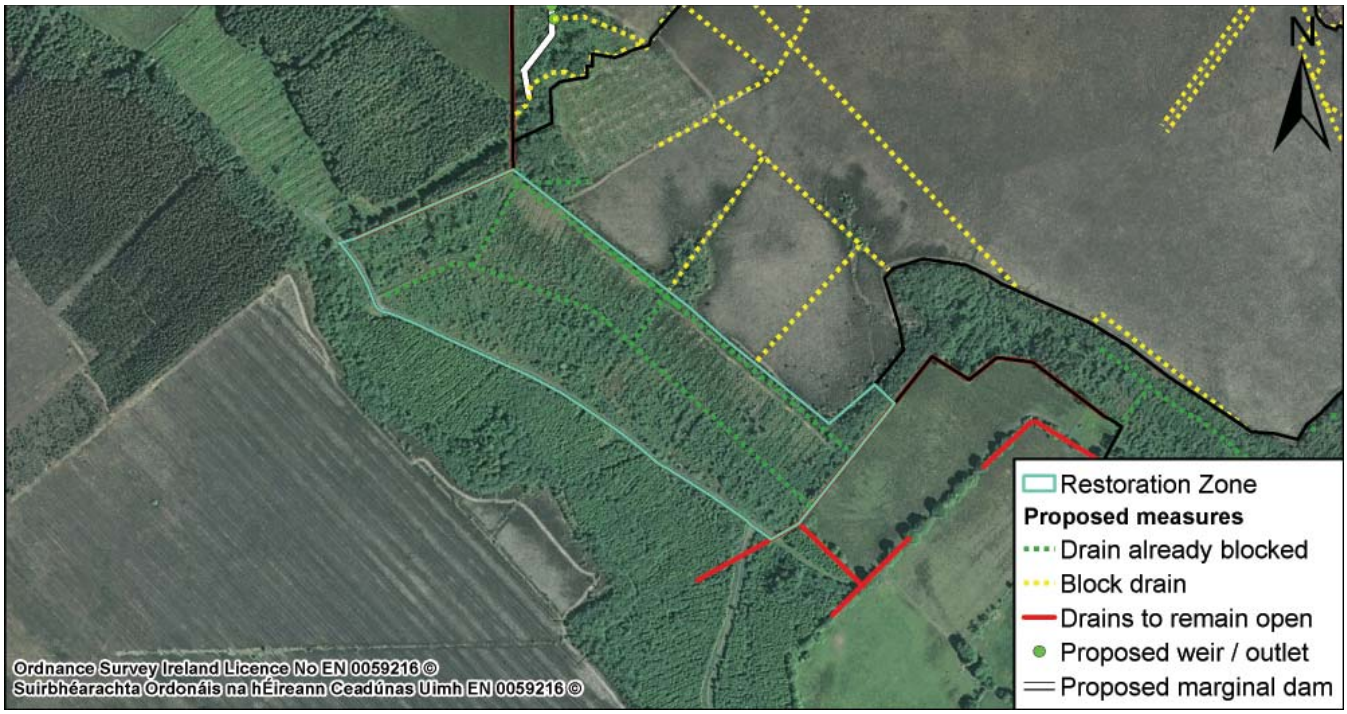
Measure 1:	Measure 2:	Measure 3:
Block 4.4 km of drains	N/A	N/A

Are restoration measures likely to benefit the high bog?	Yes - measures are proposed on the high bog and will directly support improving hydrological conditions
Current habitat:	Raised bog, scrub
Co-dependency:	N/A

Measures Summary

Peat dams required	Plastic dams required	Forestry area to clear (ha)	Length marginal dam (m)	No. Weirs/outlets	Length infill drains (m)
347	0	0	0	0	0

Restoration Zone:	Ardagullion_04
Townlands:	Asnagh, Cloonshannagh Or Coolamber Manor Demesne
Priority: N/A **Justification for measures:**	Previous Coillte restoration area (PFH - Bog)
Area of Degraded Raised Bog (DRB) (ha):	0
Potential area of peat-forming habitats (ha):	0.38



Measures Proposed

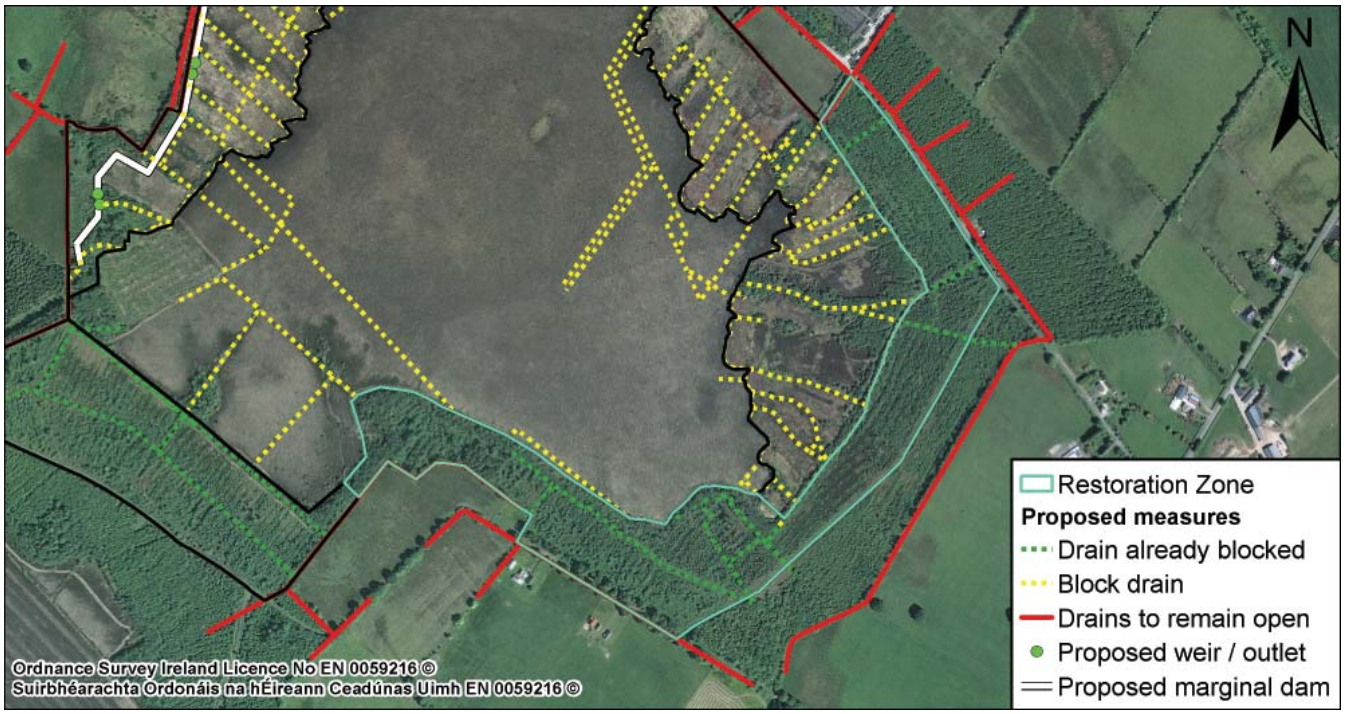
Measure 1:	Measure 2:	Measure 3:
No measures proposed (former Coillte restoration area)	N/A	N/A

Are restoration measures likely to benefit the high bog?	Yes - previous restoration works are likely to contribute to reducing the gradient between the water table in the high bog and the water table in the margins
Current habitat:	Cutover bog, scrub, recently felled woodland, bog woodland
Co-dependency:	N/A

Measures Summary

Peat dams required	Plastic dams required	Forestry area to clear (ha)	Length marginal dam (m)	No. Weirs/outlets	Length infill drains (m)
0	0	0	0	0	0

Restoration Zone:	Ardagullion_05
Townlands:	Ardagullion, Cloonshannagh Or Coolamber Manor Demesne
Priority: N/A **Justification for measures:**	Previous Coillte restoration area (PFH - Bog)
Area of Degraded Raised Bog (DRB) (ha):	0
Potential area of peat-forming habitats (ha):	0.14



Measures Proposed

Measure 1:	Measure 2:	Measure 3:
No measures proposed (former Coillte restoration area)	N/A	N/A

Are restoration measures likely to benefit the high bog?	Yes - previous restoration works are likely to contribute to reducing the gradient between the water table in the high bog and the water table in the margins
Current habitat:	Cutover bog, scrub, recently felled woodland, bog woodland
Co-dependency:	N/A

Measures Summary

Peat dams required	Plastic dams required	Forestry area to clear (ha)	Length marginal dam (m)	No. Weirs/outlets	Length infill drains (m)
0	0	0	0	0	0

Appendix 7

Bog Relocation Process

Process involved in the Relocation of Turf-Cutters to Non-Designated Bogs

Stage 1-Potential Site Identification

The first stage of the process is to identify potential alternative bogs near the SAC that would be suitable for turf-cutting. In certain cases, turf-cutting groups identified a bog which they would like to have investigated in terms of its suitability for turf-extraction. In some cases this has proved to be successful and in others the identified bog has been ruled out for various reasons, and the search moves on to other alternatives.

Stage 1 has also involved an assessment of potential relocation sites identified in the Turf Cutters and Contractors Association (TCCA) proposals on 56 raised bog complexes to the EU Commission and Irish Government on 4th March 2012, the Quirke Report (Quirke, 2012), by local turf-cutting communities, and by Departmental staff. Department officials undertook an initial identification exercise and investigated the presence of potential relocation sites suitable for further consideration within a radius of 15km from each of the SACs. This exercise included an examination of ownership details available from the Property Registration Authority of Ireland. Where this exercise indicated that a site had potential, a field inspection of the site was undertaken by Department officials. These sites were initially investigated by Departmental staff and if this inspection indicated that a site appeared suitable, the details were passed to Bord na Móna which was engaged by the Department, for further assessment. To date, Department staff have identified and screened several hundred sites.

Stage 2-Preliminary suitability assessment of a potential relocation site

This involves a site visit by a specialist from Bord na Móna with an examination of the high bog, spread ground, access roads, drainage and any other key issue.

Stage 3-Stratigraphy suitability assessment of a potential relocation site

A stratigraphy assessment is undertaken to determine the depth and quality of peat deposits in the site. Peat samples are taken at various locations across the site, analysed and graded in accordance with the Von Post Scale of Decomposition of Peat.

Stage 4-Full suitability assessment of a potential relocation site

A full assessment is undertaken in order to evaluate the suitability of the site for turf-cutting for domestic purposes. The site is evaluated in terms of peat characteristics, peat depth and volume, site access, face bank and spread ground, drainage, potential number of turf-cutters that could be accommodated on the site, and current site activity. The work involved includes topographic surveys, peat depth probing, and site design and layout.

Stage 5-Secure agreement of landowners for purchase of relocation site

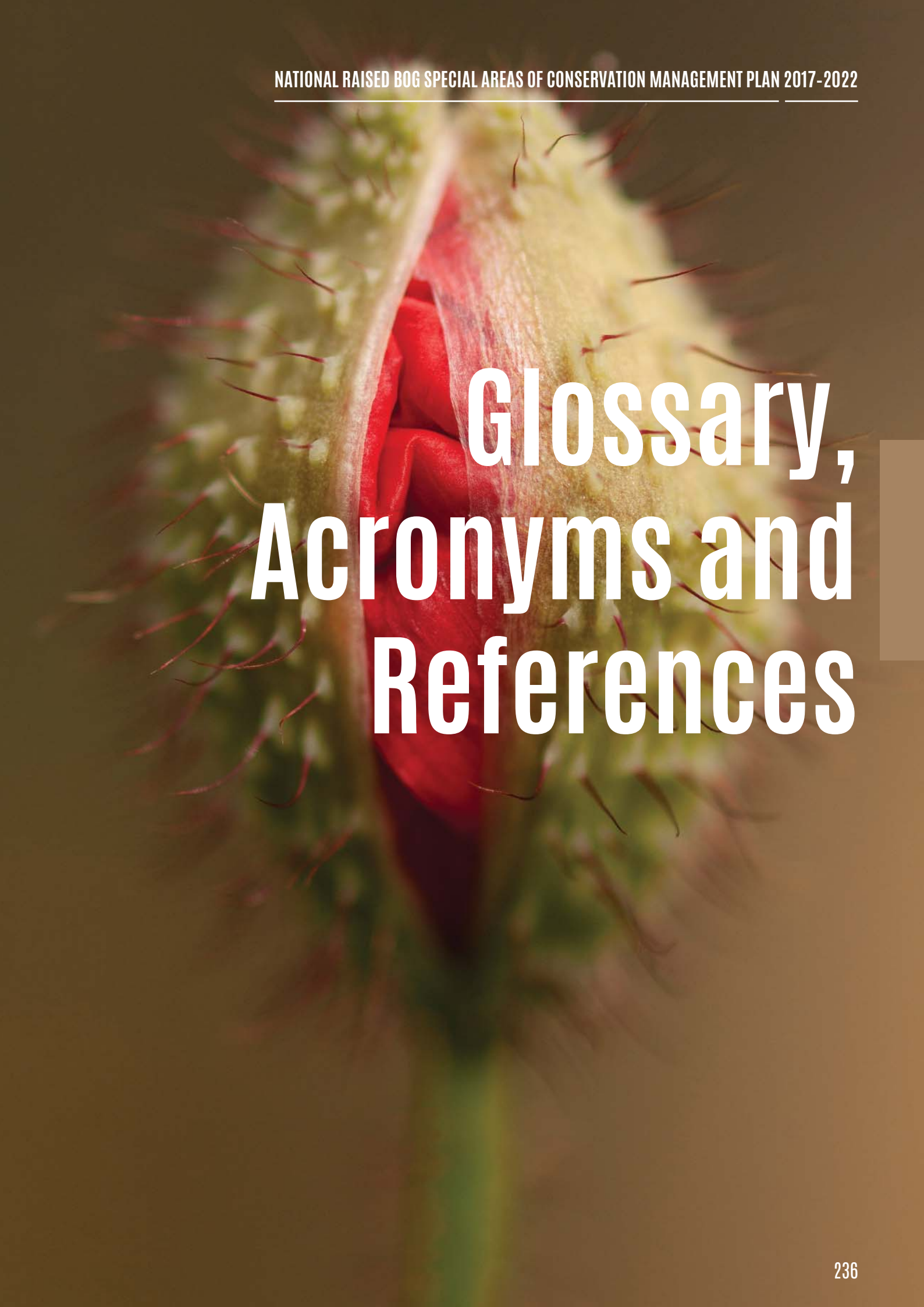
Following agreement on land purchase, individual relocation legal agreements are then signed by the relocating turf-cutters and the Department.

Stage 6-Secure any necessary planning permission and any necessary consents

Stage 7-Conclude purchase of site

Stage 8-Prepare relocation site and relocation of turf-cutters

This may involve site clearance, drainage works, access road works, laying out spread grounds and preparing facebank for cutting. In facilitating relocation, the Department will undertake all the necessary access, drainage and infrastructure works, unless otherwise agreed.



Glossary, Acronyms and References

Glossary

ACROTELM
The living, actively growing upper layer of a raised bog, composed mainly of living bog mosses.

ACTIVE RAISED BOG
Where the conditions are right for peat to continue to form, and where species of plants and animals typical to bogs can thrive.

ANAEROBIC
The absence of oxygen.

ANNEX I
Annex I of the EU Habitats Directive lists natural habitats types of Community interest whose conservation requires the designation of SACs.

ANNEX II
Annex II of the EU Habitats Directive lists animal and plant species of Community interest whose conservation requires the designation of SAC.

APPROPRIATE ASSESSMENT
A multi-staged process for ascertaining whether a plan or project, alone or in combination with other plans or projects, will adversely affect the integrity of the Natura 2000 Network of internationally important sites. Required under Article 6(3) of the Habitats Directive.

ARTICLE 6(1)
Article 6(1) of the Habitats Directive states that for SACs, Member States shall establish the necessary conservation measures involving, if need be, appropriate management plans specifically designed for the sites or integrated into other development plans, and appropriate statutory, administrative or contractual measures which correspond to the ecological requirements of the natural habitat types in Annex I and the species in Annex II present on the sites.

ARTICLE 6(2)
Article 6(2) of the Habitats Directive states that Member States shall take appropriate steps to avoid, in the SACs, the deterioration of natural habitats and the habitats of species as well as disturbance of the species for which the areas have been designated, in so far as such disturbance could be significant in relation to the objectives of the Directive.

ARTICLE 6(3)
Article 6(3) of the Habitats Directive states that a plan or project not directly connected with or necessary to the management of the site but likely to have a significant effect thereon, either individually or in combination with other plans or projects, shall be subject to appropriate assessment of its implications for the site in view of the site's conservation objectives. In the light of the conclusions of the assessment of the implications for the site, the competent national authorities shall agree to the plan or project only after having ascertained that it will not adversely affect the integrity of the site concerned and, if appropriate, after having obtained the opinion of the general public.

ARTICLE 6(4)
Article 6(4) of the Habitats Directive states that if, in spite of a negative assessment of the implications for the site and in the absence of alternative solutions, a plan or project must nevertheless be carried out for imperative reasons of overriding public interest, including those of a social or economic nature, the Member State shall take all compensatory measures necessary to ensure that the overall coherence of Natura 2000 is protected. It shall inform the Commission of the compensatory measures adopted.

BIODIVERSITY
A general term used to describe all aspects of biological diversity including the number of species present in a given environment, the genetic diversity present within a species and the number of different ecosystems present within a given environment.

BOG WOODLAND
Woodland on a wet peaty substrate, with the water level permanently high and even higher than the surrounding water table. The water is poor in nutrients and the ground surface has high cover of bog moss species, with active peat accumulation taking place. Bog woodland is listed as a priority habitat in Annex I of the Habitats Directive. It differs from dry woodland on bog where peat accumulation is not taking place.

BIRDS DIRECTIVE
Council Directive 79/409/EEC of 2 April 1979 on the conservation of wild birds.

CARBON SEQUESTRATION
The capture and long-term storage of atmospheric carbon dioxide, for example, in peat bogs.

CATCHMENT
An area of land draining to a defined point. The term river catchment refers to the area of land that drains into a particular river system.

COLONISATION
The entry and spread of a species into an area, habitat or population from which it was formerly absent.

CUTAWAY BOG
Areas where all of the peat has been removed.

CUTOVER BOG
Areas of bog which have been previously cut (by hand or by mechanical means), although not down to the marl layer or bedrock. Remaining peat may still be an economic reserve. Cutover areas are normally a mosaic of cut areas, face banks, pools, drainage ditches, uncut areas of peat, scrub, grassland etc.

DEGRADED RAISED BOG
The area of high, uncut bog which has been damaged by human activities but which could be transformed into active raised bog again through restoration measures.

DISSOLVED ORGANIC CARBON
Organic molecules of varied origin and composition within aquatic systems. When peat is degraded DOC is leached into the water and this can impact on water quality which can have ecological impacts on ecosystem health as well as result in costs for water treatment.

ECO-HYDROLOGY
The sub-discipline of scientific study shared by ecology and hydrology. Investigates the effects of hydrological processes on the distribution, structure, and function of ecosystems, and on the effects of biotic processes on elements of the water cycle.

ECOLOGY
The study of the interactions between organisms, and their physical, chemical and biological environment.

ECOSYSTEM
A biological community of interacting organisms and their physical environment.

ECOSYSTEM SERVICES
Humankind benefits from a multitude of resources and processes that are supplied by ecosystems. Collectively, these benefits are known as ecosystem services and include products like clean drinking water and processes such as the decomposition of wastes.

ECOTOPE
The smallest ecologically distinct landscape features in a landscape.

EFFECTIVE RAINFALL
The rainfall useful for meeting plant water requirements. This does not include water percolating down to aquifers, or surface run-off of water.

EIA DIRECTIVE
Council Directive 85/337/EEC of 27 June 1985 on the assessment of the effects of certain public and private projects on the environment.

ENDANGERED
At risk of extinction.

EROSION
The processes whereby the materials of the Earth's crust are dissolved, or worn away and simultaneously moved from one place to another by natural processes which include weathering, solution, corrosion and transportation.

EUROPEAN SITE
Under European Communities (Birds and Natural Habitats) Regulations 2011, the term European site means:

(a) a candidate site of Community importance;
(b) a site of Community importance;
(c) a candidate special Area of Conservation;
(d) a Special Area of Conservation;
(e) a candidate Special Protection Area; or
(f) a Special Protection Area.

EVAPOTRANSPIRATION
Water loss to the atmosphere from soil (evaporation) and vegetation (transpiration).

FACEBANK
Areas at the edge of the high bog where peat cutting has taken place. This is an ecotope that is highly degraded and absent of typical *Sphagnum* species.

FAUNA
Animal life.

FAVOURABLE CONSERVATION CONDITION
This is the condition of a habitat or species considered to be favourable at site level. Favourable conservation condition is defined by site-specific conservation objectives. 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.

FAVOURABLE CONSERVATION STATUS
The conservation status of a natural habitat will be taken as favourable when its natural range and areas it covers within that range are stable or increasing, and the specific structure and functions which are necessary for its long-term maintenance exist and are likely to continue to exist for the foreseeable future, and the conservation status of its typical species is favourable.

FENS AND FLUSHES
An NPWS habitat classification. Fens are peatlands fed by calcium rich water, either from groundwater or from inflowing surface water. Flushes are wet areas maintained by the seepage of water down slopes of various gradient, and are usually local features. Both are characterised by an abundance of small sedge forming species-rich mosaics with other species.

FLORA
Plant life.

HABITAT
Refers to the environment defined by specific abiotic and biotic factors, in which a species lives at any stage of its biological cycle. In general terms it is a species' home.

HABITATS DIRECTIVE
Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora.

HIGH BOG
The area of bog which has not previously been cut.

HUMMOCK
A small hillock or mound. Often used to describe the surface of active bogs where the ground forms a pattern of mounds, hollows and pools. Such hummocks commonly comprise bog mosses.

HYDROLOGICAL REGIME
Changes with time in the rates of flow of rivers and in the levels and volumes of water in rivers, lakes, reservoirs and marshes.

HYDROLOGY
The movement of water through a catchment area including freshwater and seawater inputs, water level changes and drainage mechanisms which are all influenced by the underlying geology.

KYOTO PROTOCOL
The Kyoto Protocol to the United Nations Framework Convention on Climate Change is an international treaty that sets binding obligations on industrialised countries to reduce emissions of greenhouse gases.

LAGG
A term used to describe the area of transition from bog to mineral soil around a raised bog.

LiDAR
A remote sensing technology that measures vertical surface elevation by illuminating a target with a laser and analysing the reflected light.

LIFE
The EU's financial instrument supporting environmental and nature conservation projects throughout the EU.

MICROTOPOGRAPHY
Variations in elevation at a relatively small scale. Generally the high spots are about a meter higher than the low spots, and only a couple of metres across. On a high bog this consists of hummocks, hollows, pools, flats and lawns.

NATIONAL PARKS AND WILDLIFE SERVICE
Part of the Department of Culture, Heritage and the Gaeltacht responsible for the protection and conservation of Ireland's natural heritage and biodiversity at national level.

NATURA 2000
A network of sites across the European Community selected for the purpose of conserving natural habitats and species of plants and animals which are rare, endangered or vulnerable. SACs and SPAs form the Natura 2000 Network.

NATURAL HERITAGE AREA
Area designated for wildlife conservation under the Wildlife Amendment Act 2000.

PALAEO-ARCHAEOLOGY
The study of the archaeology of deep time focusing on hominid fossils ranging from 15,000,000 to 10,000 years ago.

PALAEO-CLIMATOLOGY
The study of the climate of past ages.

PEAT DAM
A peat dam is a form of restoration measure commonly used on raised bogs or blanket bogs. The dam is constructed from layers of peat typically extracted from a nearby location, placed into a drain and compacted to block the drain and raise the water level in the peat.

PEAT-FORMING HABITAT
These are habitats where peat is actively forming, it includes typical raised bog vegetation that indicates peat accumulation as well as lagg or fen vegetation indicating peat is actively forming.

PIEZOMETER
A piezometer is either a device used to measure liquid pressure in a system or a device which measures the pressure of groundwater at a specific point.

PRIORITY HABITAT
A subset of the habitats listed in Annex I of the EU Habitats Directive. These are habitats which are in danger of disappearance and whose natural range mainly falls within the territory of the European Union. These habitats are of the highest conservation status and require measures to ensure that their favourable conservation status is maintained.

QUALIFYING INTERESTS
Qualifying Interests are the Annex I habitats or Annex II species for which an SAC has been designated.

RAISED BOG
A peatland ecosystem which typically develops in topographic depressions where drainage is impeded. This may be due to a high groundwater table, or presence of a low permeability substrate (e.g. lacustrine clay). The waterlogged conditions provide anaerobic conditions which results in slow decomposition of organic matter leading to an accumulation of peat. Eventually the peat elevates the bog above regional groundwater levels to form a dome from which the term 'raised' bog is derived.

STRATEGIC ENVIRONMENTAL ASSESSMENT
Directive 2001/42/EEC of the European Parliament and of the Council of 27 June 2001 on the assessment of the effects of certain plans and programmes on the environment.

SITE-SPECIFIC CONSERVATION OBJECTIVE
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.

SPECIAL AREA OF CONSERVATION
Area designated for the conservation of habitats and/or species under the Habitats Directive.

SPREAD GROUNDS
Area where turf is spread after cutting to dry out. Typically drained cutover bog or agricultural areas adjacent to the high bog.

STRATIGRAPHY
The branch of geology concerned with the order and relative position of strata and their relationship to the geological timescale.

TILL
Geological term referring to unsorted material deposited by glacial ice and showing no stratification. Often referred to as boulder clay.

TOPOGRAPHY
The arrangement of the physical features of an area.

Acronyms

AA	Appropriate Assessment
ARB	Active Raised Bog
CO2	Carbon Dioxide
CTCCS	Cessation of Turf Cutting Compensation Scheme
DECLG	Department of Environment, Community and Local Government.
DEFRA	Department for Environment, Food and Rural Affairs
DPER	Department of Public Expenditure and Reform.
DRB	Degraded Raised Bog
EC	European Commission
EIA	Environmental Impact Assessment
EPA	Environmental Protection Agency
ERT	Electrical Resistivity Tomography
EU	European Union
GIS	Geographic Information System
GPR	Ground Penetrating Radar
LiDAR	Light Detection and Ranging
MFAC	Modified Flow Accumulation Capacity
NHA	Natural Heritage Area
NPWS	National Parks and Wildlife Service
OPW	Office of Public Works
PAC	Potential Acrotelm Capacity
SAC	Special Area of Conservation
SEA	Strategic Environmental Assessment
SEC	Specific Electrical Conductivity
SPA	Special Protection Area
TCCA	Turf Cutters and Contractors Association

References

Aherne, J. and Farrell, E. 2000. *Final Report: Determination and mapping of critical loads for sulphur and nitrogen and critical levels for ozone in Ireland.* Environmental Protection Agency, Dublin, p. 212.

Bellamy, D. 1986. *Bellamy's Ireland: the wild boglands.* Country House, Ireland.

Bobbink, R. and Hettelingh, J. 2011. *Review and Revision of Empirical Critical Loads and Dose-response Relationships,* s.l. Proceedings of an expert workshop, Noordwijkerhout, 23–25 June 2010. RIVM report 680359002, Coordination Centre for Effects, National Institute for Public Health and the Environment (RVIM).

Bonn, A., Reed, M. S., Evans, C. D., Joosten, H., Bain, C., Farmer, J., Emmer, I., Couwenberg, J., Moxey, A., Artz, R., Tanneberger, F., von Unger, M., Smyth, M.-A., and Birnie, D. 2014. Investing in nature: Developing ecosystem service markets for peatland restoration. *Ecosystem Services* 9: 54–65.

Bord na Móna, 2016. *Biodiversity Action Plan 2016–2021*. Bord na Móna. Dublin. (Accessible at http://www.bordnamona.ie/company/bord-na-mona-story/biodiversity/biodiversity-action-plan/)

Bullock, C. and Collier, M. 2011 When the public good conflicts with an apparent preference for unsustainable behaviour. *Ecological Economics* 70: 971–977.

Bouwer, H. and Rice, R.C. 1976. A slug test method for determining hydraulic conductivity of unconfined aquifers with completely or partially penetrating wells. *Water Resources Research*, 12(3): 423–428.

Collier, M. J. and Scott, M. 2009. Conflicting rationalities, knowledge and values in scarred landscapes. *Journal of Rural Studies* 25(3): 267–277.

Collier M. J. and Scott, M. 2010. Focus group discourses in a mined landscape. *Land Use Policy* 27(2): 304–312.

DECLG, 2012. *Our Sustainable Future: A framework for sustainable development for Ireland.* Department of Environment, Community and Local Government.

DEFRA, 2013. *The State of Natural Capital: Towards a framework for measurement and valuation.* A report from the Natural Capital Committee, UK.

Derwin, J. and MacGowan, F. 2000. *Raised Bog Restoration Project*. Unpublished report, Dúchas – The Heritage Service, Dublin.

DPER, 2015. *Building on Recovery: Infrastructure and capital investment 2016–2021*. Department of Public Expenditure and Reform. Dublin. (Accessible at: http://www.per.gov.ie/en/capital-investment-plan-2016-2021/).

Duffy, P., Hanley, E., Hyde, B., O'Brien, P., Ponzi J., Cotter E. and Black, K. 2013. *National Inventory Report 2013. Greenhouse gas emissions 1990–2011 reported to the United Nations Framework Convention on Climate Change.*

EC, 2007. *Guidance document on Article 6(4) of the 'Habitats Directive' 92/43/EEC.* European Commission. (Accessible at http://ec.europa.eu/environment/nature/natura2000/management/docs/art6/guidance_art6_4_en.pdf)

EC, 2010. *Communication from the Commission to the European Parliament, the Council, the European , Economic and Social Committee and the Committee of the Regions. Options for an EU vision and target for biodiversity beyond 2010.* European Commission. Brussels. (Accessible at http://ec.europa.eu/environment/nature/biodiversity/policy/pdf/communication_2010_0004.pdf)

EC, 2011, *EU Biodiversity Strategy to 2020.* European Commission. Luxembourg. (Accessible at http://ec.europa.eu/environment/nature/biodiversity/strategy/index_en.htm

Fernandez, F., Connolly, K., Crowley, W., Denyer, J., Duff, K. and Smith, G. 2014. *Raised Bog Monitoring and Assessment Survey 2013. Irish Wildlife Manuals,* No. 81. National Parks and Wildlife Service, Department of Arts, Heritage and Gaeltacht, Dublin, Ireland.

Fernandez, F., Fanning, M., McCorry, M. and Crowley, W. 2005. *Raised Bog Monitoring Project 2004–05. Unpublished report*, National Parks and Wildlife Service, *Department of Environment*, Heritage and Local Government, Dublin.

Fernandez, F., MacGowan, F., Crowley, W., Farrell, M., Croal, Y., Fanning, M. and McKee, A. 2006. *Assessment of Impacts of Turf-cutting on Designated Raised Bogs 2003–06.* Unpublished report, National Parks and Wildlife Service, Department of Environment, Heritage and Local Government, Dublin.

Flynn, R., Regan, S., and Johnston, P. 2013 Clara Bog – A groundwater dependent ecosystem. In Feehan, J. *The Geology of Laois and Offaly*. Offaly County Council.

Forchheimer, P. 1898. Grundwasserspiegel bei brunnenanlagen.Z. *Osterreichhissheingenieur Architecten*, 434(44): 629–635.

Foss, P.J., O'Connell, C.A. and Crushell, P.H. 2001. *Bogs and Fens of Ireland Conservation Plan 2005*. Irish Peatland Conservation Council.

Fowler, D., Smith, R., Muller, J., Hayman, G., & Vincent, K. 2005. Changes in the atmospheric deposition of acidifying compounds in the UK between 1986 and 2001. *Environmental Pollution*, 137: 15–25.

Hammond, R.F. 1981. *The Peatlands of Ireland. To accompany Peatland Map of Ireland*, 1978. Soil Survey Bulletin 35. 2nd Edition. An Foras Talúntais, Dublin.

Hammond, R.F. 1984. *The Classification of Irish Peats as Surveyed by the National Soil Survey of Ireland.* Proceedings of 7th International Peat Congress, Dublin, Vol. 1: 168–187. The International Peat Society, Helsinki.

Holden, J., Chapman, P. J. and Labadz, J. C. 2004. Artificial drainage of peatlands: hydrological and hydrochemical process and wetland restoration. *Progress in Physical Geography* 28(1): 95–123.

Hvorslev, M.J. 1951. Time lag and soil permeability in ground-water observations, *Bulletin No. 36, Waterways Experiment Station, Corps of Engineers, U.S. Army,* Vicksburg, Mississippi.

Kelly, L., Doak, M. and Dromey, M. 1995. *Raised Bog Restoration Project: An Investigation into the Conservation and Restoration of Selected Raised Bog Sites in Ireland.* Unpublished report, National Parks and Wildlife, Department of Environment, Heritage and Local Government, Dublin.

Kelly, L. and Schouten, M.G.C. 2002. Vegetation. In Schouten, M.G.C. 2002. (Ed.) *Conservation and Restoration of Raised Bogs: Geological, hydrological and ecological studies.* Department of Environment and Local Government, Dublin, Ireland/ Staatabosbeheer, The Netherlands.

Kelly, M.L. 1993. *Hydrology, Hydrochemistry and Vegetation of Two Raised Bogs in County Offaly.* PhD thesis, Trinity College Dublin.

Kjeldsen, T.R., Jones, D.A. and Bayliss, A.C. 2008. *Improving the FEH Statistical Procedures for Flood Frequency Estimation. Final Research Report to the Environment Agency, R&D Project SC050050*. Environment Agency, Bristol.

Mackin, F., Flynn, R., Barr. A. and Fernandez-Valverde, F. 2017. Use of geographical information system-based hydrological modelling for development of a raised bog conservation and restoration programme. *Ecological Engineering*, 106: 242–252.

Malmer, N. and Wallén, B. 2005. Nitrogen and phosphorus in mire plants: variation during 50 years in relation to supply rate and vegetation type. *Oikos*, 109: 539–554.

Market Research Partners 2008. *Public Perceptions of Wild Places and Landscapes in Scotland.* Comissioned Report No. 291, Scottish Natural Heritage. (Available at: https://www.nature.scot/snh-commissioned-report-291-public-perceptions-wild-places-and-landscapes-scotland [Accessed: 18/08/2017]).

Marshall, D.C.W. and Bayliss, A.C., 1994. Flood Estimation for Small Catchments. *The Institute of Hydrology Report No. 124 (IH 124)*. Institute of Hydrology, Wallingford.

Martin-Ortega, J., Allott, T. E. H., Glenk, K., and Schaafsma, M. 2014. Valuing water quality improvements from peatland restoration: Evidence and challenges. *Ecosystem Services, 9: 34–43,*.

Met Éireann, 2013. *Climate – 30 year Averages*. (Available at: http://www.met.ie/climate-ireland/30year-averages.asp. [Accessed: 01/06/2013]).

Moloney, A., Jennings, D., Keane, M., McDermott, C. 1993. *Excavations at Clonfinlough County Offaly*. Transactions of the Irish Archaeological Wetland Unit, Volume 2, Dublin. Crannóg Publications.

Murphy, C. 2009. *Flood Studies Update Programme, WP2.3, Flood Estimation in Ungauged Catchments, Final Report (FSU WP2.2)*. National University of Ireland Galway and the Office of Public Works.

NPWS, 2013. *The Status of EU Protected Habitats and Species in Ireland. Habitat Assessments Volume 2. Version 1.1.* Unpublished report, National Parks and Wildlife Services. Department of Arts, Heritage and the Gaeltacht, Dublin, Ireland.

NPWS, 2014. *Review of Raised Bog Natural Heritage Area Network.* National Parks and Wildlife Services, Department of Arts, Heritage and the Gaeltacht. Dublin. (Accessible at https://www.npws.ie/sites/default/files/general/Final%20NHA%20Review%2017%20January%202014.pdf).

NPWS, 2015. *National Peatlands Strategy 2015*. National Parks and Wildlife Services, Department of Arts, Heritage and the Gaeltacht. Dublin. (Accessible at http://www.npws.ie/peatlands-and-turf-cutting/peatlands-council/national-peatlands-strategy).

NPWS, 2016a. *Conservation Objectives: Lough Ree SAC 000440. Version 1*. National Parks and Wildlife Service, Department of Arts, Heritage, Regional, Rural and Gaeltacht Affairs. (Accessible at https://www.npws.ie/protected-sites/sac/000440).

NPWS, 2016b. *Conservation Objectives: Moneybeg and Clareisland Bogs SAC 002340. Version 1*. National Parks and Wildlife Service, Department of Arts, Heritage and the Gaeltacht. Dublin. (Accessible at https://www.npws.ie/sites/default/files/protected-sites/conservation_objectives/CO002340.pdf).

NPWS 2017. *Actions for Biodiversity 2017–2021. Ireland's national biodiversity plan*. National Parks and Wildlife Services, Department of Arts, Heritage and the Gaeltacht. Dublin. (Accessible at https://www.npws.ie).

Quirke, J. 2012. *The Quirke Report*. Peatlands Forum 28 February–2 March, 2012.

Renou-Wilson, F., Bolger, T., Bullock, C., Convery, F., Curry, J. P., Ward, S., Wilson, D. and Müller, C. 2011. *BOGLAND: A Protocol for the Sustainable Management of Irish Peatlands*. STRIVE Report No. 76 prepared for the Environmental Protection Agency (EPA), Johnstown Castle, Co. Wexford.

Schouten, M. G., Streefkerk, J. G. and Zandstra, R. J. 1994. *General Proposals for Technical Measures for the Conservation and Restoration of the Raised Bogs Clara and Raheenmore*. National Parks and Wildlife Serivce, Dublin and National Forestry Service of the Netherlands, Driebergen.

Schouten, M.G.C. 2002. (Ed.) *Conservation and Restoration of Raised Bogs: Geological, hydrological and ecological studies*. Department of Environment and Local Government, Dublin, Ireland/ Staatabosbeheer, The Netherlands.

van der Schaaf, S. 2002a. Bog hydrology. In Schouten, M.G.C. (Ed.), *Conservation and Restoration of Raised Bogs: Geological, hydrological and ecological studies*, pp. 54–109. Dúchas – The Heritage Service of the Department of the Environment and Local Government, Ireland; Staatsbosbeheer, the Netherlands; Geological Survey of Ireland, Dublin.

van der Schaaf, S. 2002b. *Using Surface Topography to Assess Potential and Actual Ecological Conditions in Irish Midland Raised Bogs. Annals of Warsaw Agricultural University*. Land Reclamation 33: 49–56.

van der Schaaf, S. and Streefkerk, J. G. 2002. Relationships between biotic and abiotic. In: Schouten, M. G. C. (Ed.), *Conservation and Restoration of Raised Bogs: Geological, hydrological and ecological studies*, pp.186–209. Dúchas – The Heritage Service of the Department of the Environment and Local Government, Ireland; Staatsbosbeheer, the Netherlands; Geological Survey of Ireland, Dublin.

Wilson, D., Müller, C. and Renou-Wilson, F. 2013. Carbon emissions and removals from Irish peatlands: current trends and future mitigation measures. *Irish Geography*, 46(1-2): 1–23.

World Commission on Environment and Development 1987. *Our Common Future*. Oxford, Oxford University Press.

Zerbe, S., Steffenhagen, P., Parakenings, K., Timmermann, T., Frick, A., Gelbrecht, J., and Zak, D. 2013. Ecosystem service restoration after 10 years of rewetting peatlands in NE Germany, *Environmental Management*, 51: 1194–1209.

List Of Tables

List Of Plates

List Of Figures

An Roinn
Cultúir, Oidhreachta agus Gaeltachta

Department of
Culture, Heritage and the Gaeltacht

National Parks and Wildlife Service
Department of Culture, Heritage and the Gaeltacht
7 Ely Place, Dublin 2, D02 TW98, Ireland

t: +353-53-9117384/9117456 e: peatlandsmanagement@chg.gov.ie w: www.npws.ie www.chg.gov.ie