National survey and assessment of the conservation status of Irish sea cliffs

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National survey and assessment of the conservation status of Irish sea cliffs

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Executive Summary

Sea cliffs are steeply sloping land formations on the coast, the base of which occurs in the intertidal zone. They are one of the least modified habitat types occurring in Ireland and support highly diverse vegetation communities, ranging from bare rock communities through to wooded slopes. The habitat is included on Annex I of the EU Habitats Directive as the habitat type *Vegetated sea cliffs of the Atlantic and Baltic coasts* (1230).

This is the first systematic national survey of sea cliff vegetation and conservation status in Ireland. The research carried out here will provide baseline data for future habitat studies and a starting point for a comprehensive classification of sea cliff vegetation. In addition, the findings of this study will be used in reporting on the conservation status of Irish sea cliffs to the European Commission under section 17 of the Habitats Directive. All of the sea cliffs on the Irish coast can be considered to correspond to the EU Annex I habitat *Vegetated sea cliffs of the Atlantic and Baltic coasts* (1230). Under Article 17 of the Habitats Directive, the Irish State is required to monitor the conservation status of Annex I habitats occurring within the state, and to provide a report on these habitats to the European Commission every six years.

As part of this project a desk study was completed on 196 sea cliff sites. Factors such as structure, vegetation and anthropogenic influences were investigated using aerial photographs, oblique photographs of the coast and a range of GIS data. All of the results presented in the report are calculated on the basis of the cliffs present in the database and does not include sites which have only been provisionally identified or those for which no photographic imagery was available. It was found that sea cliff habitat covers 22% of the coastline of Ireland and is primarily distributed along the southern, western and northwestern seaboards. A total of 177 (90%) cliff sites are at least partly within a National Parks and Wildlife Service conservation site, though soft cliffs were found to be under-represented in the network of sites. Candidate Special Areas of Conservation (cSACs) coincide with 135 sites, Special Protection Areas (SPAs) coincide with 100 sites, proposed Natural Heritage Areas (pNHAs) coincide with 150 sites and Nature Reserves coincide with 5 sites. Sites designated as being of conservation importance often coincide with only part of a cliff site. Anthropogenic influences, which were recorded within and adjacent to cliffs, were noted at 58% of sites. Data collected during the desk study were entered into a specifically designed database along with the information available for a further 20 sites for which a desk study was carried out as part of the pilot study for this project (MERC/EirEco, 2009). An additional 140 sea cliff sites were provisionally identified during this project but have not been fully investigated. The location of

sea cliffs were mapped and presented in a GIS project with maps of all of the cliff sites in the database and of the sections which were surveyed in the field being submitted to NPWS.

Field studies were carried out at a sub-sample of 32 sites; five of these were surveyed using rope survey techniques. Data were collected from swaths at 62 sea cliff sections with a total of 161 relevés recorded. Remote survey techniques were utilised at all sites, using high powered photographic equipment to take photographs of relevés with species lists being developed at a later date by a botanist. Rope survey techniques involved a botanist being lowered down the cliff by rope and taking relevés directly from the cliff face. In comparisons of the same relevé locations the rope survey techniques were found to be more accurate with only 54% of species being recorded using remote techniques. Data collected using remote techniques from more open habitats (crevice and ledge communities) were found to have a higher level of accuracy than that collected from species-rich, densely vegetated communities (such as grassland communities). Relevé data are presented in a Turboveg database.

Sea cliff microhabitats or zones were defined on the basis of (a) relative position on the cliff, (b) maritime influence and (c) vegetation. The most commonly recorded zone types were crevice and ledge zones and splash zones. A range of fauna was observed to utilise the cliffs including the EU Annex I Birds Directive species chough (*Pyrrhocorax pyrrhocorax*) and peregrine (*Falco peregrinus*). Several examples of the priority Annex I habitat *Petrifying springs with tufa formation (Cratoneurion)* (7220) were also recorded.

The conservation status of the 32 sites surveyed in the field was assessed on the basis of extent, structure and function and future prospects. Criteria for assessing each of these parameters were developed. Of these sites, 29 were scored as Favourable for extent, with the remainder assessed as Unfavourable - Inadequate. For structure and function, 18 sites were assessed as Favourable, ten were assessed as Unfavourable - Inadequate and four were assessed as Unfavourable - Bad. For future prospects, 19 were considered Favourable and 13 were considered Unfavourable - Inadequate. No sites were considered Unfavourable - Bad for this parameter. These results were combined and an overall rating for each site obtained. Of the 32 sites surveyed the assessment for 16 sites was Favourable (50%), 12 sites (38%) were assessed as Unfavourable - Inadequate and four sites (13%) were assessed as Unfavourable - Bad. The findings of these assessments can be extrapolated to give a national assessment of the conservation status of the habitat. Current threats to the habitat include sea defences such as rock armour, invasive species, paths and tracks and dumping of household waste.

Seven vegetation groups were identified from the relevé data after analysis. Six of these were well-defined groups which reflected distinct communities. Two of these communities had a strongly maritime character, and were located primarily on exposed, hard cliffs; two were maritime grassland communities and a single heath community was described.

Recommendations are made in relation to completing a desk based study for the additional 140 sea cliff sites that were identified during this project. A future monitoring programme is presented with a provisional list of sites to be surveyed. A critical assessment of the methods used in this project is presented, and several recommendations are made for modifying the survey methodology for use in future survey work, particularly in relation to viewing as much of the site as is practical either by walking the full site or viewing it from a boat prior to selecting locations for detailed survey.

Acknowledgements

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Introduction

This is the first systematic survey dedicated to exploring the vegetation composition, vegetation structure and conservation status of sea cliffs in Ireland on a national basis. It builds on the research into sea cliff vegetation and survey methodologies reported in previous studies on the habitat (MERC/EirEco 2009, Browne 2005). The research carried out here will provide baseline data for use in habitat studies in the future and provides a starting point for a comprehensive vegetation classification of cliffs from the splash zone at the cliff base to the top of the cliff. In addition, the findings of this study will be used in reporting on the conservation status of Irish sea cliffs to the European Commission under section 17 of the Habitats Directive.

Sea cliffs in Ireland

Sea cliffs are steeply sloping land formations on the coast, the base of which occurs in the intertidal zone. They are one of the least modified habitat types occurring in Ireland and support highly diverse vegetation communities, ranging from bare rock communities through to wooded slopes. Sites are generally unmanaged, with plant development being determined by factors such as exposure to wind and spray from the sea, geology and slope. Sea cliffs are found mainly along the southern and western coasts of Ireland, with occasional formations also occurring on the east coast. The undisturbed, inaccessible locations provide nesting sites for large seabird colonies and support a number of rare plants. The value of sea cliffs has been recognised through inclusion of the habitat type *Vegetated sea cliffs of the Atlantic and Baltic coasts* (habitat code 1230) on Annex I of the EU Habitats Directive. Despite being one of the more natural habitats in the country, they have historically been an under-studied habitat, presumably due to their inaccessibility.

Sea cliffs can be broadly divided into two categories: hard (or rocky) cliffs and soft (or sedimentary) cliffs. Hard cliffs are composed of rocks such as limestone, sandstone or quartzite which are hard and relatively resistant to mechanical erosion. Soft cliffs are composed of softer rock or unconsolidated material such as glacial till, or soft sedimentary rocks such as shale. Vegetation of hard sea cliffs in exposed situations exhibits a strong maritime influence and is relatively stable. Soft cliff habitats are more prone to slope failure, which results in the presence of fast-colonising pioneer species. Due to their unstable nature, soft cliffs are often subject to sea defence projects, this being one of the main threats to the habitat. Other threats and pressures affecting sea cliffs include colonisation by non-native species, presence of footpaths and tracks, and quarrying.

Definition of a sea cliff

The definition of a sea cliff presented in Box 1 was developed for this study following a review of relevant literature (Fossitt 2000, JNCC 2004, Commission of the European Communities 2007, NPWS 2008, MERC/EirEco 2009) and review of the information collected during fieldwork for this project.

Box 1 Definition of a sea cliff

A sea cliff is a steep or vertical slope located on the coast, the base of which is in either the intertidal (littoral) or subtidal (sublittoral) zone. The cliff may be composed of hard rock such as basalt, or of softer substrate such as shale or boulder clay. Hard cliffs are at least 5m high, while soft cliffs are at least 3m high. The cliff top is generally defined by a change to an obvious less steep gradient. In some cases the cliff may grade into the slopes of a hillside located close to the coast. In these cases the cliff is defined as that part of the slope which was formed by processes of coastal erosion, while the cliff top is where there is the distinct break in slope. Both the cliff and the cliff top may be subject to maritime influence in the form of salt spray and exposure to coastal winds. A cliff can ascend in steps with ledges, and the top of the cliff is taken to occur where erosion from wave action is no longer considered to have been a factor in the development of the landform. The cliff base may be marked by a change in gradient at the bottom of the cliff. Where the base is exposed it can be characterised by scree, boulders, a wave-cut platform or sand, among other substrates. During this survey, where cliffs occur within the subtidal zone the base was considered to be the high water mark. A cliff is considered to have reached its end point where it is no longer over 5m high (hard cliffs) of 3m high (soft cliffs), or no longer has a steep slope. To be considered in this study, a cliff had to be a minimum of 100m in length. Sea cliffs may support a range of plant communities such as grassland, heath, scrub and bare rock communities, among others.

Vegetation studies and classification of sea cliffs

Sea cliffs can be difficult and dangerous to access, and are often exposed to inclement maritime and weather conditions. As a result, relatively little research has been carried out on sea cliffs in Ireland up until now. A *National inventory of sea cliffs and coastal heaths* (Browne 2005) collated existing information on sea cliffs in Ireland, including what was known of their vegetation. As part of that study, the likely locations of cliffs on the Irish coast were drawn on a set of OSI Discovery Series maps. These were later digitised using ArcGIS. Browne (2005) identified 140 "potential coastal heath and cliff sites". Sites were identified primarily using Discovery Series maps and, by eye, viewing the close nature of the contour lines. Additional sources used included NPWS conservation site information and an inventory of cliff nesting seabirds. As stated in Browne (2005), only sites greater than 10 m in height were identified through this process.

In preparation for the current project, a pilot survey was conducted in 2009 (MERC/EirEco 2009). The primary focus of that report was to develop a methodology for surveying Irish sea cliffs, and to develop a conservation assessment protocol. A desk survey of 20 sites was completed and information compiled in a database. In addition to the sites identified by Browne (2005), three more sites were identified during the desk study. Survey work was trialled at five sites. The survey work tested proposed survey methodologies which were evaluated and presented in the pilot survey report.

Literature available from other countries includes the body of work on cliffs in Cornwall amassed by A.J.C. Malloch, the most relevant of which is the *Vegetation of the maritime cliff-tops of the Lizard and Land's End Peninsulas, West Cornwall* (Malloch 1971). Here, vegetation records from relevés in Cornwall are combined into a classification of eight classes containing a total of 26 noda and associations. Vegetation groups identified are named after previously established associations where possible. Each of the associations is described and tables of frequency and abundance for the constituent species are given. Similarities to communities surveyed elsewhere are discussed. The paper highlights the similarity between relevés recorded in the Burren by Ivimey-Cook and Proctor (1966) and the Crithmo-Spergularietum rupicolae association in the Crithmo-Armerietalia maritimae class (which corresponds to the vegetation of Atlantic sea cliffs). It is suggested that the Burren relevés, along with some relevés recorded in Cornwall, represent an *Aster tripolium* subassociation of the Crithmo-Spergularietum rupicolae. Associations which were first described in this paper include those in the Silenion Maritimae class, which are grasslands located on cliff tops where cover of *Festuca rubra, Armeria maritima, Daucus carota* ssp. *gummifer* and *Silene maritima* is high. Although the association had not been described elsewhere, Malloch speculated that the Festuco-Armerietum rupestris association of the Silenion Maritimae class was likely to occur in western Ireland. A maritime therophyte nodum, the Thero-Sedetum anglici association, is described as a provisional association. Although a therophyte group had been documented in Ireland by Braun-Blanquet and Tüxen, there was no evidence that this was a particularly maritime group.

White and Doyle's paper (White & Doyle 1982) consolidates phytosociological and other accounts of vegetation communities which occur, or are likely to occur, in Ireland. It describes several plant communities which are associated with coastal cliffs. The most relevant associations are the Crithmo-Armerietalia maritimae and the Asteretea tripolii. The assertion by Malloch (1971) that the Crithmo-Spergularietum association may have been recorded from the Burren is reiterated. The cliff top grassland type identified by Malloch (Festuco-Armerietum rupestris association of the Silenion Maritimae class) is here considered under the Asteretea tripolii class.

A paper by Cooper (1997) describes sea cliff habitat in addition to inland cliff community types occurring near the north coasts of counties Antrim and Derry. This study sought to explain how plants which generally demonstrate differing ecological preferences can be found close together on cliffs in north-eastern Ireland. Eight vegetation groups were identified, five of which reflected some coastal influence. Of these, the least maritime vegetation group was the *Anthoxanthum odoratum*/*Calluna vulgaris* heath group (group 3), which had some similarities with the Calluno-Scilletum vernae (maritime heath) described by Malloch (1971). The other four groups showed clearer maritime influences. The *Anthyllis vulneraria*/*Thymus polytrichus* group (group 5) was similar to the Thero-Sedetum anglici association (Malloch 1971). Two groups were dominated by *Festuca rubra* and *Armeria maritima*. The first of these most resembled the Festuco-Dactyletum maritime grasslands association described by Malloch (1971). The second group was similar in composition to the cliff top "*Plantago* sward" communities described by Praeger (1911), McVean (1961) and Gimingham (1964). The final vegetation group identified was the *Armeria maritima*/*Cochlearia* group which most closely resembled the *Heracleum sphondylium* nodum of the Festuco-Armerietum rupestris association (Malloch 1971). The study showed that community compositions are affected more strongly by maritime influences than by physical and chemical characteristics of cliffs.

The National Vegetation Classification (NVC) used to classify British plant communities (Rodwell 1991, 1992, 1995, 2000) does not utilise Irish data, but it does provide an indication of the range of plant communities likely to exist in Ireland. It also provides this in a system that does not follow the subjective methods inherent in the central European phytosociological approach of Braun-Blanquet and Tüxen (1952). The NVC defines 12 plant communities characteristic of maritime sea cliffs. Some of the characterising species used are either not present in Ireland or are extremely limited in their distribution. A further limitation of the recognised NVC communities is that vegetation of soft cliffs may not fit any of the currently recognised NVC cliff communities; in a review of the coverage of the NVC (Rodwell *et al*. 2000) some vegetation types were recommended for inclusion in the NVC but soft sea cliffs were not included. MERC/EirEco (2009) reviewed Rodwell (2000) and listed 16 coastal NVC community types which they considered relevant to the study of sea cliffs in an Irish context (Table 1).

Table 1: NVC communities occurring on Irish sea cliffs (MERC/EirEco 2009)

Code	Vegetation Zone
	Maritime rock crevice / cliff ledge zone
MC1	Crithmo-Spergularietum maritime rock-crevice
MC2	*Armeria maritima-Ligusticum scoticum* maritime rock-crevice community
MC3	*Rhodiola rosea-Armeria maritima* maritime cliff-ledge community
MC8	*Festuca-Armeria* maritime grassland
	Maritime therophyte zone
MC5	*Armeria-Cerastium* vegetation
	Vegetation of seabird cliffs zone
MC6	*Atriplex prostrata-Beta vulgaris* ssp. *maritima* seabird cliff community
MC7	*Stellaria media-Rumex acetosa* seabird cliff community
	Maritime grassland zone
MC8	*Festuca-Armeria* maritime grassland
MC9	*Festuca-Holcus* maritime grassland
MC10	*Festuca rubra-Plantago* spp. maritime grasslands
MC12	*Festuca rubra-Hyacinthoides non-scripta* maritime bluebell community
	Pioneer zone
P2	*Tussilago farfara-Agrostis stolonifera* pioneer community
	Maritime slope flush zone
	This vegetation is often unlikely to fit any currently recognised NVC community
	Maritime heath zone
H7	*Calluna–Scilla* Coastal heath community
	Maritime scrub zone
W21/22/23	*Crataegus / Prunus spinosa / Ulex europaeus* Coastal scrub community

It was recognised in Rodwell (2000) that sea cliff communities develop in a number of habitat zones related to the degree of maritime influence (exposure to wind and sea spray), geology and soil type. There is considerable variation but the general pattern would be that the maritime influence is strongest near the base of the cliff and becomes gradually less dominant towards the cliff top. At the cliff base, the vegetation is very open and the species which occur have a high tolerance to salinity. These plant communities are dependent on rock crevices for rooting. Moving up the cliff, between the splash zone and the cliff top, vegetation on cliff ledges is less open and can support some species which are not exclusively associated with coastal conditions. Closer to the cliff top, maritime grasslands can occur. The plant communities and physical characteristics of maritime grasslands vary depending on the degree of exposure and whether grazing is a factor. Plant communities typical of sea-bird cliffs and maritime therophyte communities are exceptions to this pattern of horizontal zonation, and can occur as a mosaic with the other plant communities.

Climate can influence the geographic distribution of plant communities on cliffs through influences such as temperature and availability of water. For example, the *Armeria maritima-Ligisticum scoticum* community in the UK is believed to be limited by climatic conditions to Scotland (Rodwell 2000).

Recently O'Neill *et al.* (2009) produced an NVC-style classification of Irish grasslands from Cavan, Cork, Leitrim, Longford, Monaghan, Offaly, Roscommon and Waterford. This included a description of the vegetation type *Armeria maritima – Plantago coronopus,* which was restricted to maritime cliff top grasslands and subject to considerable grazing, exposure and sea-spray. A further vegetation type, *Festuca rubra – Agrostis stolonifera*, is a species-poor, rank sward occurring on well-drained mineral soils. It has a coastal distribution but also includes abandoned grasslands from inland sites. As this national survey of grasslands is currently on-going, the vegetation descriptions may be subsequently modified as additional grassland cliff top relevés are added to the dataset.

Sea cliffs are listed in Annex I of the EU Habitats Directive under the habitat *Vegetated sea cliffs of the Atlantic and Baltic coasts* (habitat code 1230). The description of the habitat type given in the *Interpretation Manual of European Union Habitats* (Commission of the European Communities, 2007) is reproduced in Box 2 below. This is a broad definition which outlines the habitat types which should be considered under this habitat type but it does not provide a workable definition to classify the habitat. The definition of sea cliffs developed for this study is presented in Box 1.

Box 2 Definition of Vegetated sea cliffs of the Atlantic and Baltic coasts (1230) (Commission of the European Communities 2007)

Vegetated sea cliffs exhibit a complex pattern of vegetation reflecting the degree of maritime exposure, geology and geomorphology, biogeographical provenance and pattern of human management. Typically, on the most exposed cliffs there is a zonation from crevice and ledge communities of the steepest slopes beside the sea (Crithmo-Armerietalia, Géhu 1964) through to closed maritime grasslands on upper cliff slopes, cliff tops and cliff ledges where there is a deeper accumulation of soils (Silenion maritimae, Malloch 1973). Further inland and on more sheltered cliffs, these grade into a complex assemblage of maritime and para-maritime types of heath, calcareous grassland, acid grassland, therophyte, tall herb scrub and wind-pruned woodland vegetation, each enriched by floristic elements characteristic of coastal habitats. On soft coasts with much active movement, complex assemblages of maritime and non-maritime vegetation occur.

The most widely utilised habitat classification in Ireland is *A Guide to Habitats in Ireland* (Fossitt 2000). This classification system utilises soils, geology and landscape features, in addition to plant communities, to define each habitat. Fossitt (2000) presents a simplified and standardised way to

classify habitats in Ireland but is based on the results of previous phytosociological studies rather than being based objectively on empirical data. There are three habitat categories within the subsection *Sea cliffs and islets* (*CS)* all of which are described as loosely corresponding to the Annex I habitat *Vegetated sea cliffs of the Atlantic and Baltic Coasts* (1230). *Rocky sea cliffs* (CS1) are defined as steep or vertical rocky cliffs on the coast greater than 5 m in height. Fossitt states that parts of the cliff in the littoral zone should be classed in the littoral rock section. This is defined elsewhere in Fossitt (2000) to include the 'spray zone'. Exposed rock should exceed 50% for inclusion in the category *Rocky sea cliffs CS1*. This definition therefore includes areas of crevice and ledge but does not allow for other habitat types (such as maritime heath or grassland) occurring on the cliff, which the definition of Annex I habitat 1230 (presented in Box 2) does include. *Sedimentary sea cliffs* (CS3) are defined in Fossitt (2000) as steep to almost vertical coastal cliffs that are higher than 3 m and formed primarily of unconsolidated material such as mud, sand, gravel or mixtures of these. A threshold for the amount of bare ground required for this habitat type is not given. A third habitat, *Sea Stacks and Islets* (CS2), covers small (<1 ha) rocky outcrops in the sea that are separated from the coast and are either surrounded by cliffs (forming sea stacks) or rocky slopes (forming islets).

It can be seen from the Fossitt (2000) description of *Rocky sea cliffs* (CS1) that this will not usefully describe the Annex I habitat *Vegetated sea cliffs of the Atlantic and Baltic coasts* (1230) as it does not allow vegetation cover of greater than 50%, whereas the Annex I habitat definition extends from crevice and ledge communities through to closed maritime grassland, maritime heath, tall herb scrub and wind-pruned woodland. It was therefore decided to adopt the general approach to habitat descriptions of sea cliffs as described in the *Common Standards Monitoring Guidance* (JNCC 2004), whereby different vegetation zones on the cliff are recognised. Vegetation zones noted by JNCC (2004) as occurring on hard cliffs are rock crevice, therophyte vegetation, ungrazed coastal grassland, grazed coastal grassland, maritime scrub, and coastal heath. Soft cliff sites are noted as supporting a pioneer zone, grassland and scrub in addition to flushed areas. Additional descriptions of the zones recorded are given in the Methodology section of this report.

Species associated with sea cliffs in Ireland

In addition to the plant communities that are unique to sea cliffs, the wider conservation value of sea cliffs includes the birds and invertebrates that use them. Burrowing seabirds like puffins use thick, ungrazed maritime *Festuca*-dominated grasslands, while choughs forage on grazed coastal grasslands (JNCC 2004, Grey *et al.* 2003). The Birds Directive Annex I species chough and peregrine are known to breed on Irish cliffs such as Glenamoy Bog Complex pNHA (proposed

Natural Heritage Area site code 000500) and Horn Head to Fanad Head SPA (Special Protection Area site code 004194). Twite, which is considered 'Red' on the Birds of Conservation Concern list (Lynas et al. 2009), generally nests near the top of north-facing sea cliffs among stands of tall *Calluna vulgaris* and, occasionally, *Pteridium aquilinum* (Derek McLoughlin pers. comm.). Populations occur in north Mayo, Donegal and on the Dingle Peninsula. Soft cliffs provide an important habitat for invertebrates. In the UK, 29 invertebrate species are endemic to soft coastal cliffs, of which 22 are categorised as Red Data Book species in the UK (Whitehouse 2007).

Conservation status of Irish sea cliffs

All of the sea cliffs on the Irish coast can be considered to correspond to the EU Annex I habitat *Vegetated sea cliffs of the Atlantic and Baltic coasts* (1230). Under Article 17 of the Habitats Directive, the Irish State is required to monitor the conservation status of Annex I habitats occurring within the state, and to provide a report on these habitats to the European Commission every six years. The *Assessment Monitoring and Reporting Under Article 17 of the Habitats Directive* report (Anon. 2006) provides guidelines for reporting on the conservation status of habitats listed under Annex I of the Habitats Directive. Additional guidance is provided through the Joint Nature Conservation Council (JNCC) *Common Standards Monitoring Guidelines* series of documents prepared for a selection of habitats found in the UK. These sources have been used as the main references for previous conservation status methodologies for assessing Annex I habitats in Ireland (Ryle *et al.* 2009, O'Neill *et al.* 2009, and Perrin *et al.* 2010).

The EU Habitats Directive (92/43/EEC) specifies that habitats protected through the Directive must be maintained in a Favourable Conservation Status (FCS). This is the overall objective to be reached for all habitats of community interest. FCS can be described as a situation where a habitat is prospering in both quality and extent, and with good prospects to do so in the future. The fact that a species is not threatened (i.e. not faced by any extinction risk) does not mean it is in favourable conservation status (Anon 2006). The conservation status of a natural habitat will be taken as favourable when:

- its natural range and the area it covers within the range are stable or increasing,
- the specific structure and functions which are necessary for its long-term maintenance exist and are likely to continue for the foreseeable future, and
- the conservation status of its typical species is favourable.

Four parameters are scored to assess a habitat's conservation status. These are range, area, structure and function, and future prospects. The assessment for *Vegetated sea cliffs of the Atlantic and Baltic Coasts* (1230) presented in Anon. (2008) is summarised in Table 2.

Table 2: Conservation assessment status of Annex I habitat *Vegetated sea cliffs of the Atlantic and Baltic Coasts* (1230) (NPWS 2008).

***Vegetated sea cliffs of the Atlantic and Baltic Coasts* (1230)**	
Range	Good
Area	Good
Structure & function	Poor
Future prospects	Poor
Overall	**POOR**

There is a general perception that sea cliffs are a stable habitat which, relative to other habitat types in the country, are not being significantly impacted or threatened. 'Management' of sea cliffs generally refers to abating coastal erosion. Threats to the sea cliff habitat listed in Anon. (2008) include erosion, grazing, recreational pressures, development of golf courses and housing, dumping, cutting of peat, and coastal defences. Rock armour and seawalls are particularly associated with soft cliffs. These can disrupt patterns of erosion, and the distinctive soft cliff vegetation communities can be lost as a result. Vegetation of the cliff face can be influenced by the species growing at the cliff top, and if activities such as intensive agriculture or development take place right up to the cliff face, recruitment on the cliff face can be reduced (Lee *et al.* 2001). Development and recreational facilities such as golf courses increase the likelihood that coastal defences will be constructed and interfere with ecological processes at the coast, and they increase the likelihood of trampling. Invasive species have become problematic within cliff habitats. For example, *Carpobrotus edulis* (the Hottentot fig) is a highly invasive species native to South Africa which has become a nuisance in parts of the UK (JNCC 2004) and Ireland (www.botanicgardens.ie). It forms large monospecific mats in coastal areas, and stems can be used by seabirds for nest material, allowing the spread of the plant to cliffs. Currently, there are fewer than 15 populations of the species known to occur on the island of Ireland, and eradication programmes are underway (www.botanicgardens.ie).

Aims and objectives

The objectives of this project were to:

1. Conduct a desk-based analysis of all known Irish sea cliff sites.
2. Undertake a national baseline monitoring survey of 31 sites to assess the conservation status of Irish vegetated sea cliffs.
3. Design and populate an MS® Access database with data from the desk study, field surveys and conservation status assessments.
4. Design, expand, populate, analyse and assess the Irish sea cliff database.
5. Conduct an assessment of the conservation status of EU Annex I habitat *Vegetated sea cliffs of the Atlantic and Baltic coasts* (1230) at each of the survey sites.
6. Refine the conservation monitoring protocol for sea cliffs.
7. Develop a preliminary vegetation classification of sea cliff communities in Ireland.

Methodology

Overview

There were two main approaches utilised during this project. The first was a desk-based study of the known sea cliff sites (143 sites identified by Browne (2005) and MERC/EirEco (2009)). This desk study was a broad review of the existing GIS data available for the sites including aerial photographs and other remote imagery. During the desk study, sites were sub-divided into sections based on similarities in physical structure. Some of the data recorded were relevant to the whole site, but most of the data were recorded for each section, as this gave a more detailed understanding of the cliff. Sites were represented as polylines in the ArcGIS project prepared as part of this project. All data were initially compiled in an ArcGIS project and then transferred into an Access database. This database was designed and constructed to hold all of the data from this project, including the field data, and constitutes the main method of data management.

Through the second phase of the project more detailed assessments were made of a sample of 32 of the sites. Originally 31 sites were selected for survey (MERC/EirEco 2009) but one of these was subdivided during the desk survey, so a total of 32 sites were assessed in the field. Sites were surveyed in the field using remote field survey methods developed in the pilot phase of this survey (MERC/EirEco 2009), though five sites were selected for survey using ropes whereby a botanist was lowered onto the cliff face to collect botanical data. The field survey was largely based on a sub-sample (a 20 m-wide swath of the cliff) established within one of the sections of the site, with relevés and representative photos being collected. A preliminary vegetation classification was developed on the basis of data from 161 relevés that were collected. Data collected during the field survey were also added to the Access database; while relevé data were compiled on a Turboveg database.

The conservation status of the EU Annex I habitat *Vegetated sea cliffs of the Atlantic and Baltic coasts* (1230) in Ireland was assessed on the basis of the desk and field studies. An assessment of the conservation status of each site surveyed in the field was compiled on the basis of field data and data from the desk study (review of aerial photographs and oblique images). Information on the extent, the structure and function and the future prospects of each site were collated and an overall assessment of the habitat made. The findings of these assessments can be extrapolated to give a national assessment of the conservation status of the habitat. The methodologies used for the desk survey and the field surveys are detailed in this section.

Desk study methodology

Data preparation

The objective of the desk study was to compile all readily available information on the cliffs and to characterise their physical structure. A total of 143 cliff sites were identified through surveys by Browne (2005) and MERC/EirEco (2009). In addition, MERC/EirEco had completed a desk study for 20 of these sites during the pilot survey for this project (MERC/EirEco 2009).

Sites identified by Browne (2005) had been annotated on a set of OSI Discovery Series maps. These were subsequently digitised in ArcGIS by the National Parks and Wildlife Service (NPWS) by selecting sections of the county boundary line developed from OSI six inch maps of Ireland. The attributes of the shapefile included information regarding NPWS conservation sites: candidate Special Areas of Conservation (cSACs), Special Protection Areas (SPAs) and proposed Natural Heritage Areas (pNHAs) associated with the cliffs and the name and site code assigned to each cliff by Browne (2005). During the pilot study for this project, MERC/EirEco (2009) further developed this shapefile and added a further three sites to it.

This shapefile was used during the present study to illustrate the locations of the cliffs included in the desk study. Amendments to the shapefile were made during the course of the project, with sites being extended or reduced as necessary and some large discontinuous sites being divided. Following the approach devised by MERC/EirEco (2009), cliff sites identified were subdivided into sections reflecting the variation within each site. The main tool utilised during the desk study were oblique photographs which were used to view the cliff faces. These photographs were derived from video imagery captured by the Department of the Communications, Energy and Natural Resources during a helicopter fly-over of the Irish coast over an 11-day period in 2003. These images are available on a helicopter image viewer at http://www.coastalhelicopterview.ie/imf5104/imf.jsp?site=Helicopter and an example of one of these images is shown in Plate 1. Physical characteristics were assessed using aerial photographs (2005 series) and OSI Discovery Series maps, information on soils from Teagasc soil and parent material maps, and information on bedrock from the Geological Survey of Ireland bedrock maps. The cliff characteristics recorded from these sources include height, length, aspect, slope, location grid references, cliff face features including stratification and hydrological features, cliff base features and cliff top habitats, vegetation cover, exposure to wind and wave action, obvious anthropogenic impacts, cliff type and soil type, bedrock and parent material type. Features typical

of erosion were also noted. Lists of the characteristics recorded for the sites and sections are presented in Appendix I.

Plate 1: Example image from the helicopter viewer Bulls Head to Inch, Co Kerry (Copyright 2004 Dept. Communications, Energy and Natural Resources).

In some cases, it was found that cliffs extended beyond the boundaries indicated in Browne (2005). Where this occurred, the boundary was extended so that the whole cliff was considered in the desk survey. There were occasional gaps within the sites established in 2005 where a cliff was interrupted by a bay or by littoral rock. Where a gap was over 500 m long, the site was split into two separate sites and one cliff was assigned a new name and code. In some cases, a single cliff identified in Browne (2005) contained many gaps over 500 m, so that it was divided into several smaller sites, and new names and codes were assigned to each new site. Similarly, these rules were applied where a site established by Browne (2005) encompassed cliffs on several separate islands (as occurred at Roaringwater Bay) and the site was divided such that a cliff found on any individual island was considered to be a site in itself with a new name and number being assigned.

Site and section codes

Following the numbering system devised by MERC/EirEco (2009), each cliff was assigned a 5-digit code in the following fashion: [2 digit county code][3 digit cliff number]. For example '01009' would be the ninth cliff in County Clare. The county codes used are summarised in Table 3. Continuing this, each section is assigned a 7-digit code: [2-digit county code][3-digit cliff number]

[2-digit section number]. For example '0100902' would be the second section of cliff number nine, in County Clare. Using this approach it is possible to easily select all the sites in a particular county. Each cliff was named after a local landmark or townland. Where the cliff site corresponded with one identified in Browne (2005), the name assigned by Browne was retained.

Table 3: Digits used to indicate county in the site code.

County	Code	County	Code
Clare	01	Mayo	08
Cork	02	Sligo	09
Donegal	03	Waterford	10
Dublin	04	Wicklow	11
Galway	05	Wexford	12
Kerry	06	Leitrim	13
Louth	07		

Dividing sites into sections

Sites were subdivided into sections based on the physical characteristics of the cliff and vegetation cover. Hence, the vegetation cover and overall physical structure within each section was relatively uniform. Physical structure includes main aspect, main slope, broad rock type category (hard or soft) and cliff base characteristics (e.g. boulders, wave-cut platform). The minimum length for a cliff section was 100 m. Where there was a break of between 80 m and 500 m in a section, the section was divided into two sections, with different section numbers assigned. The intervening non-cliff area was not included in either of the sections.

Data collection

An ArcGIS project was developed for use during the desk study which contained the cliff and section shapefiles as well as OSI aerial photographs, Discovery Series maps and contour lines, Teagasc soil and parent material maps, Geological Survey of Ireland bedrock maps, townland boundaries and NPWS conservation sites. Each cliff was viewed using these data resources, with the primary resource being the oblique images from the helicopter viewer. Certain attributes and characteristics, as outlined below, were assessed and recorded. Information was initially entered in the ArcGIS attributes tables for each site. These were then transferred into an Access database. Data were recorded at either the site level (i.e. the whole cliff) or the section level, with the vast majority of information being recorded at the section level. Lists of the characteristics recorded for the sites and sections are presented in Appendix I.

At the site level, data on the following parameters were recorded: length (km), extent (the total percentage of cliff habitat occurring within the site), adjacent habitats (habitats occurring at each

end of the cliff), internal habitats (non-cliff habitats occurring within the cliff section, such as beaches and littoral rock). Both adjacent and internal habitats were recorded to level 2 of Fossitt (2000). The county in which each cliff site was located was also noted. Appendix Ia presents the categories of information recorded at the site level, in addition to the main source utilised for each of these parameters.

Appendix Ib lists the categories of information recorded at the section level together with the main data source utilised for each category. Parameters recorded include: rock stratification, maximum height, aspect and slope. Slope was recorded within set ranges, as indicated in Appendix Ic. Cliff face features recorded include crevices, ledges, overhanging rock, and boulder or scree slopes. Geomorphological features associated with coastal erosion, such as sea stacks, islets, arches, wave-cut platforms, caves, blowholes and wave-cut notches, were recorded. A note was made of the character of the cliff base substrate where it was visible, and 'Open water' was recorded where the base was submerged. An assessment was made as to whether the site was hard cliff, soft cliff or a combination of the two. The vegetation cover in the lower, middle and upper thirds of the cliff face was estimated using the set ranges as indicated in Appendix Ic. The presence of streams or flushes was also recorded.

Where there was a clear anthropogenic influence present on the cliff face or at the cliff base, such as a road or coastal defences, the type of pressure and the extent of the influence were recorded. This was recorded within set ranges, as indicated in Appendix Ic. The purpose of these data was to give an indication of the type of pressures and threats impacting sites. It was not the intention for these impacts to be automatically considered during the conservation assessment of sites. Anthropogenic influences observed on the cliff top directly adjacent to the cliff were noted if it was considered that they could affect the cliff face. This type of influence was only recorded where it could be easily detected on aerial photographs or oblique imagery and where it was very likely to have a negative impact on the cliff. As such, agriculture was not recorded as a negative influence. Cliff top habitats (i.e. within 20 m of the cliff top) were recorded to level 2 of Fossitt (2000). This included agricultural habitats. Any recent slope failure visible was noted; a slope failure was considered to be recent where the resulting sediment or spoil was still visible at the foot of the failure and vegetation had not yet recolonised the exposed area. The extent of the cliff habitat within the section (i.e. the total percentage of cliff habitat occurring within the section) was estimated within the set ranges, as indicated in Appendix Ic. Other small areas (up to 80 m in length) within the section were generally composed of features such as littoral rock or beach.

The general topography of the coastline where the section was located (e.g. a bay, promontory or off-shore island) was recorded, as well as the degree to which the cliff was exposed to wind and

wave action. A cliff was considered exposed where it faced directly into the prevailing wind or swell. If it was protected by another landform or faced away from the prevailing wind or swell, it was considered to be sheltered. Hence, if it was only partly protected in this way, it was considered to be partially exposed.

Use of GIS

A GIS project was prepared as part of this project. Due to the difficulties in representing data for a vertical habitat in GIS format it was decided to indicate the location of the cliffs by a line (MERC/EirEco 2009). The line used was the county boundary line developed from OSI six inch maps of Ireland; made available by NPWS. Though there are known problems with the accuracy of this line (including overlapping with the contour lines and divergence from the coastline represented on the OSI Discovery Series maps), it was used as it was the line used by Browne (2005) and would therefore build on this earlier dataset, it was readily available, it can be used to provide a figure for the entire length of coast for Ireland and it would not require significant further digitising. An alternative considered was the high water mark but this was found to be less representative of the coastline than the county boundary line. The 1:5000 raster mapping was also considered but this does not provide a continuous line along the coast, so use of this would entail digitising a line by snapping to the most appropriate line within the dataset. In sections where there was no appropriate line, reference would need to be made to aerial photographs. This would be a time-consuming task and, as updates of the 1:5000 maps are occasionally being released by OSI, the re-digitised dataset would be largely redundant in three or four years' time.

Comparison of the county boundary line with other datasets

A comparison was attempted between the 1:5000 vector maps and the county boundary line to investigate the level of discrepancy between the two datasets. Two areas were digitised using the 1:5000 vector maps: the Dingle Peninsula (from Pointe na Cathracha in Brandon Bay to the beginning of Inch Strand) and the south Wexford coast (from Buttermilk Point on the River Suir to Carnsore Point). These two areas were selected as representing two differing types of the Irish coastline. A line was digitised using the methods outlined above whereby the 1:5000 vector maps were viewed and the coastline was digitised, with any gaps in the dataset being supplemented with reference to the aerial photographs. It should, however, be pointed out that the vector maps rarely had a line depicting the coast in the correct location when compared to the aerial photographs. Therefore a line digitised mostly from the aerial photographs but with some reference to the 1:5000 vector maps was used for this comparison. This digitisation was carried out

at a scale of 1:5000. The total lengths of these digitised lines were then compared with the length indicated by the county boundary line. Though this calculation will be based on a very small sub-sample of the datasets, the comparison would give an indication of the level of accuracy of the county boundary line.

Calculating the length of the Irish coastline

The county boundary shapefile was also used to generate an approximate total length for the Irish coast for use in assessing the percentage of the Irish coastline which is considered to be sea cliff. In ArcGIS the boundary was converted to a polyline shapefile and sections without coastline were removed, including all inland county boundaries, counties in Northern Ireland and sections of river. All features less than 400 m in length (generally very small islands and other small features) were removed from the dataset. Sections of coastline retained are areas which could, potentially, support sea cliff habitat. This approach retains any mapped offshore islands with a coastline greater than 400 m and has the benefit of being the data source used to derive the location of the sea cliffs identified.

Cliff shapefiles

The cliff shapefiles developed by the NPWS based on Browne's (2005) annotated maps were used as the basis for the mapping of cliff sites and sections. Two ArcGIS shapefiles were produced during the desk study, one of which presents the location of each of the cliff sites as a whole, and another which presents the sections of the cliff. The most significant difference between these shapefiles is that the shapefile representing the sections is more accurate as regards length, as any breaks in cliff habitat have been removed. Contained in the attribute table of the cliff site shapefile are the site ID code, the site name and the length of the site. The attribute table for the section shapefile contains the section ID code, the section length, whether the site is composed of hard or soft substrate, and grid references of the start and end point of the section.

The cliff shapefiles were used to obtain the length of the cliffs sites and sections and the grid references for the start and end point of each section. The section shapefiles were also used to establish the bedrock, soil type, parent material type and whether the site was designated by NPWS as a site of conservation importance by intersecting the cliff section shapefiles with existing datasets. Full metadata have been provided with the GIS project.

Identifying new sites

It was realised when viewing the coastline using the oblique images that the 143 sites identified by Browne (2005) and MERC/EirEco (2009) did not represent the full resource of cliff sites in the country. Therefore the whole of the coast was viewed, identifying sections of cliff not previously identified. Full assessment of these sites was not completed and these additional sites can only be considered a provisional list. A further shapefile is provided in the GIS project which indicates the location of each of these additional sea cliffs and their provisional length. Some areas, in particular off-shore islands, are poorly covered by digital imagery and it was not possible to adequately search for new cliff sites in those areas.

Summary statistics

Summary statistics regarding some of the physical characteristics of cliffs included in the desk study were calculated using ArcGIS and MS® Excel. As described above, the overall length of the site can include a number of gaps (between 80 m and 500 m in length) where non-cliff habitat occurs. The more accurate calculation of length is the combined total of each of the sections. The combined total of cliff sections has been used in this report when assessing length of cliff habitat. However, in some instances the length of cliff sites has been presented, and this is indicated in the text where it occurs. The lengths of cliff sections occurring within sites of conservation importance (cSAC, SPA, Nature Reserve, NHA or pNHA) were calculated. An intersect was carried out using ArcGIS and a 100 m buffer was applied to allow for mapping inconsistencies between the NPWS designated areas and the county boundary used to delineate where cliffs occurred. These were then reviewed to ensure that designated sites unrelated to the sea cliffs had not been included. The length of each section of the site which is within a designated site was calculated. The figure generated from that calculation should be considered indicative, as the use of the buffer may have distorted the results to some degree. The intersected files were checked in order to ensure that no duplicated records were present.

Representative section photographs

A representative oblique image of each cliff section was taken from the Coast of Ireland, 2003 oblique imagery survey (http://www.coastalhelicopterview.ie/imf5104/imf.jsp?site=Helicopter). These photographs have been hyperlinked to the polyline within the GIS project representing the particular section of cliff. In this way a representative view of the section of cliff can be rapidly obtained.

Rare Species database

The NPWS Rare Species database was reviewed with a view to including records of rare plants in the database for different sections of cliffs. The accuracy of the accompanying grid references varied from 10-figure accuracy to two-figure accuracy. Thus it was not possible to automatically link records to a particular site with any level of consistency. These data have therefore not been included in the database.

Field study

Overview

The methodology for the field study was based on that proposed in the *Survey plan to assess the conservation status of Irish sea cliffs* (MERC/EirEco 2009), which was developed during the pilot study for this project and further refined during the present survey. The basic unit for survey was a 20 m-wide swath established within a cliff section. Within this swath different zones of vegetation were recognised and a profile of the structure of the cliff was recorded, photographic records were made and vegetation surveys carried out. To view the swath a vantage point was established in a position which was, ideally, perpendicular to the swath being surveyed. Of the 32 sites surveyed during 2010, five were surveyed by rope. Surveying by rope is time consuming, expensive and unsuitable for some cliff sites (soft cliffs are too unstable to access them by rope and some hard cliff sites may have a slope which is too shallow to warrant survey by rope). Part of this project was to compare data collected remotely with that collected using rope techniques. The basic approach of the rope surveys and the remote surveys was the same, with the main difference being that, during the rope surveys, the relevé was collected by a botanist on the cliff face while, for the remote surveys, the relevé was collected by taking a photograph with a high-powered lens which was analysed by a botanist at a later date.

Site selection

Sites were selected for survey during the pilot survey for this project on the basis of distribution, geology, height, exposure, hydrology, vegetation cover and management (MERC/EirEco 2009). The five sites to be surveyed by rope were established by NPWS, with the exception of Preghane to Ballymacus Point, which was used instead of Bear Island due to the limitations in accessing Bear Island by ferry. All sites selected for rope survey were hard cliffs and had a maximum height of at least 40 m. Sites were selected to ensure geographic spread and to represent a range of geological types (see Table 4).

Table 4: Sites selected for survey in 2010.

Site name	County	Site code	Rope survey
Cliffs of Moher	Clare	01001	Yes
Rineen	Clare	01002	
Moveen to Bridge of Ross	Clare	01005	
Loop Head	Clare	01006	
Dursey Island	Cork	02003	
Bear Island	Cork	02006	
Preghane to Ballymacus Point	Cork	02023	Yes
Cloddagh North, Sherkin Island	Cork	02060	
Hare Island West	Cork	02066	
Stookanillar & Five Fingers	Donegal	03004	Yes
Dunaff Head	Donegal	03007	
Saldanha Head to Yellow Rock	Donegal	03012	
St. John's Point	Donegal	03030	
Ballintra, Aran Island	Donegal	03058	
Killiney	Dublin	04004	
Shankill	Dublin	04005	
Tully	Galway	05001	
Onaght, Inishmore	Galway	05006	
Rusheen	Galway	05008	
Kerry Head	Kerry	06002	
Brandon to Ballydavid Head	Kerry	06003	
Clogher Head to Slea Head	Kerry	06005	Yes
Great Blasket	Kerry	06006	
Bulls Head to Inch	Kerry	06010	
Clogher Head	Louth	07001	Yes
Moyne	Mayo	08001	
Kilcummin Head	Mayo	08002	
Ballincar	Sligo	09004	
Ardmore	Waterford	10002	
Arklow Head	Wicklow	11001	
Bray Head	Wicklow	11003	
Gaunagh Gap	Wexford	12003	

General site survey

Surveyors were provided with the following equipment:

- TruPulse 360 Laser Rangefinder
- Nikon D300 Digital Camera (fully charged)
- AF-S Nikkor 400 mm Lens (Nikon ED)
- AF-S Nikkor 18-105 mm(Nikon DX)
- Opticron ES80 GA EDv3 20-60 x Zoom telescope
- 2 x tripods
- 2 x PDAs loaded with recording forms
- 2 x GPS (with spare batteries)
- First aid kit
- Whistles
- Two-way radios (fully charged)
- Three collapsible ranging poles (with guy ropes and hi-visibility material)

- Tide timetable
- Waterproof jackets and overtrousers
- Warm clothes
- Food and water
- Mobile phones (fully charged)
- Identity cards
- Official letter of introduction from NPWS
- Certificate of insurance
- Compass and maps of the area
- Digital camera (minimum 7.0 megapixels)
- Binoculars (8 x 30 magnification)
- Large waterproof bags (for protecting maps, notebooks and camera equipment)
- Small plastic sample bags
- Envelopes (for bryophyte samples)
- Permanent marker
- Relevés
- Botanical field guides
- Hand lens (x10/x20)
- Pencils, eraser, sharpener
- Insect repellent
- Sun protection lotion and sun hat
- A4 weatherwriter clipboard
- Waterproof paper
- Paper recording sheets (in case of technical problems with the PDAs)
- Waterproof rucksacks
- Copy of *A Guide to Habitats in Ireland* (Fossitt 2000)
- A list of the codes for threats and pressures (Ssymank 2009)

Before entering private land, permission for access to the site was sought. This was particularly important for sites being surveyed by rope, as access by vehicle was required as close to the top of the cliff as possible. In many instances, access through private land was not necessary, with the survey being carried out from areas with open public access, such as beaches or headlands.

Site packs were prepared containing:

- Map of cliff and sections
- Potential transect locations and viewing points

- Access map (aerial photo)
- Oblique image of the section (of access and viewing points if possible)
- Land ownership details
- Information from NHA site files and site synopses for designated sites
- Information on rare plants and seabird colonies.

Potential swath locations and viewing points were ascertained by reviewing the Discovery Series maps and aerial photographs. It was necessary to establish a swath and a vantage point whereby a clear view of the entire swath could be achieved. This view should be directly opposite (or as near opposite as possible) the swath and, to facilitate use of the camera equipment, be no more than 260 m from the cliff face. Additional information on establishing the swath is given below. Details from the desk study were reviewed such that certain sections of the cliff could be prioritised for survey. For instance, sections which were atypical (e.g. soft cliff sections on the west coast) were prioritised or sections which were considered representative of the majority of the cliff site were prioritised. A further factor which influenced the positioning of the swath locations and the viewing points was ease of access, with swaths usually being located less than 1 km from the road. The weight and bulk of the equipment made longer distances from the car impractical.

On arrival at the selected site, a review of the desk study data was undertaken to obtain an overview of the cliff in relation to access, suitability of the selected swath and vantage point locations, and to undertake a site risk assessment. The coastguard base for the region being surveyed was contacted giving details of the number of surveyors, the location being surveyed, the anticipated time of departure and contact details for the surveyors. The coastguard base was contacted again on departure from the cliff. An assessment was undertaken of the potential for impacts on nesting birds following the protocol given in Box 3. In the event that either the identified transect or vantage points were deemed unsuitable for either technical or health and safety reasons, the alternative location identified during the desk study was assessed for suitability.

As noted above, the vantage point was established in a position which was, ideally, perpendicular to the swath being surveyed. This was not always possible due to a range of factors. Site safety was always the paramount concern during fieldwork, and only locations which could be accessed safely were considered. Straight sections of coastline did not provide a suitable viewing location and rounded vantage points often prevented a view of the base of the cliff. Ideally, the distance from the vantage point to the swath was less than 200 m, with distances of greater than 260 m being impractical for using the camera and telescope. The GPS position of the vantage point was recorded.

Box 3. Protocol for minimising disturbance to nesting birds during rope surveys

The optimum time for vegetation surveys is between April and September, which largely coincides with the breeding season of seabirds in Ireland. It was the aim of the project to provide the fullest possible description of Irish sea cliffs and their vegetation without disturbing breeding seabirds. When selecting sites for rope work, records of breeding bird populations were examined. Contact was made with the local District Conservation Officer, and the presence of breeding birds was discussed. Where necessary, a licence was sought to work close to breeding bird colonies. If, at this stage, a decision was made that bird colonies were too sensitive for any work to be carried out directly on the cliff face, then another cliff was chosen for survey. On arrival at the cliff site, the cliff face was subjected to a visual inspection by the ecologists and the rope access team. The purpose of the visual inspection was to ensure that the cliff face could be accessed by ropes safely and to identify nesting birds. A point was chosen from which to lower the surveyor, ensuring that at no time during the descent would the surveyor come within 10 m of nesting birds. If additional information is required from within seabird colonies and direct access of seabird colony sites is required, this should only be undertaken from September to April, which is outside of the breeding season, (David Tierney, pers. comm.).

The swath was, ideally, established on a part of the cliff which was representative of the cliff section being surveyed. The swath centre point was defined by a visual marker on the top, or bottom, of the cliff by placing high-visibility material on a 2 m pole. Two additional markers which could be clearly seen from the vantage point were placed 10 m either side of this pole to define the 20 m sub-section for survey. The location of each of these three points was recorded using GPS.

The swath outer markers on the left hand side (LHS) and right hand side (RHS) of the centre line when viewing the markers from the vantage point indicate the position of the outer limits of the swath area. A line was imagined running down, or up, from these points, taking into account the slope of the cliff face to ensure the limits of the swath were seen in the same vertical plane.

The aspect of the swath was recorded by reviewing 1:50 000 Discovery Series maps, assessing the alignment of the swath in the field, or by reference to a compass.

Vegetation zones

Following the approach described in JNCC (2004) and the vegetation descriptions given in Rodwell (2000), swaths were divided into a number of zones based on the habitats occurring on the cliff face. The zones were subsequently used in the conservation assessment of the swath and as areas of study for recording plant species. When defining zones, a minimum mapping area of 10 m² was applied. This was based on 20 m (the width of the swath) multiplied by 0.5 m. However, point

features of interest such as flushes were also noted. The zones are defined on the basis of location on the cliff, exposure to maritime influences and vegetation. The definitions for each of these zones are given here. Where possible, these have been developed in keeping with the habitat parameters (e.g. >25% cover of dwarf shrub species for heath) established by Fossitt (2000).

Splash zone. This zone occurs at the base of hard cliffs and may extend well above the high water mark. The bottom of the splash zone can be difficult to determine in the field but was generally taken to be above the limit of barnacle growth and usually corresponds with a change in colour on the rock. It is generally characterised by lichens such as *Verrucaria maura*, *Ramalina* spp. and *Xanthoria* spp. It can include some vascular plants, such as *Armeria maritima* at the upper limit. As such, the transition from the splash zone into the crevice and ledge zone is often unclear but colouration of the rocks can act as a guide.

Crevice and ledge. This community is generally ungrazed, with regulation of vegetation community development coming from exposure to wind and sea spray. In keeping with the Fossitt (2000) definition of exposed rock habitats, vegetation cover should not exceed 50%. Typical species include *Armeria maritima, Festuca rubra, Silene uniflora* and *Anthyllis vulneraria.* It was originally intended to have a separate zone for maritime therophyte vegetation, as detailed in JNCC (2004). However, on review of Rodwell (2000) it was decided that this habitat type be considered a sub-section of the crevice and ledge zone. A similar approach was taken with the seabird communities which were also considered within the crevice and ledge zone.

Ungrazed grassland on hard cliffs. This habitat type is typically comprised of *Festuca rubra* and *Holcus lanatus*. Substantial clumps of broadleaved herbs such as *Armeria maritima* and *Silene uniflora* can also occur. Like each of the subsequent grassland zones considered, if dwarf shrubs exceeded 25% then the area was considered under heath, and if bare ground exceeded 50% the area was considered a crevice and ledge community for hard cliffs and a pioneer community for soft cliffs.

Grazed grassland on hard cliffs. There should be evidence of grazers (generally sheep or goats) accessing this habitat zone. The sward should be short, with species such as *Plantago coronopus*, *Festuca rubra* and *Armeria maritima* occurring.

Coastal grassland on soft cliffs. This habitat type should only be considered for unstable soft cliffs. It is quite distinct from grasslands on hard cliffs and grasslands which develop on unconsolidated material lying on top of hard cliffs. It is generally ungrazed, with a wide range of species occurring. These include *Agrostis stolonifera, Tussilago farfara, Daucus carota* and *Lotus corniculatus.*

Soft cliff pioneer. Areas of soft cliff are characteristically unstable. Areas of newly exposed substrate and slumped soft material with an overall vegetation cover of less than 50% are considered here. *Agrostis stolonifera* and *Tussilago farfara* are characteristic species.

Flush on soft cliff. This can be a point feature rather than a zone. It is an uncommon and understudied habitat type characterised by *Equisetum* spp. and *Schoenus nigricans* and may be important for orchids.

Coastal heath. To be considered coastal heath a zone requires at least 25% cover of dwarf shrubs. *Calluna vulgaris*, *Erica tetralix*, *E. cinerea* and *Ulex gallii* are typical species.

Other zones within the swath were recognised in the field when habitats did not fall into these categories. These included bracken, scrub and scree and generally followed the habitat descriptions given in Fossitt (2000). Slumped material on hard cliffs was recorded separately from soft cliff pioneer habitat and corresponds to the Fossitt (2000) category *Disturbed Ground* (ED).

Cliff profiling

Cliff profiling was carried out as a means of recording the characteristics and profile of the cliff swath being recorded. This allows the different zones occurring within the swath of the cliff to be accurately measured. Data gathered gives a record of the range of zone measurements throughout the surveyed sites in addition to providing baseline data for individual swaths against which comparisons can be made in future years. Review of these data also gives an overview of the type of sea cliffs occurring in Ireland.

Cliff profiling was carried out from the vantage point using the Laser Rangefinder (LR) mounted on a tripod (see Plate 2). The LR is a device which uses a laser beam to determine the distance to an object. The parameters listed below were recorded. In the following descriptions, the 'Measurement mode' used on the LR is given. Full instructions on how to operate each of the measurement modes on the LR are given in the user's manual.

Height of cliff. The overall cliff height is measured in metres using the 'Height routine' on the LR.

Cliff slope. Overall cliff slope is measured in degrees using the 'Missing line routine: Inclination between point #1 and point #2' on the LR.

Direction of view (Azimuth). The direction of view between the vantage point and centre of the swath was recorded. This was measured in degrees using the 'Azimuth' mode on the LR. This measurement was used, together with the horizontal distance (see below), to assist in positioning the remotely recorded relevés within the GIS package.

Plate 2: Ecologist taking measurements using a laser rangefinder

Slope distance. The overall cliff slope distance measures the distance between the top of the cliff and the base of the cliff, measuring along the slope rather than vertically. This is measured in metres using the 'Missing line routine: slope distance' on the LR. These data can be used to give an approximation of the area of the cliff by multiplying the length of the cliff section (measured using GIS) by the slope distance of the cliff.

Width of zones. The width of each recognised zone was measured in metres using the 'Height routine' on the LR. Measurements were taken from the LHS, the centreline and the RHS of the swath. For consistency of data entry, the zones were always recorded starting with the one at the top.

Slope of zones. As different zones on the cliff face could have different slope angles, recordings were taken of the slope angle of each zone. To give an accurate picture of the whole swath, replicates were recorded from the LHS, the centreline and the RHS of the swath. It was measured in degrees using the 'Missing line routine: Inclination between point #1 and point 2#' on the LR.

Distance. The distance from the vantage point to the cliff face was recorded. Both the 'Horizontal distance' and the 'Slope distance' on the LR were recorded. The horizontal distance is the distance between the vantage point and the cliff face when viewed in two dimensions, such as would be done in GIS. The slope distance is the actual distance from the vantage point to the cliff face (in three dimensions). When viewing down (or up) a steep gradient, the slope distance will be greater than the horizontal distance. The slope distance is utilised when assessing relevés remotely recorded using the 400 mm lens when it is necessary to incorporate the true distance from the

camera lens to the subject. For this reason, the distance was recorded in relation to the point on the cliff face where the relevé was being recorded.

When the cliff was being viewed obliquely, rather than from directly opposite, it was necessary to account for the slope of the cliff when recording slope distance (see above) and height of the cliff. It was not sufficient simply to tilt the LR in the vertical plane. To give a full picture of the characteristics of the swath, replicate records for some of the data were recorded from the centre line of the swath as well as the left-hand side (LHS) and right-hand side (RHS) of the swath.

Photographing the swath area

A photograph of the swath area was taken. Where necessary, a series of photographs was systematically taken either from the top of the cliff down to the base or from the base upwards, depending on where the swath markers were established. It was necessary to ensure the swath markers were clearly visible in the first photograph. Where the swath was being viewed obliquely, it was necessary to take into account the slope of the cliff rather than simply tilting the camera on the tripod in its vertical plane. All images were taken in the NEF format (Nikon Electronic format) to ensure the best resolution for subsequent analysis. These were subsequently converted into JPEG format as this format is more commonly used and works with a broader range of viewing software.

Vegetation surveys

Data were recorded on PDA, and back-up paper copies of recording forms were carried for use in the event of technical failure. Copies of the PDA recording forms are shown in Appendix IIa-f.

Species lists

A species list was recorded for each zone within the swath, with each species being given a cover value on the Domin scale (Kent & Coker 1992; Table 5). Swath species lists were generally recorded while viewing the swath using the telescope and/or binoculars, with the list being augmented with any additional species identified during the relevé survey. As many species identifications were carried out remotely, the degree of certainty attributed to identifications was given a rating on a three-point scale. Where characters confirming identification were clearly visible, the record was given a degree of certainty of 1. Where some characters were present and the ecologist was not in doubt regarding the record, the degree of certainty was 2. If there were few characters, but the ecologist felt that there was a high degree of probability that the record was

correct, the degree of certainty was 3. If a sample could not be identified with a degree of certainty of at least 3, no identification was made as the record could be misleading.

Table 5: Domin Scale

Scale	Range
+	A single individual
1	1-2 individuals
2	Several individuals but < 1% cover
3	1-4 % cover
4	5-10 % cover
5	11-25 % cover
6	26-33 % cover
7	34-50 % cover
8	51-75 % cover
9	76-90 % cover
10	91-100 % cover

Adjacent habitats

The vegetation type occurring on the cliff top and cliff base adjacent to the swath was recorded using Fossitt level 2 codes (Fossitt 2000).

Invasive species

The presence of any invasive species occurring on any part of the cliff was noted. The section(s) within which the species was observed was recorded and notes on the extent were made.

Relevés

A representative relevé was recorded from the vegetation within each of the zones. These were generally positioned in a location which best represented the vegetation occurring in the zone, though accessibility was also a determining factor in some instances. Relevés were generally 2 m x 2 m, but for habitats with very little vegetation (the splash zone and bare rock faces) and for zones which were narrow, 1 m x 1 m relevés were used.

Cover in vertical projection for all vascular plants, bryophytes and, where possible lichens, was recorded using the Domin scale (Kent & Coker 1992), as were other general parameters: bare soil, bare rock, leaf litter, surface water, and total cover of bryophytes, lichens, dwarf shrubs, shrubs, canopy species and forbs. For purposes of this project, sand and mud substrates were included in the bare soil category. The median vegetation height was also recorded and, for grassland habitats, the forb-to-grass ratio.

In some instances the vegetation being sampled could be accessed from the base of the cliff. At these times relevés were recorded in the field and data were entered directly into a PDA. For

accessible sites a 10-figure grid reference was obtained using a GPS unit, and a photograph of the relevé was taken using a small digital camera.

Photographic relevés

At inaccessible locations being viewed from a distance of greater than 50 m, photographs of the relevé were taken using the 400 mm lens. At distances less than this, the 2 m x 2 m area was not captured on the photographed area; therefore the 18-105 mm lens was used. The photographs were assessed later and species lists for the relevé compiled. In order to calculate the area represented on the image it is necessary to record the distance from the camera to the centre of the relevé and the focal length of the lens being used. The area of the image was calculated using the "*Dimensional field of view calculator*" available online at www.tawbaware.com/maxlyons/calc.htm. Photographs were viewed in ArcGIS and using the Measure tool it was possible to indicate a known area (either 2 m or 1 m) on the image; this was drawn onto the photograph and the image was exported as a PDF. The PDF version was then viewed alongside the original NEF version using Picasa Photo Viewer. This produced the clearest image quality and allowed for rapid zoom in and out of different sections of the image. Species lists were then compiled and a Domin cover score for each species was noted. In addition, the environmental variables for each relevé were recorded. It is recognised that the technique described here for remotely delineating a relevé is only reliable when viewing the relevé from a position directly opposite the cliff face and when the cliff is more or less vertical. The area represented on the image within a delineated 2 m area will be greater for images taken from an oblique location or when the cliff face is sloping rather than vertical. However, this has not been factored into the positioning of remote relevés.

Surveys using ropes

Surveys using ropes were completed at five sites (ten swaths in total). At these sites the swath was set up as described above and cliff profiling was completed. The rope anchor point was established at the top of the centre line of the swath. A botanist was then lowered down the cliff (see Plate 3) and relevés were collected within each of the zones identified using the techniques described in the *Relevés* section above. Where possible, the botanist marked out the relevé area with a rope secured by tent pegs and the location of the relevé was recorded using a GPS. In order to provide a comparison of the results from the remote (photographic) relevés with the rope technique relevés, a photograph of the rope relevé was taken from the vantage point. These photographs were then assessed by a botanist and a species list with Domin covers compiled. Advantages of the rope survey techniques over the remote methods include collection of difficult

plant samples for further identification, close inspection of crustose lichens and collection of close-up photos of these, and collection of additional plant data from the swath while moving between relevés.

Plate 3: A botanist collecting relevé data from the cliff face using rope survey techniques.

Comparison of results from field survey and remote survey

A comparison of relevés recorded using rope techniques and relevés recorded using remote (photographic) methods was made for 23 of the 29 relevés recorded using ropes. For each relevé that was recorded using rope techniques, a photograph of the same relevé was taken from the vantage point. These photographs were later assessed as remote relevés (as described in the *Photographic relevés* section above). If a species could not be identified to genus (e.g. crustose lichen), it was not included in the comparison. The species lists and cover values were then compared to assess how accurate the relevés recorded remotely were. The assumption was made that the relevé recorded by the botanist on the ropes was an accurate record of the composition of the relevé and the remote relevé would be compared with this. To provide an unbiased comparison of these techniques, a botanist who had not been to the site carried out the review of the photographic relevés collected from the rope survey sites.

Features of interest

Features of interest for a site were recorded in relation to the section of the cliff where they were observed during the field survey. Such features included any rare or uncommon plant species, non-native species or tufa springs.

Conservation status assessment

Overview

An individual assessment of the conservation status of the Annex I habitat *Vegetated sea cliffs of the Atlantic and Baltic coasts* (1230) at each site surveyed was made. Data for the assessment were collected during the field survey and also through review of the oblique images. Three parameters were scored in order to assess the overall conservation status of the habitat at each site. These were: extent, structure and function, and future prospects. Once each of these aspects has been considered, an overall assessment of the conservation status of the habitat at a particular site was made using the criteria in Table 6. These data can be used to provide a national assessment of the status of the Annex I habitat *Vegetated sea cliffs of the Atlantic and Baltic coasts* (1230) in Ireland.

Table 6: General evaluation table for determining conservation status (modified from Ryle *et al.* (2009).

	Favourable	Unfavourable - Inadequate	Unfavourable - Bad
Extent	Stable	> 0% < 1% decline/year	≥1% decline/year
Structure & function	Structure and functions in good condition and no significant deteriorations / pressures.	Any other combination	More than 25% of the area is unfavourable as regards its specific structure and function
Future prospects	The habitat's prospects for its future are excellent / good, no significant impact from threats expected; long-term viability assured.	Any other combination	The habitat's prospects are bad, severe impact from threats expected; long-term viability not assured
Overall	All Favourable	Combination of Favourable and / or Unfavourable - Inadequate	One or more Unfavourable - Bad

Extent

The loss of extent or area of sea cliff habitat can be difficult to ascertain. The natural effects of erosion should not be interpreted as loss of habitat unless the rate of erosion has been exacerbated by anthropogenic factors. Through natural erosion the cliff location may be retreating but the extent of cliff habitat is not reduced. These processes are more evident and dramatic for soft cliffs than for hard cliffs. Erosion may result in the loss of cliff habitat in some instances over a very long time period but these factors, as long as they have not been exacerbated by anthropogenic factors, should be considered natural processes.

Loss of extent can occur where sections of cliff are entirely removed (such as for quarrying or building developments), through the development of piers and ports (which often abut directly onto the hard surface of rocky sea cliffs) and through infrastructural developments such as roads and railways (which can require modification of the cliff face and/or rock armour to abate erosion processes). Positioning of rock armour at the base of a cliff can effectively reduce the extent of the cliff habitat by burying a section of the cliff. Additionally, material can accumulate behind rock armour and cause the disruption of the natural processes.

Loss of extent was estimated using aerial photographs from 2000 and 2005, and the oblique images from the helicopter viewer (taken in 2003). This was augmented with data collected in the field relating to observations of pressures and threats to the site.

As outlined in Table 6, where no loss of extent was observed (either from aerial photographs or in the field) the extent for that site was assessed as Stable. Where extent of the sea cliff had been obviously reduced by anthropogenic factors, but the loss of habitat equated to a loss of less than 1% per year, the condition of the cliff was classed as Unfavourable - Inadequate. When these impacts were considered to have caused the loss of more than 1% per year of the extent of the cliff, then this was classed as Unfavourable - Bad. When extent had been reduced by natural causes (e.g. erosion) rather than through anthropogenic factors, then some loss of habitat was considered acceptable based on best expert judgment and was generally recorded as Favourable. The assessment did, however, consider the possibility that the erosion had been caused, or exacerbated, by anthropogenic influences. In this instance, the condition of the whole feature was to be classed as Unfavourable - Inadequate or Unfavourable - Bad if the loss was the equivalent of more than 1% per year. It should, however, be noted that anthropogenic exacerbation of soft cliff erosion can originate some distance from the site being surveyed and it can be difficult to recognise these impacts in the field.

Only losses which had occurred since 1994 (when the Habitats Directive came into force) were considered. As the oldest photographic records of the sites available digitally are from 2000, it was not always possible to determine if an impact was post- or pre-1994. If no loss of extent was apparent from the 2000 or 2005 aerial photographs, or from the current survey work, then the area was considered to be Stable.

Structure and function

Structure and function relates to the occurrence of habitat-typical floristic and environmental parameters and is assessed largely in the field through the collection of specific, detailed data.

Vegetated sea cliffs can support a variety of habitat types ranging from splash zones, which are essentially areas of bare rock with lichens, through to maritime scrub and woodland, with additional variation introduced from the cliff being composed of either hard or soft substrates, or a combination of the two. It was therefore not possible to apply a single list of criteria which would be applicable for all scenarios. The application of the structure and function criteria was therefore based on the vegetation zones found on sea cliffs. A preliminary list of criteria was developed following review of the *Common standards monitoring guidance for maritime cliff and slope habitats* (JNCC 2004) and also the *Irish semi-natural grasslands survey* (O'Neill *et al.* 2009) for grassland communities and, for dry heath communities, the *Scoping study and pilot survey of upland habitats in Ireland* (Perrin *et al.* 2010). In addition, experience of Irish sea cliffs gained during the course of the fieldwork was applied. Additional texts reviewed were Ryle *et al.* (2009) and Murphy & Valverde (2009). The preliminary list used in the current survey was developed and structured in such a way that modifications could be made to the criteria and to the indicator species lists being used at a later date with the minimum of difficulty.

There are 22 criteria for assessing sea cliffs (see Table 7). Not all of these criteria will be applicable for an individual cliff and it will only be necessary to apply the criteria relevant to a particular zone when it has been recorded from the survey swath. The first three criteria are general criteria applied to all zones occurring on the cliff within the swath, in addition to any sections of the cliff which were not surveyed in detail but which were viewed in the field. For instance, if a section of rock armour was recorded on a section of cliff which was not surveyed in detail, this information was recorded and considered when making an assessment of the overall structure and function of the site. In addition, information on potential impacts recorded during the desk study was considered here. As the data recorded during the desk study were much broader in scope than the specific questions being assessed through the structure and function assessment, each occurrence was reassessed for its relevance to the structure and function assessment using the oblique helicopter viewer images. Any impacts recorded from the desk study that were not considered to fit within the parameters of the criteria being assessed were not included. As the whole of the site being assessed was not viewed in the field, there was some reliance on the oblique images. From these it was not always possible to state if a certain section had passed or failed a specific criterion. For example, it may be possible to assess a section for the presence of a pier or a slipway, but it may not be possible to say definitively that no rock armour occurs within the section or that there are no footpaths affecting the site. Where there were insufficient data to make an assessment from the oblique images, this was stated.

Similarly, the fourth criterion '*No non-native species present'* is also applied to all zones within the swath and all other sections of the cliff observed during fieldwork. This allows the occurrence of a non-native species occurring outside the swath area to be considered during the assessment of the site's structure and function. It is generally not possible to use the helicopter viewer to assist with assessing the presence of non-native species, though the presence of *Gunnera tinctoria* was recorded on some sites during the desk study. It would certainly not be possible to state definitively that there were no non-native species on a section of cliff by simply viewing the area on the helicopter viewer. Some plants which are non-native may not be considered invasive and as such may not present a threat to the structure and function of the habitat. However, rather than adopting a list of invasive species prior to conducting survey work, such as the Problematic Terrestrial Species compiled by the National Biodiversity Data Centre (NBDC) (www.biodiversityireland.ie), it was decided to collect data on any non-native species and from those recorded make an assessment of the threat posed by each of these species to the structure and function of cliff habitats. It is therefore seen, in the section below, that only a small number of the non-native species recorded were considered when assessing this criterion.

The remaining eighteen criteria (see Table 7) record additional information about the structure and function of the habitats within the different zones. These are applied to the area within the swath, with the exception of the last criterion, which records the occurrence of the burning of coastal heath on any section of the cliff face. The following paragraphs outline the approach taken for each of the relevant habitat zones. Lists of positive and negative indicator species for each of the zones are presented in Appendix III.

Table 7: Monitoring criteria for assessment of the structure and function of *Vegetated sea cliffs* (1230).

Criterion no.	Vegetation zone	Target	Scale of assessment
1	All zones	No sea defences such as rock armour, sea walls or fences affecting the zonation, geomorphology or natural hydrology of the cliff are present. If target is failed record the cliff section(s) this occurs in.	Within visible area of the site.
2	All zones	No artificial structures including piers and slipways affecting the zonation, geomorphology or natural hydrology of the cliff are present. If target is failed record the cliff section(s) this occurs in.	Within visible area of the site.
3	All zones	No access points such as paths or tracks which affect the zonation, geomorphology or natural hydrology of the cliff are present. If target is failed record the cliff section(s) this occurs in.	Within visible area of the site.
4	All zones	No non-native species are present. If target is failed record the cliff sections(s) this occurs in, the non-native species occurring and the approximate extent.	Within the visible area of the site.
5	Splash zone	Number of positive indicator species present ≥ 1.	Within zone in swath.
6	Crevice and ledge zone	Number of positive indicator species present ≥ 4.	Within zone in swath.
7	Coastal grassland on hard or soft cliffs	Combined cover of *Pteridium aquilinum* and woody species (inc. *Rubus fruticosus* agg., *Ulex europaeus, Prunus spinosa, Calluna vulgaris, Hedera helix* etc.) is <5%.	Within zone in swath.
8	Coastal grassland on hard cliffs	No negative indicator species present.	Within zone in swath.
9	Grazed coastal grassland on hard cliffs	Average grassland sward height is <10 cm.	Within zone in swath.
10	Grazed coastal grassland on hard cliffs	Number of positive indicator species present ≥ 3.	Within zone in swath.
11	Grazed coastal grassland on hard cliffs	Broadleaf herb component is 20 – 90%.	Within zone in swath.
12	Ungrazed coastal grassland on hard cliffs	Ungrazed grassland sward height is ≥ 10 cm.	Within zone in swath.
13	Ungrazed coastal grassland on hard cliffs	Number of positive indicator species present ≥ 2.	Within zone in swath.
14	Coastal grassland on soft cliffs	Number of positive indicator species present ≥ 2.	Within zone in swath.
15	Soft cliff pioneer	Number of positive indicator species present ≥ 1.	Within zone in swath.
16	Flush on soft cliff	No evidence of anthropogenic impacts on the hydrological processes or water quality levels.	Within zone in swath.
17	Flush on soft cliff	Number of positive indicator species present ≥ 1.	Within zone in swath.
18	Coastal heath	Number of positive indicator species present ≥ 2.	Within zone in swath.
19	Coastal heath	No negative indicator species present.	Within zone in swath.
20	Coastal heath	Cover of *Pteridium aquilinum* < 10%.	Within zone in swath.
21	Coastal heath	Cover of scattered native trees, shrubs and woody climbers < 20%.	Within zone in swath.
22	Coastal heath	No signs of burning of heath habitat on the cliff. If target is failed record the cliff section(s) this occurs in.	Within visible area of the site.

Splash zone. Criterion 5 considers the number of positive indicator species for this zone. In recognition of the extreme nature of this habitat, which is often devoid of vegetation, the threshold has been set accordingly low.

Crevice and ledge zone. Criterion 6 considers the number of positive indicator species for this zone. The list of species (see Appendix III) includes those which are frequent and typical of this habitat type (*Armeria maritima* and *Festuca rubra*), in addition to species which are more local in their distribution (*Inula crithmoides* and *Ligusticum scoticum*). Species which indicate a potential maritime therophyte community are included here (*Cerastium diffusum* and *Catapodium marinum*), in addition to those which develop in response to increases in nutrients from bird colonies (*Beta vulgaris* ssp. *maritima* and *Atriplex prostrata*). Though the list of positive indicator species is quite extensive and includes species which are typical of this habitat type, it has been recognised that species cover within this habitat can be low due to factors such as exposure, instability of the substrate and lack of suitable growing niches.

Coastal grassland zones. Criteria 7 to 14 have been set for the different grassland zones which occur. Grasslands on soft cliffs differ greatly from those on hard cliffs. The dynamic nature of soft cliff habitats results in a sward comprised of species which would be generally considered ruderal. A list of positive indicator species for grassland on soft cliffs (Appendix III) has been developed but this should be considered preliminary for a habitat type for which there is very little information. A negative indicator list has not been developed, again due to the lack of information for the habitat. Grasslands on hard cliffs are divided into grazed and ungrazed sites. Grazed sites would generally be considered to be more species-rich. The height, number of positive indicator species and ratio of broadleaved herbs to grasses is recorded. The sward height and the number of positive indicator species for ungrazed grasslands on hard cliffs are recorded. The development of *Pteridium aquilinum* and woody species on grassland habitats, whether on soft or hard cliffs, is generally considered undesirable as it results in a loss of diversity, and so its occurrence is recorded. A further scenario is when a cliff is comprised of both hard and soft material and grassland occurs on the unconsolidated material. These grasslands were, in general, found to have more in common with grasslands found on hard cliffs and they were assessed as such.

Soft cliff pioneer. Criterion 15 considers the number of positive indicator species occurring within this zone. As this habitat type can be, in some instances, devoid of vegetation through recent or on-going erosion, the threshold for species numbers has been set accordingly low.

Flush on soft cliff. Criteria 16 and 17 have been set for the flushes on soft cliffs. These features can contribute to the unstable nature of the habitat and should not show evidence of modification.

There has been little research carried out on this habitat type and the list of positive indicator species is likely to be developed further as additional information is recorded. As such, the threshold for species numbers has been set accordingly low.

Coastal heath. Criteria 18 to 22 are considered for areas of coastal heath on cliffs. Cover of *Pteridium aquilinum* and trees and shrubs on coastal heath is generally considered undesirable as, if unchecked, it can result in the loss of this habitat. The occurrence of these is therefore recorded, with thresholds set. Similarly, repeated or excessive burning of coastal heath habitat can be detrimental to the habitat and occurrence of this anywhere within the site is recorded.

No specific criteria have been developed for other habitat types which can occur on cliffs (e.g. scrub, dense bracken or scree).

Applying the criteria

When all the relevant structure and function data had been recorded, an overall assessment for the site was made. Unlike the approach taken when assessing dune systems (Ryle *et al* 2009), grasslands (O'Neill *et al.* 2009) and upland habitats (Perrin *et al.* 2010), it was not possible to record four replicate assessment stops with which to assess the site due to the amount of time taken at each swath. There was, therefore, a reliance on the use of the oblique images from the helicopter viewer when extrapolating from the data collected during the field survey assessment.

If a site failed one of the first three criteria, an assessment was made, using information collected during the field survey and from the oblique images, as to the extent of the impact. If it was considered to be affecting less than 25% of the site it was assessed as being Unfavourable - Inadequate. If the impact was affecting more than 25% of the site it was assessed as Unfavourable - Bad. When assessing the extent of an impact, an assumption was made that the full face of the cliff was affected by an impact occurring at the base or the top of the cliff. For instance, when rock armour was positioned at the base of a cliff the assumption was made that the top of the cliff was being adversely affected by this due to the impacts on erosional processes. Similarly, where quarrying was removing the upper section of a cliff, the assumption was made that the lower section of cliff was being adversely affected through falling spoil and debris.

When a site failed the criterion referring to the presence of non-native species, an assessment was made of the invasive nature of the species recorded. Species recorded during the 2010 survey that were considered to be problematic species and which warranted a site failing this criterion were *Senecio cineraria*, *Gunnera tinctoria*, *Cotoneaster* sp. and *Hebe* sp. The first two of these species occur on the list of Problematic Terrestrial Species compiled by the National Biodiversity Data Centre

(NBDC) (www.biodiversityireland.ie). The NBDC also include *Cotoneaster integrifolius* but as it was not always possible to identify *Cotoneaster* species from remote locations the presence of any *Cotoneaster* species was considered reason to fail this criterion. *Hebe* sp. does not appear on the NBDC list, but having viewed the self-sown growth of this plant on cliffs during fieldwork this was also considered a reason to fail this criterion. An assessment was made as to what percentage of the site was being affected by the invasive plant, and the thresholds detailed above were applied.

Information about the habitat zones was recorded through the remaining 18 criteria. However, due to the natural variation that occurs within the zones it was not considered appropriate to systematically incorporate the outcome of these into the assessment of the structure and function of the site. If a swath failed a particular criterion due to anthropogenic impacts, the result would be considered for incorporation into the overall assessment. However, as no sites during the current survey were considered to have failed these structure and function criteria due to anthropogenic impacts, guidelines on the incorporation of such failures into the overall site assessment have not been developed. This should be done on a site-by-site basis with consideration given to the habitat zone which has failed. As sites are resurveyed these data will be of assistance in assessing the trends occurring at a site and will form valuable baseline data for future assessments.

Future prospects

The future prospects assessment relates to the long-term maintenance of the habitat in favourable condition through both the area covered by the habitat and its specific structures and functions. Land-use, impacts and threats were recorded using the impact codes from the list provided in Appendix IV. Following Ssymank (2009), for each of the pressures recorded at a site the nature of the influence was also recorded as positive, neutral or negative. The intensity of effect was indicated as high, medium or low. The percentage of the site area under this pressure was also recorded. This was assessed in the field with reference to the section being surveyed; this was then extrapolated to the whole site following review of the aerial photographs and oblique images. In addition, the source of the impact, whether originating inside or outside the Annex I habitat, was recorded. When assessments are being repeated in future years for a particular site, the trend in intensity of the impact or activity relative to the previous assessment can be made. This can also be based on other available data such as information from local NPWS staff or comparison of aerial photographs. These should record if the intensity is increasing or decreasing. As baseline data were being collected in 2010, no sites were being reassessed and trends in impact intensity could therefore not be determined.

When considering the future prospects of a site, the pressures considered were mainly recorded for a site on the basis of observations during field survey, but these were augmented by information from the desk survey. Where the desk study recorded pressure on a site, the nature of the impact was reassessed for its relevance to the future prospects assessment. Future sources of potential impacts, such as proposed coastal protection works, quarries or other infrastructure, were only considered if some actual progress had been made towards their development (such as inclusion in a county development plan), rather than speculation that they might be developed. Consideration of any recorded or predicted impacts of climate change were also considered amongst the various pressures and these were related to the different habitat vulnerabilities. As detailed in Ellmauer (2010), a period of 12 years was considered when assessing the future prospects of sites.

Equal vulnerabilities of different habitats to factors were not assumed. For instance, soft cliffs are likely to be much more vulnerable to high levels of trampling and to increases in sea level than a hard cliff site.

Overall assessment

An overall assessment of the Annex I habitat *Vegetated sea cliffs of the Atlantic and Baltic coasts* (1230) at each site is then formulated by combining the results from the parameters. If a site is assessed as Favourable for each of the three parameters assessed then the overall assessment for the site is Favourable. If the assessment for any of the three parameters is Unfavourable - Bad then the overall assessment is Unfavourable - Bad. If the parameters are assessed as a combination of Favourable and / or Unfavourable - Inadequate, then the overall assessment is Unfavourable - Inadequate. This approach is detailed in Table 6.

Data management

Sea cliffs database

A detailed relational database (MS® Access) was constructed to store all of the information gathered through both the desk and field studies. This database was also populated with the results of the pilot study sites collected by MERC/EirEco. However, some of the parameters recorded during the pilot stage of the project had been modified and new parameters had been subsequently added during the current phase of the project. As a consequence there are some gaps in this section of the dataset. In addition to providing a method for storing data, the database has been constructed so that queries can be easily constructed and run, reports generated and data exported to MS® Excel and statistical packages as required.

GIS project

As mentioned previously, a GIS project was prepared as part of the desk study. The following additional data were added to the project for sites which were surveyed in the field:

- GPS location of the vantage point
- GPS location of the two outer markers of the swath and the centre point of the swath
- GPS location of each relevé (either recorded in the field or, for inaccessible locations, taken from the GIS using the horizontal distance from the vantage point to the relevé and the azimuth).

It was noted in the field that GPS readings were, at times, difficult to obtain when on the cliff face (on ropes) or at the cliff base, due to the cliff obscuring reception by the GPS unit. The accuracies of the points taken were recorded in the field and have been added to the database.

Storage of photographs

Photographs have been labelled as detailed in Table 8. The numbering protocol follows that for the cliff sections given in MERC/EirEco (2009). Using the relevé photograph given as an example in Table 8, photograph number 0100302Ra indicates the [2 digit county code]-[3 digit cliff number]-[2 digit section number]-[R; indicating the photo is of a relevé]-[lower-case letter corresponding to the letter assigned to the relevé in the database]. The photographs are labelled in this way such that all those of a particular site can be sorted and easily grouped together. General views are assigned to the appropriate section of the cliff and then assigned a letter. The general views category includes features of note such as rare plants, damaging activities, invasive species, additional views of the cliff and images for use in the report. The Sea Cliffs Image Databank, which has been submitted to NPWS as part of this project, is compatible with the NPWS Image databank. This spreadsheet includes information on the photograph file name, date taken, camera used, copyright and various keywords. These include the subject of the photograph (e.g. swath photo, bird colony, overview of swath, oblique image, etc.). If the image is of an impact this is also noted, together with the nature of the impact such that these can be easily grouped together.

Table 8: Guide to labelling photographs.

Photograph type	Notes	Example
Helicopter view	Assigned to a particular section of the cliff.	0100302Ha
Swath (individuals)	Photographs numbered from the top down.	0100302Sa
Relevés	Relevés are labelled in the order in which they were collected.	0100302Ra
General views	Numbered as required, assigned to the cliff or section as appropriate, with a letter added if more than one image taken of a particular site or swath.	0100302Ga, 0100302Gb

Photograph format

All images taken using the Nikon D300 camera were recorded in NEF format (Nikon Electronic format). This format ensures the best resolution for subsequent analysis and is a 'lossless' format as there is no loss of data when the file is modified or resaved. They do, however, require a large amount of memory capacity for storage (approximately 20 megabytes per photo), can be slow to open and are not supported by some standard viewing software. For these reasons each NEF image has also been converted into JPEG format. The advantage of JPEG format is that the memory capacity required for storage is smaller (approximately 9 megabytes per photo) but they are a 'lossy' format as each time the file is modified or resaved data are lost. Both image types can be viewed using Picasa 3 Photo Viewer which runs on Windows, Macintosh and Linux and is freely available at http://picasa.google.com/. Images taken during the survey with other cameras (an Olympus μ 760 was also used during fieldwork) and oblique helicopter viewer images are only available in JPEG format.

Hyperlinked photographs

Photographs have been hyperlinked to the GIS package. Oblique images and general views are linked to the polyline indicating the relevant section of the cliff, swath photos are linked to the point indicating the centre point of the swath and relevé photos are linked to the point within the GIS package indicating the location of the relevé. As such there are instances when more than one image is linked to a particular GIS feature (a point or a polyline). It is therefore necessary to use the identify tool to indicate the list of images linked to a particular feature.

Summary statistics

Using the total length of all sections of cliff, obtained from the GIS project, it was possible to calculate an approximate total area of cliff habitat by multiplying the length of cliff by the slope distance. Slope distance is more applicable than height as it represents the surface of the actual cliff face. However, slope distance data were only collected for the 62 sections surveyed in the field. The median of these measurements (25.4 m) was multiplied by the overall length of the sites to obtain a value for the total area of cliff habitat. It must be noted these figures for slope distance will not represent the full range of heights occurring within a site and these data could only be improved by taking more replicates from each site. It was decided against using the height data collected during the desk survey as this records the maximum height for each section rather than an average height.

Vegetation analysis

Data preparation

The taxa included in vegetation analysis must be recorded in a consistent manner to obtain the clearest results possible. To ensure that the vegetation groups identified in the analysis are well defined, only species or taxa which add meaningful information to the analysis were included in the dataset.

Vascular plant species which were identified only to genus were removed from the dataset, with some exceptions. *Sedum anglicum*, *S. album* and S. *acre* are superficially similar in appearance and all occur in similar situations on sea cliffs. *S. anglicum* was identified to species at several sites during the survey. During the remote survey, some small *Sedum* individuals were seen, but were not flowering and could not reliably be identified to species. These individuals were recorded as '*S. anglicum* type'. All records for *S. anglicum* and '*S. anglicum* type' were combined into one taxon for the purpose of analysis. Similarly, *Festuca rubra* and *F. ovina* could not be distinguished satisfactorily using remote techniques, and were combined in the analysis.

Due to the constraints associated with remote sampling, it was frequently impossible to record lichens even to a genus level. These lichens were excluded from the dataset. Some genera were identified frequently, but could not always be identified to species. Where these genera displayed some ecological consistency, they were grouped together and included in the analysis. Dark-coloured or black *Verrucaria* species (most frequently *Verrucaria maura*, as well as *V. mucosa* and *V. amphibia*) are associated with rocky coasts, around the littoral zone. These were grouped together as *Verrucaria* spp. for the purposes of the analysis. *Caloplaca thallincola* and *C. marina* were recorded during the survey, but in several instances lichens were identified as *Caloplaca* but could not be ascribed to a particular species. In addition to *C. thallincola* and *C. marina*, *C. verruculifera*, *C. maritima* and *C. microthallina* occur on coastal rocks, as well as the somewhat less frequent *C. littorea*. All of these *Caloplaca* species are found above the high water mark, although *C. maritima* and *C. littorea* are generally found higher up the shore than the other species. Due to identification difficulties, all of the *Caloplaca* records were grouped together as a single taxon for analysis. *Xanthoria parietina* was the only *Xanthoria* recorded to species during the survey. However, other species such as *X. calcicola* and *X. ectanoides* are similar in appearance and habitat preferences, so all *Xanthoria* records were combined into a single taxon for analysis. Several *Ramalina* species occur on coastal rocks above the high water mark, most notably *R. cuspidata*, *R. siliquosa* and *R. subfarinaceae*. *Ramalina* was recorded to genus at 16 swaths, *R. siliquosa* at two and *R. cuspidata* at

one swath. All *Ramalina* records were combined into a single *Ramalina* group for the analysis. Where *Cladonia* species occurred, there were included in the dataset as a single *Cladonia* group. Where lichens were recorded to species consistently (e.g. *Anaptychia runcinata*), they were included in the dataset as species. Algae were recorded in two relevés, but could not be identified and were removed from the dataset. Information on lichens' distribution and ecological preferences was obtained from Dobson (2000).

Bryophytes were included where they were identified to species. Species which occurred only once were deleted from the dataset to reduce noise. Where a species covering over 10% of a relevé was deleted, that relevé was removed from the analysis.

Multivariate outlier analysis was used to examine the dataset in PC-Ord 5 (MjM Software). The mean distance of each sample from each other sample was calculated using Quantitative Sørensen (Bray-Curtis) as the distance measure. A threshold of three standard deviations of the grand mean for all distances between samples was used and no outliers were identified.

Preparing the data in this way yielded a total of 86 taxa recorded in 145 relevés.

Species cover was recorded following the Domin scale in the field. These were converted to mid-range values as shown in Table 9, as mean values cannot be calculated directly from a non-linear scale.

Table 9: The Domin scale, range and mid-range values ascribed for the purposes of analysis.

Domin scale	Range (%)	Mid-range value (%)
10	91-100	96
9	76-90	83
8	51-75	63
7	34-50	42
6	26-33	30
5	11-25	18
4	5-10	8
3	1-4	3
2	<1	0.7
1	<1	0.5
+	<1	0.1

Analysis techniques

A pair of complementary statistical techniques was used to analyse the dataset. Analysis was conducted using PC-Ord 5 with the aim of defining an objective classification that largely followed

the procedures in Perrin *et al.* (2006a, 2006b, 2008a, 2008b) and Martin *et al.* 2007). Perrin *et al.* (2006a, 2006b) also discuss the advantages of these techniques over the more commonly used method of TWINSPAN.

Hierarchical, polythetic, agglomerative cluster analysis. This was the main method selected for grouping the data into vegetation types. From a data matrix of n samples x p species, an n x n distance matrix is calculated by measuring the dissimilarity (or similarity) between each pair of samples. The most similar samples, which are selected using a predetermined criterion of minimum distance (linkage method), are merged into a group and their attributes are combined. The procedure is repeated n - 1 times until the samples have been merged (clustered) into two groups, with the results being displayed as a dendrogram (McCune & Grace 2002). Quantitative Sørensen (Bray-Curtis) was selected as the distance measure, as it has been shown to be one of the most effective measures for ecological community analysis, being less prone to exaggerating the influence of outliers and retaining greater sensitivity with heterogeneous datasets (McCune & Grace 2002). Flexible beta was used as the linkage method, with $\beta = -0.25$ (Lance & Williams 1967). This option is compatible with Sørensen distance and is space-conserving, i.e. properties in theoretical space defined by the original dissimilarity matrix are preserved, as groups form during the cluster procedure. Space-distorting strategies can lead to undesirable effects such as high levels of chaining, the sequential addition of single items to existing groups (Legendre & Legendre 1998; McCune & Grace 2002).

Indicator Species Analysis (ISA) This method of Dufrene & Legendre (1997) was used to identify species that differentiated between clusters of samples. ISA produces percentage indicator values (IndVals) for species and works on the concept that, for a predetermined grouping of samples, an ideal indicator species will be found exclusively within one group and will be found in all the samples in that group at maximum abundance. IndVals are thus a simple combination of measures of relative abundance between groups and relative frequency within groups. At any given level of clustering, species are assigned to the group for which their IndVal is maximal. Dufrene & Legendre (1997) concluded that ISA was more sensitive at identifying indicator species than TWINSPAN. Significance of indicator species was ascertained using montecarlo tests (1000 iterations). An indicator species was considered to be significant where it had a p value of less than 0.05.

Results

This section presents the results of the project. The results of the desk study are presented first, followed by the general results of the field study. The results of the conservation assessments are then presented and these are followed by the results of the vegetation analysis.

All calculations presented here are based on the length or occurrence of sea cliffs as presented in the database unless stated otherwise. The additional cliffs which were found during the desk study should be considered tentative identifications and have yet to be confirmed by site visit or detailed photographic analysis.

Desk survey

Sea cliffs database

As detailed in the Methodology section of this report, the approach adopted during the desk survey was primarily populating the database. An example of a database site record, Dunaff, Co. Donegal (site 03007), is provided in Appendix Va-d. As this site was surveyed during the field study in 2010, the data presented include all desk study data in addition to field survey data such as impacts recorded, field swath grid references, species recorded from the swath, relevé locations and results of the conservation assessment for the site. A total of 196 cliff sites were included in the desk study; this includes the sites for which a desk study was completed in 2009. An inventory of sites, including site name, county, the length and proportion of cliff habitat (extent) is presented in Appendix VI. Finally, a data model diagram showing the data tables and the relationships between them is presented in Appendix VII.

GIS

A GIS project has been produced in ArcMap, and this contains the shapefiles for all of the cliff sites and sections included in the database. In addition, it shows the undocumented sites and those sites which were not included in the desk study due to lack of information. The locations of relevés, vantage points and swaths are marked. Photographs are hyperlinked to the swath, section and relevé shapefiles. Maps were produced for each site included in the database, and examples of the maps for Dunaff (site 03007) are presented in Appendix Ve-f.

Sea cliffs image databank

The sea cliffs image databank, which has been submitted to NPWS as part of this project, is a spreadsheet that includes information on the photograph file name, date taken, camera used, copyright and various keywords. The databank includes references to the 2008 photographs which have been submitted to NPWS as part of this project. A total of 1,061 of these photographs are oblique images taken from the Coast of Ireland, 2003 helicopter image survey and the remaining 947 were taken during field work for this project. Of these 304 are relevé photos, 289 are swath photos and 354 are general photos.

Site distribution

The distribution of confirmed and probable sea cliffs in Ireland, on a 100 km² grid basis, is shown in Figure 1. It can be seen that the Annex I habitat *Vegetated sea cliffs of the Atlantic and Baltic coasts* (1230) is confirmed as occurring in 158 100 km² grid squares. This is an increase of five grid squares on the data presented in the first Article 17 report (NPWS 2008). Cliffs are likely to occur in a further 40 100 km² grid squares, but these cliffs were not confirmed as being present during the desk study in 2010 as some of the imagery is missing for them or they were newly identified sites that have not been fully investigated.

Coverage and length

The coverage of sea cliff sites included in the database is shown in Figure 2, together with a comparison indicating the coastline of Ireland. The total length of the Irish coastline is calculated as 7,678 km. This figure is in keeping with the estimate given in Devoy (2008) of >7000 km. The total length of cliff habitat in Ireland calculated during this project is presented in Table 10. The length of cliff recorded in the database was calculated by totalling the length of the individual sections recorded. Also presented in Table 10 are approximate figures for additional, newly identified sites which have not yet been fully investigated and sites which were previously identified (Browne, 2005) but have no remote imagery;, neither of which have not been included in the database. The total length of sea cliff habitat obtained, 1,750.83 km, represents 23% of the coastline of Ireland.

Table 10: Calculation of total length of sea cliff resource in Ireland.

Data source	No. sites	Length of habitat (km)
Sea cliffs recorded in database	196	1,522.38
Identified sites (Browne 2005) without remote imagery	10	42.75
Additional sites (provisional)	140	185.70
Total	**346**	**1,750.83**

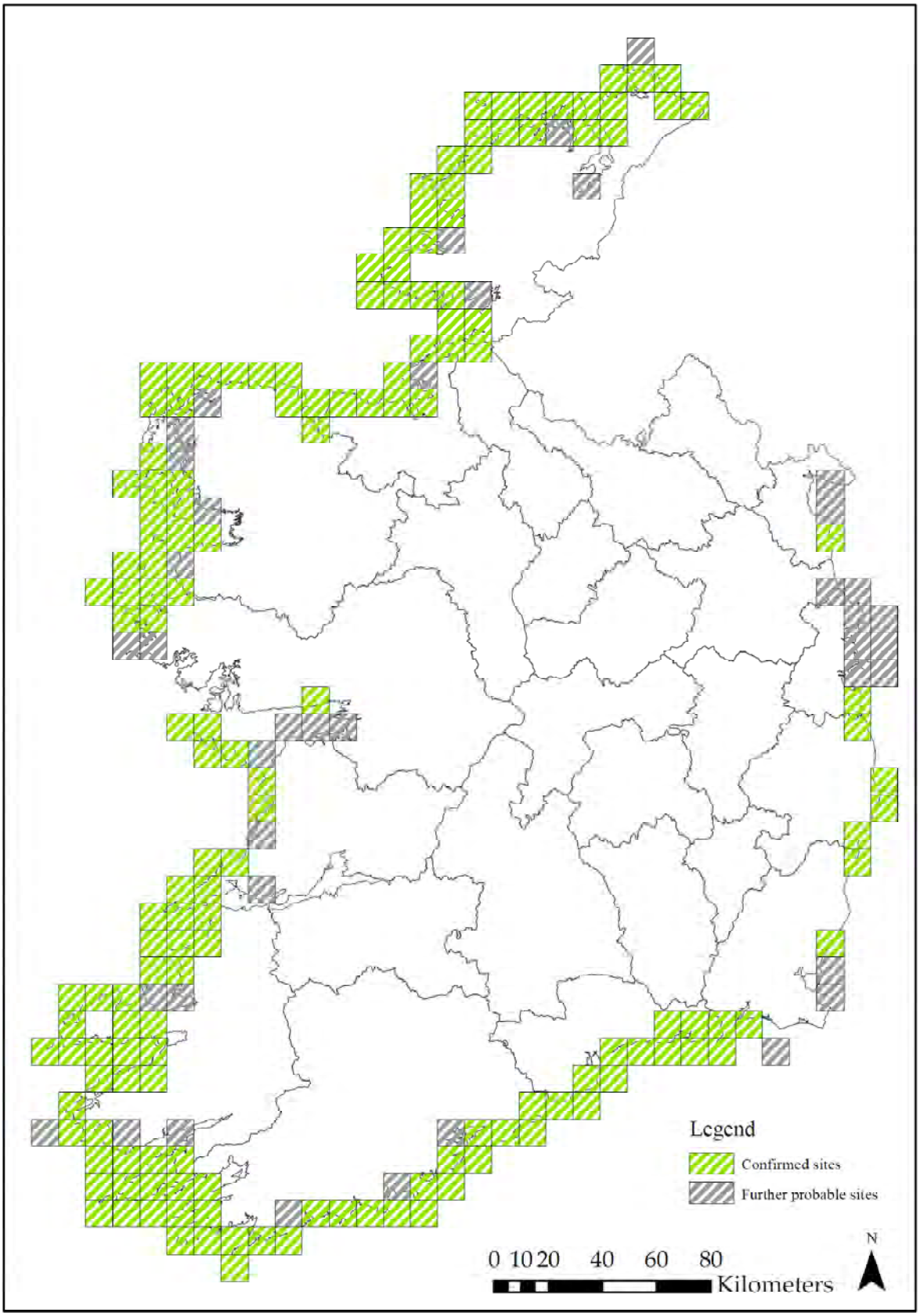

Figure 1: The distribution of confirmed and probable cliff sites in Ireland.

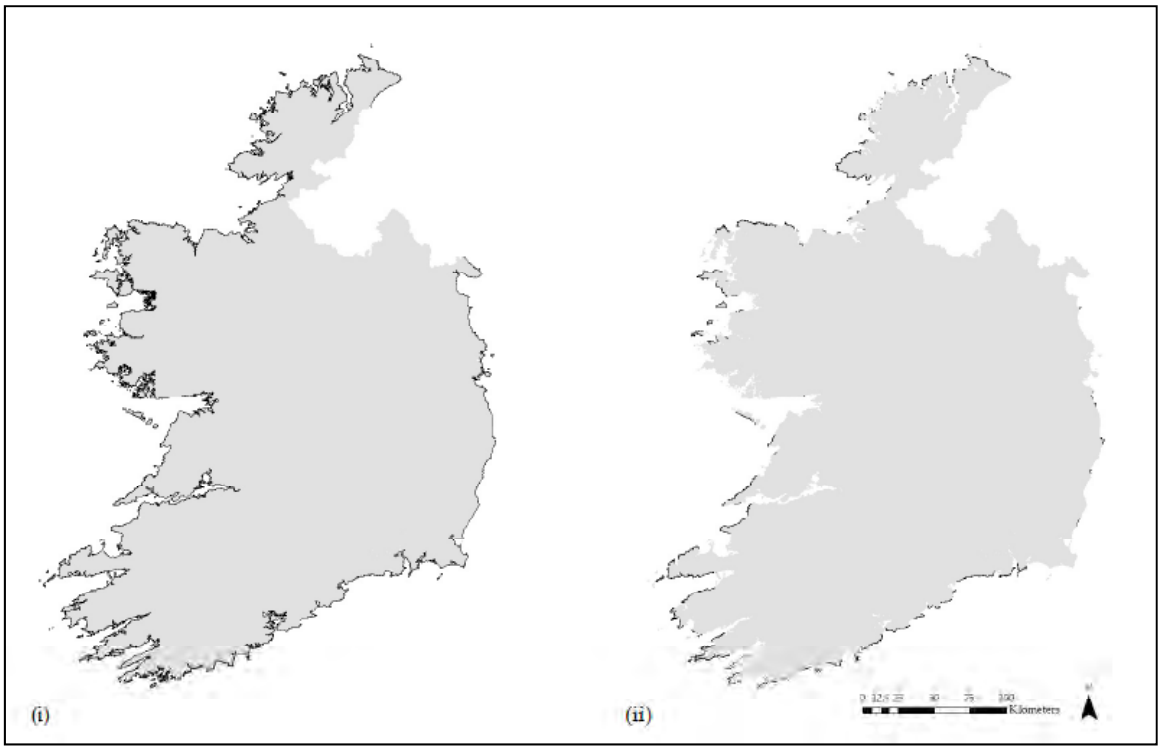

Figure 2: The Irish coastline (i) and the distribution on cliff sites included in the database (ii)

As noted above, there are 10 cliffs for which no remote imagery was available. These sites (The Skelligs, Deenish and Scarriff, Co. Kerry; Inishtrahull, Owey and Gola, Co. Donegal; Lambay and Ireland's Eye, Co. Dublin; Saltee, Co. Wexford) were identified by Browne (2005) but were not brought into the database as there were no oblique images available for them and therefore it was not possible to verify the occurrence of sea cliff habitat. The total length for these sites, as indicated in Table 10, is 42.75 km.

An additional previously unrecorded 140 sites were identified during the desk study with a total length of approximately 185.7 km. These additional sites are, on average, shorter than the sites included in the database (average length 1.3 km) and as they were not identified during previous surveys they will, presumably, be lower in height. Only preliminary investigations have been made into these sites so this additional length must be considered provisional. These sites have not been included in the desk study but are presented in the GIS project. They could increase the range of sea cliffs in Ireland by an additional 40 100 km² grid squares, but as they have not been fully investigated they have not been included in Figures 1 or 2. The search for new cliffs could not be undertaken in areas with insufficient photographic imagery, so some areas which are known to contain low sea cliffs, such as Clew Bay, Co. Mayo, had to be omitted. It should be noted that the lengths given are approximate as they are based on the county boundary line derived from OSI six inch maps.

Figure 2 shows the main distribution of sea cliffs to be along the southern and western sea boards. There is a significant distribution of cliffs along the south coast from Mizen Head, Co. Cork to Hook Head, Co. Wexford, with reasonably continuous sea cliff in this area. The peninsulas of the south west, from Mizen Head to Loop Head, Co. Clare, also support significant numbers of sea cliffs, though these are discontinuous due to the indented nature of the peninsulas. There are only occasional cliffs along the east coast and south Wexford coast from Hook Head, Co. Wexford to Carlingford Lough, Co. Louth. Other notable gaps in coverage occur along the Galway and north Clare coast from Omey Island, Co. Galway, to Doolin, Co. Clare, the area around the southern section of the Mullet peninsula, Co. Mayo and the Shannon Estuary. In addition there are also just occasional occurrences of sea cliff from St. John's Point in Donegal Bay along the south Donegal, Leitrim and Sligo coasts to Killala Bay.

Table 11 gives a breakdown by county of the sites included in the desk study. Almost a quarter of the total resource of sea cliff habitat in the country occurs in Co. Cork (24.1%), while Donegal and Kerry account for almost a fifth of the habitat each. A third of all sites occur in Co. Cork.

Table 11: Breakdown of desk-based data by county.

County	**No. sites**	**No. sites as %**	**Total length of cliff habitat (km)**	**% of total resource**
Clare	7	3.6	76.03	5.0
Cork	66	33.7	371.11	24.4
Donegal	50	25.5	300.19	19.7
Dublin	2	1.0	3.99	0.3
Galway	9	4.6	68.31	4.5
Kerry	23	11.7	299.09	19.6
Louth	1	0.5	2.10	0.1
Mayo	16	8.2	238.68	15.7
Sligo	7	3.6	17.82	1.2
Waterford	7	3.6	99.97	6.6
Wexford	5	1.5	28.84	1.9
Wicklow	3	2.6	16.26	1.1
Total	**196**	**100**	**1522.38**	**100**

A comparison was made between the county boundary line and a line digitised from the aerial photographs to investigate the level of discrepancy between the two datasets. Two areas were digitised using the aerial photographs as a base: the Dingle Peninsula, Co. Kerry (from Pointe na Cathracha in Brandon Bay to the beginning of Inch Strand) and the south Wexford coast (from Buttermilk Point on the River Suir to Carnsore Point). The results of this comparison are shown in Table 12.

Table 12: Comparison of the length of coastline for the Dingle Peninsula, Co. Kerry and the south Wexford coast using a line digitised from the 2005 aerial photographs and the county boundary line.

Section of coast	Line digitised from 2005 aerial photographs	County boundary line	Difference	Accuracy
Dingle Peninsula	183,133 m	131,096 m	52,037 m	72%
South Wexford coast	145,274 m	134098 m	11,176 m	92%

General desk study results

In total, 196 sites were included in the database. Of these, 20 had been assessed as part of the desk study for the pilot project in 2009 and, therefore, were not included in the desk study in 2010. Due to the differences in methodology between the pilot survey and the current project, some of the fields in the database could not be filled in for these sites. These fields contain information regarding soil and substrate information, grid references, vegetation cover, non-cliff habitats adjacent to and within the cliff sites, coast type, wind and wave exposure, the cliff top habitat and type of boundary line at the cliff top and the number of the discovery map associated with the site.

The 196 sites included in the database were divided into a total of 1,227 sections, giving an average of six sections per site. At 660 to 670 m, Slievemore (which includes Croaghaun) Co. Mayo is the tallest cliff in the survey. Of the sections recorded, 989 consisted of hard cliff only, 86 of soft cliff only, and 152 of a combination of the two. The following figures were calculated using data from sites studied in 2010 only. The average length for sites is 8.06 km, with the longest site, Glinsk Co. Mayo (site no. 08005), being 68.17 km long. The upper third tends to be the most vegetated part of the cliff; 41-60% vegetation cover was the most frequently recorded value for that part of the cliff. The least vegetated part of the cliff tends to be the bottom of the cliff, where the most frequently recorded vegetation cover was 1-20%.

The total area of cliff habitat has been calculated by multiplying the median of the slope distance measurements collected during the survey by the overall length of sites in the database. This gives a figure of 38.7 km^2. It must, however, be noted that this figure is based on just 62 replicate slope distance measurements.

Maps have been prepared for all sites included in the database and have been provided to NPWS in PDF format. In total, 172 maps are presented with this report in separate PDF documents. Figure 3 is an example of one of these maps, showing Dogs Bay to Kilcatherine Point, Co. Cork (site code 02005). Each section is numbered and is shown in a different colour. Due to the varying lengths of the cliffs, maps are displayed at a variety of scales but each has a scale bar indicated. Each map is displayed with the OSI Discovery Series map as the mapping base.

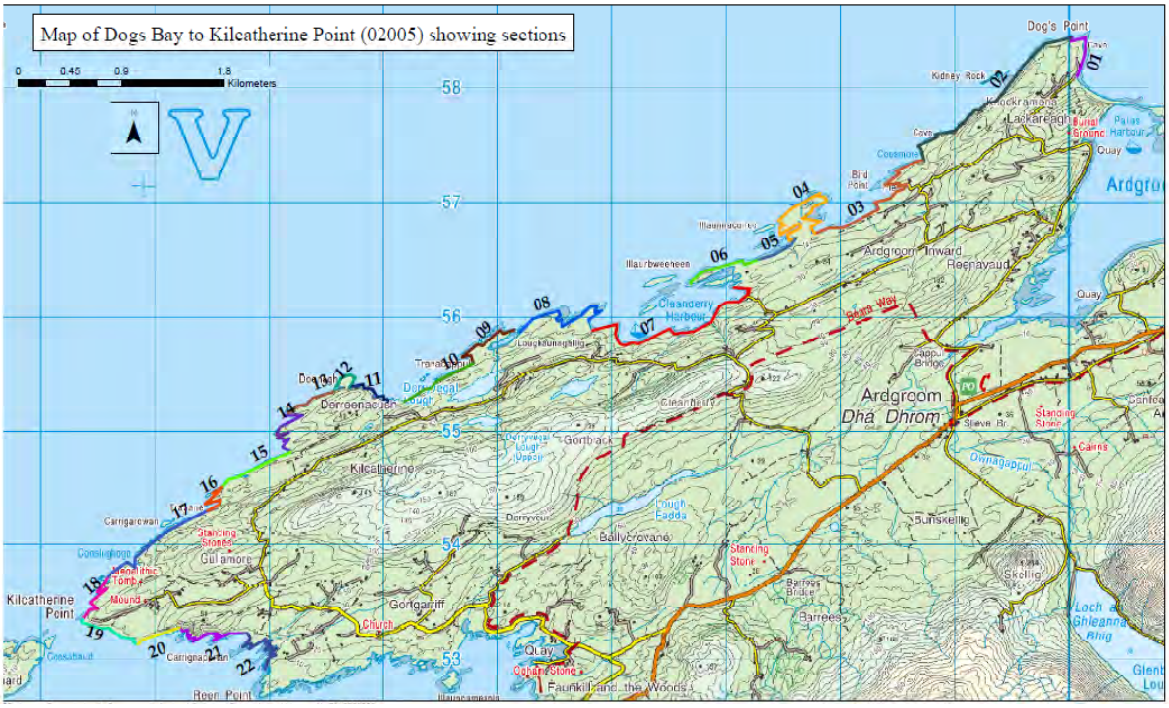

Figure 3: Example of a site-map for site 02005 Dog's Bay to Kilcatherine Point based on the desk study information

Coincidence of cliff sites with conservation designations

A total of 177 (90%) cliff sites are at least partly within an NPWS conservation site. The number of cliff sites which at least partially coinciding with NPWS conservation sites is indicated in Table 13, in addition to the total length of the cliff under each type of designation. As stated in the Methodology section, when carrying out the intersect between the cliff sections and the designated sites it was necessary to apply a 100 m buffer to the sections. The lengths given here may, therefore, be an over-estimate of the actual lengths. No cliff sections coincided with NHAs.

Table 13: Number of cliff sections that coincide, at least partially, with NPWS conservation sites.

	cSAC	SPA	pNHA	Nature reserve
Number of cliff sites	135	100	150	5
Length (km)	831.52	758.06	793.71	13.02

In total, 831.52 km (55% of the total confirmed national resource) of cliff habitat coincides with a cSAC. There are 62 cSACs which coincide with sea cliff sites. The Annex I habitat *Vegetated sea cliffs of the Atlantic and Baltic coasts* (1230) is listed as a qualifying interest for 24 cSACs, and 588.73 km of cliff habitat (39% of the total confirmed national resource) occurs within those cSACs. Of the 831.52 km of sea cliff habitat which coincides with cSACs in Ireland, 94.08 km in 35 cSACs is

accounted for by sections which are wholly or partly composed of soft cliff. This equates to 40% of all the soft cliff habitat recorded. The habitat *Vegetated sea cliffs of the Atlantic and Baltic coasts* (1230) is listed as a qualifying interest in 14 cSACs, accounting for 53.4 km (23%) of soft cliff habitat. Nineteen sites are not part of any NPWS conservation site. In total, 996 (81%) sections were covered by at least one designation.

Impacts

Anthropogenic influences, which were recorded within and adjacent to sections, were noted at 113 (57.7%) sites in 312 sections. The majority of these records were of roads and paths being present on the cliffs, recorded at 173 sections. Port facilities were recorded in 46 sections. Some form of building structure was recorded at 19 sections, but some of these may be historic. Coastal defences such as rock armour and sea walls were noted in 24 sections.

Field survey

Summary data

The sites visited during the 2010 field survey are listed in Table 14. Due to mapping irregularities present in the sites mapped in 2009, in two cases (Moveen Bridge and Arklow Head), the total length of cliff habitat within the site appears to be greater than the length of the site. Where these inconsistencies occur they are very minor. Summary data for the field-surveyed sites are presented in this section and, as can be seen from the table, a total of 62 swaths were surveyed in the field from 32 sites, with a total of 161 relevés being recorded. The combined length of the sites surveyed is 341.53km, or 22% of the total length of confirmed cliff sites in Ireland. It should however be noted, as indicated on Table 14, the full site was not viewed in the field in some instances. Between one and four swaths were surveyed per site. Of these, 44 swaths were from hard cliffs, 12 were from soft cliffs and six swaths contained both hard and soft cliff. A total of five sites were surveyed using rope survey techniques. Also presented in Table 14 is an estimate of the amount of the site which was viewed in the field; this can be seen to vary from 5% up to 100%.

Figure 4: Sites which were included in the field survey in 2010

The distribution of the field-surveyed sites is shown in Figure 4. An example of the GIS presentation for a surveyed section is shown in Appendix Ve-f. These show the position of the vantage point, the three points marking the swath and the location of the relevés recorded, displayed on the aerial photographs (Appendix Ve) and on the OSI Discovery Series maps (Appendix Vf). These maps have been prepared for all surveyed swaths, saved as PDFs and submitted to NPWS. All of these images are displayed at a scale of 1:1,500. It should be noted that aerial photographs were not available for one site (Loop Head, site no. 01006) so just maps with the Discovery Series base map have been produced for this site.

Table 14: Sites surveyed in the field.

Site name	Site code	County	No. swaths	No. relevés	Length of site (km)	Length of cliff (km) habitat within site	Approx. % of site viewed in field	Surveyed by rope
Cliffs of Moher	01001	Clare	2	6	14.47	14.47	20	Yes
Rineen	01002	Clare	2	5	3.38	3.38	15	
Moveen to Bridge of Ross	01005	Clare	3	8	31.36	31.57	10	
Loop Head	01006	Clare	3	10	6.20	6.20	15	
Dursey Island	02003	Cork	1	4	17.17	14.30	20	
Bear Island	02006	Cork	1	3	14.02	14.02	20	
Preghane to Ballymacus Point	02023	Cork	2	7	6.23	6.21	20	Yes
Cloddagh North, Sherkin Island	02060	Cork	1	1	2.18	2.18	40	
Hare Island West	02066	Cork	1	3	1.86	1.61	100	
Stookanillar & Five Fingers	03004	Donegal	4	10	3.31	3.31	100	Yes
Dunaff Head	03007	Donegal	1	3	6.37	6.37	10	
Saldanha Head to Yellow Rock	03012	Donegal	2	4	3.91	3.91	20	
St John's Point	03030	Donegal	3	5	3.28	3.27	100	
Ballintra, Aran Island	03058	Donegal	2	5	23.04	21.74	10	
Killiney	04004	Dublin	1	3	0.78	0.79	100	

Site name	Site code	County	No. swaths	No. relevés	Length of site (km)	Length of cliff (km) habitat within site	Approx. % of site viewed in field	Surveyed by rope
Shankill	04005	Dublin	1	5	3.21	3.20	100	
Tully	05001	Galway	1	3	3.41	3.41	20	
Onaght, Inishmore	05006	Galway	3	5	17.38	17.38	25	
Rusheen	05008	Galway	2	2	1.94	1.03	100	
Kerry Head	06002	Kerry	3	11	45.19	44.59	5	
Brandon to Ballydavid Head	06003	Kerry	2	11	32.60	32.60	40	
Clogher Head to Slea Head	06005	Kerry	3	6	27.84	26.56	20	Yes
Great Blasket	06006	Kerry	3	6	17.87	17.87	15	
Bulls Head to Inch	06010	Kerry	2	7	25.09	23.77	15	
Clogher Head	07001	Kerry	1	5	2.10	2.10	100	Yes
Moyne	08001	Mayo	1	2	4.23	4.21	30	
Kilcummin	08002	Mayo	2	4	1.60	1.61	100	
Ballincar	09004	Sligo	1	2	0.98	0.98	100	
Ardmore	10002	Waterford	2	7	7.39	7.39	25	
Arklow Head	11001	Wicklow	2	3	3.05	3.06	80	
Bray Head	11003	Wicklow	2	2	4.66	4.66	80	
Gaunagh Gap	12003	Wexford	2	3	5.78	5.76	40	
Total			**62**	**161**	**341.54**	**333.51**		

Habitats of the cliff top and base

Heath is the most frequently recorded Fossitt (2000) habitat at the top of cliffs (see Figure 5), with semi-natural grassland and improved grassland the next most frequent. Heath was never recorded at the top of the soft cliffs. Semi-natural grassland and improved grassland were the most frequent cliff top vegetation at soft cliff swaths.

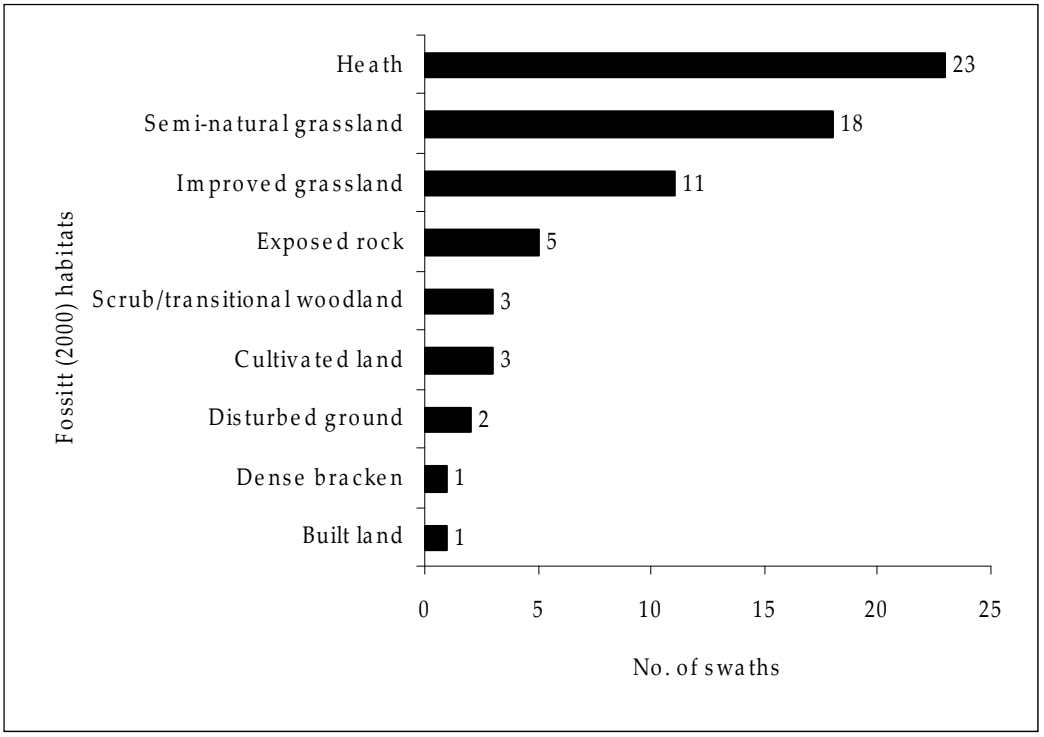

Figure 5: Frequency of cliff top Fossitt (2000) habitats found at the top of the 62 surveyed cliff swaths. In five instances, two cliff top habitats were recorded per swath.

Marine water body was the most frequent cliff base habitat, with littoral rock and littoral sediment the next most frequent (see Figure 6). It should be noted that for soft cliff swaths a marine water body was never recorded at the base of a cliff.

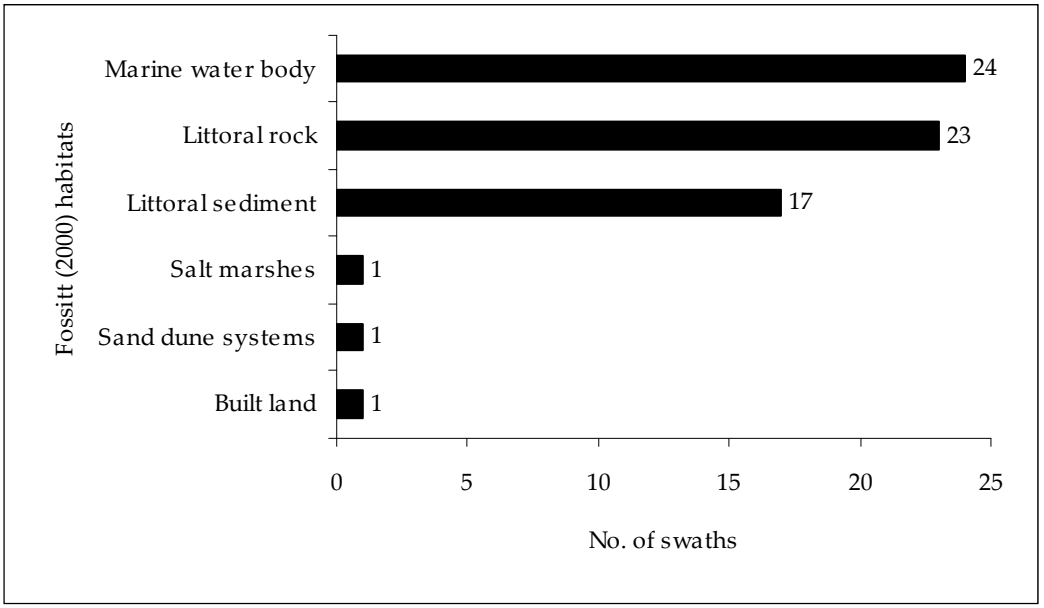

Figure 6: Frequency of cliff base Fossitt (2000) habitats found at the base of the 62 surveyed cliff swaths. In five instances two cliff base habitats were recorded per section.

Cliff structure and zone frequency

Table 15 shows that the mean cliff section height was 32.2 m (s.d. = 26.2), and the range of values was from 4.5 to 110 m. The mean slope of cliffs was 60.2° (s.d. = 14.1), with a range of values of 34.1° to 86.6°. Hard cliffs were generally taller than the soft cliffs surveyed, and overall the slope of the different types of cliff was similar.

Table 15: The height and slope of the 62 cliff swaths surveyed. The six swaths that included both hard and soft cliff are included with the soft cliff data

	Height	s.d.	Slope	s.d.
All cliffs	32.2	26.2	60.2	14.1
Hard cliffs	38.1	28.3	60.8	12.8
Soft cliffs	18	11.8	58.9	17.2

It should be noted that in some cases the same zone type was recorded more than once from a swath when two discrete areas of the same zone type occurred. The crevice and ledge zone was recorded at 42 swaths, ungrazed grassland at 19 swaths, pioneer at ten swaths, heath at nine swaths, soft cliff grassland and scrub at six swaths each, and grazed grassland at five swaths.

The crevice and ledge zone and the splash zone were the most frequently recorded zone types (see Table 16). Both of these zones were only recorded from hard cliff sites. These two zones had the steepest slope. The zone with the shallowest slope was soft cliff grassland, though it should be noted that there were only eight swaths surveyed with this habitat zone. The widest zone type was heath, followed by crevice and ledge.

Table 16: The mean width and slope of the eight main cliff zones recorded within the 62 swaths.

Zone type	Frequency	Zone width	Slope
Crevice & ledge zone	48	17.8	63.0
Splash zone	43	8.2	65.4
Ungrazed grassland	21	10.0	49.1
Pioneer	11	9.0	54.5
Heath	10	21.8	45.1
Soft cliff grassland	8	7.6	37.4
Scrub	7	13.0	52.2
Grazed grassland	7	16.3	39.7

Plate 4: Variation in cliff morphology and vegetation. From top left: sheer hard cliffs, gently sloping hard cliffs, soft cliff with slumping and pioneer zones, well vegetated soft cliff, sparsely vegetated steep soft cliff, an undercut cliff, a cliff formed partly of hard rock and partly of boulder clay.

Species frequency and environmental data from relevés

Species frequency data collected from the swaths is presented below for the three most recorded cliff zones (Tables 17-19). For the remaining five zones, the most frequent species are recorded (Table 20). In the crevice and ledge zone, *Armeria maritima* was the most frequent species, occurring in 42 of the 48 crevice and ledge zones recorded. In the splash zone, the lichen *Verrucaria* sp. was the most frequently recorded species, occurring in 41 of the 43 splash zones. *Festuca rubra/ovina* was recorded from each of the 21 ungrazed grassland sites recorded.

Table 17: Twelve most frequent species in the 48 crevice and ledge zones

Species	Frequency
Armeria maritima	42
Festuca rubra/ovina	38
Plantago maritima	28
Plantago coronopus	24
Verrucaria spp.	24
Hypochaeris radicata	22
Ramalina spp.	20
Asplenium marinum	18
Anthyllis vulneraria	16
Cochlearia officinalis agg.	16
Jasione montana	16
Plantago lanceolata	16

Table 18: Nine most frequent species in the 43 splash zones

Species	Frequency
Verrucaria spp.	41
Armeria maritima	19
Ramalina spp.	7
Festuca rubra/ovina	6
Caloplaca spp.	5
Algae species	4
Cochlearia officinalis agg.	4
Festuca rubra/ovina	4
Tripleurospermum maritimum	4

Table 19: Eleven most frequent species in the 21 ungrazed grassland zones

Species	Frequency
Festuca rubra/ovina	21
Armeria maritima	18
Anthyllis vulneraria	13
Hypochaeris radicata	13
Plantago maritima	12
Lotus corniculatus	9
Silene uniflora	9
Holcus lanatus	8
Jasione montana	8
Plantago coronopus	8
Plantago lanceolata	8

Of the remaining five zones, *Festuca rubra/ovina* was the most frequent species recorded at four of them: pioneer (frequency 73%), soft cliff grassland (frequency 75%), grazed grassland (frequency 83%) and heath (frequency 80%). *Hedera helix* and *Rubus fruticosus* agg. were the most frequent species recorded in the scrub zone, both with a frequency of 57%.

Table 20: The most frequent species recorded in the five remaining cliff zones.

Zone	Species	Frequency (%)
Pioneer*	*Plantago lanceolata*	64
Soft cliff grassland*	*Agrostis stolonifera* & *Hypochaeris radicata*	75
Grazed grassland*	*Thymus polytrichus*	67
Heath*	*Calluna vulgaris* & *Erica cinerea*	70
Scrub	*Hedera helix* & *Rubus fruticosus* agg.	57

**F. rubra/ovina* was the most frequent species recorded in these zones, and is not included in the table for the purposes of comparison

Table 20 shows the most frequent Domin scores recorded for bare rock and bare soil for the main zones. Also presented is the most frequently recorded vegetation height for each of these zones. It can be seen that the most frequent sea cliff zones of crevice and ledge and splash zone have the most bare rock and are consequently the least vegetated. Bare soil is most prevalent in the pioneer zone. As would be expected, the vegetation height of the splash zone is the lowest and that of the scrub zone is the highest.

Table 21: The most frequent bare rock, bare soil, and vegetation height Domin scores within each of the main sea cliff zones

Zone	Bare rock	Bare soil	Vegetation height (cm)
Crevice and ledge zone	10	2	20
Splash zone	10	0	0
Ungrazed grassland	5	2	25
Heath	4	2	40
Scrub	3	2	60
Grazed grassland	3	0	15
Pioneer	2	9	25
Soft cliff grassland	0	2	30

Notable features

Nesting birds were recorded from 27 of the 62 sections surveyed. Fulmar (*Fulmarus glacialis*) was the most common nesting bird species recorded on sea cliffs. It should be noted that sand martin (*Riparia riparia*) was only recorded from soft cliffs (see Figure 7).

Two EU Annex I Birds Directive species were observed in the vicinity of sea cliff sections. Choughs (*Pyrrhocorax pyrrhocorax*) were observed on 14 of the 62 surveyed sections and 10 of the 32 cliff sites, both soft and hard cliffs. A peregrine (*Falco peregrinus*) was observed flying over one site.

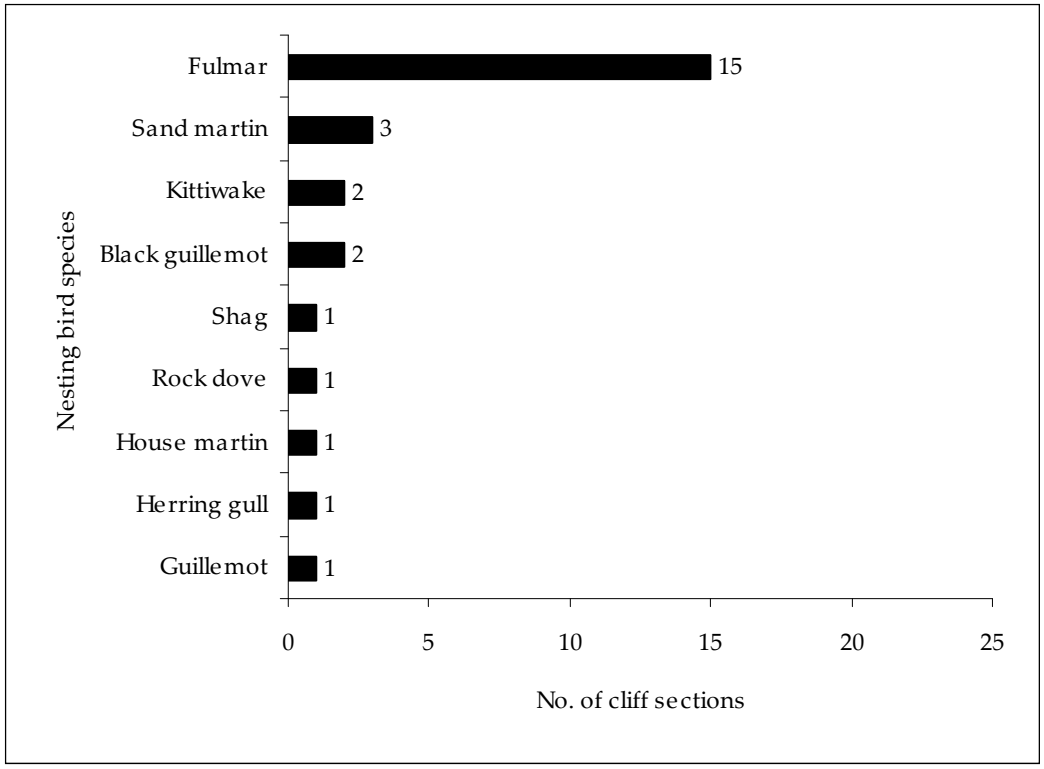

Figure 7: Nesting bird populations recorded in 27 of the 62 surveyed cliff sections

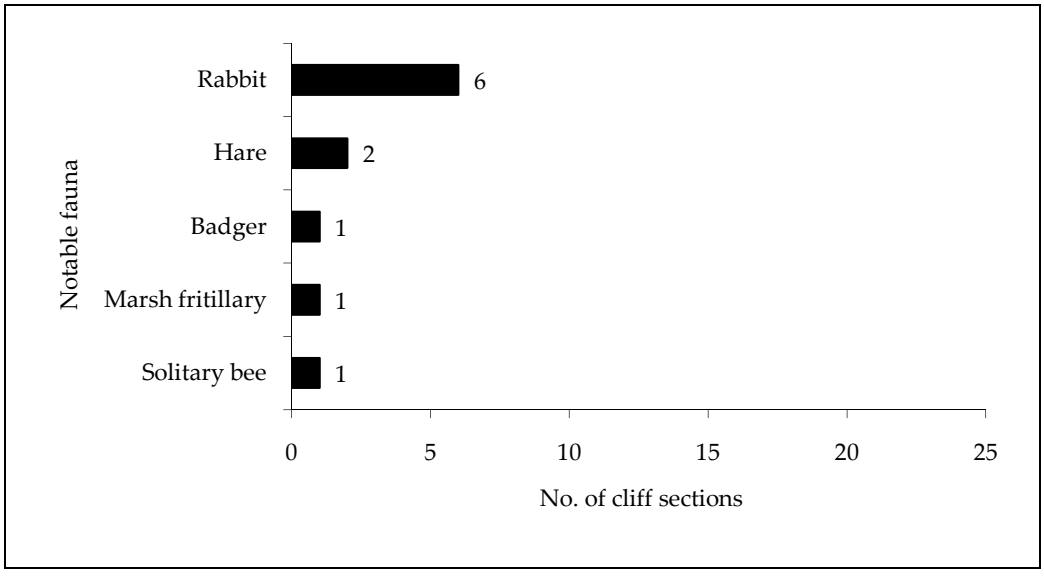

Figure 8: Notable fauna (excluding birds) recorded in 10 of the 62 surveyed cliff sections

Rabbits were the most common fauna recorded in association with sea cliffs (see Figure 8). The EU Annex II species Marsh fritillary (*Euphydryas aurinia*) was recorded in the grassland at the top of one cliff.

Plate 5: Use of sea cliff habitat by invetebrates. Left to right from top: six spotted burnet moth on soft cliff grassland, chrysalis of the six spotted burnet moth on soft cliff grassland, shield bug on crevice and ledge vegetation, evidence of use of the cliff by invertebrates, solitary bee in pioneer zone vegetation, Diptera species on a *Daucus carota* flower in pioneer zone vegetation.

Plate 6: Use of sea cliff habitat by birds. Left to right from top: Chough flying over a cliff, sand martin holes in a soft cliff-face, house martin nests on an overhang, fulmars nesting in the crevice and ledge zone, a large mixed bird colony, shags nesting on a cliff-face.

Examples of the priority Annex I habitat *Petrifying springs with tufa formation (Cratoneurion)* (7220) were recorded as features of interest from five sites (St John's Point 03030, Ardmore 10002, Kilcummin 08002, Shankill 04005, and Arklow Head 11001). The examples at Kilcummin Head were particularly extensive (Plate 7).

Plate 7: Petrifying springs with tufa formation, Kilcummin Head, Co. Mayo.

Coincidence of surveyed sites with cSACs

Table 22 shows sites surveyed in the field which were associated with cSACs. Twenty-two of the surveyed cliff sites (68%) at least partly coincide with cSACs. This is a total of 191.02km (57% of the total length of cliff habitat surveyed). Site 03058, Ballintra, Aran Island, coincides with two cSACs, such that 23 cSACs coincide with 22 of the surveyed sites. Annex I habitat *Vegetated sea cliffs of the Atlantic and Baltic Coasts* (1230) is listed as a qualifying interest for 15 of these. This is a total of 163.92km (49% of the total length of cliff habitat surveyed). Also noted in Table 22 is the conservation status of the sea cliff at each site. Additional information on the assessment of this status is given in the Conservation Status Assessment section below.

Table 22: Sites surveyed in 2010, indicating whether they coincide with cSACs, whether the Annex I habitat *Vegetated sea cliffs of the Atlantic and Baltic Coasts* (1230) has been listed as a qualifying interest (QI) for the cSAC, the total cliff length that is located within the cSAC and the conservation status of the site.

Site name	Site code	cSAC code	cSAC Name	QI	Length of habitat within cSAC (km)	Conservation status
Cliffs of Moher	1001	-	-	-	-	Favourable
Rineen	1002	-	-	-	-	Favourable
Moveen to Bridge of Ross	1005	2264	Kilkee Reefs	N	10.52	Unfavourable - Inadequate
Loop Head	1006	2165	Lower River Shannon	Y	6.20	Favourable
Dursey Island	2003	2158	Kenmare River	Y	14.30	Favourable
Bear Island	2006	-	-	-	-	Favourable
Preghane to Ballymacus Point	2023	-	-	-	-	Favourable
Cloddagh North, Sherkin Island	2060	101	Roaringwater Bay and Islands	Y	2.18	Unfavourable - Inadequate
Hare Island West	2066	101	Roaringwater Bay and Islands	Y	1.61	Favourable
Stookanillar & Five Fingers	3004	2012	North Inishowen Coast	Y	3.31	Favourable
Dunaff Head	3007	2012	North Inishowen Coast	Y	6.37	Favourable
Saldanha Head to Yellow Rock	3012	-	-	-	-	Favourable
St John's Point	3030	191	St. John's Point	N	3.28	Favourable
Ballintra, Aran Island	3058	2283	Rutland Island And Sound	N	1.78	Unfavourable - Inadequate
Ballintra, Aran Island	3058	111	Aran Island (Donegal) Cliffs	Y	18.25	Unfavourable - Inadequate
Killiney	4004	-	-	-	-	Unfavourable - bad
Shankill	4005	-	-	-	-	Unfavourable - bad
Tully	5001	-	-	-	-	Unfavourable - inadequate
Onaght, Inishmore	5006	213	Inishmore Island	Y	17.38	Favourable
Rusheen	5008	268	Galway Bay Complex	N	1.03	Unfavourable - Inadequate
Kerry Head	6002	2165	Lower River Shannon	Y	35.90	Unfavourable - Inadequate
Brandon to Ballydavid Head	6003	375	Mount Brandon	Y	19.25	Unfavourable - Inadequate
Clogher Head to Slea Head	6005	2172	Blasket Islands	Y	12.13	Unfavourable - Inadequate
Great Blasket	6006	2172	Blasket Islands	Y	17.87	Unfavourable - Inadequate
Bulls Head to Inch	6010	343	Castlemaine Harbour	N	4.66	Unfavourable - Inadequate
Clogher Head	7001	1459	Clogher Head	Y	2.10	Favourable

Moyne	8001	458	Killala Bay/Moy Estuary	N	4.21	Favourable
Kilcummin	8002	516	Lackan Saltmarsh And Kilcummin Head	N	0.64	Favourable
Ballincar	9004	627	Cummeen Strand/Drumcliff Bay (Sligo Bay)	N	0.97	Unfavourable - Inadequate
Ardmore	10002	2123	Ardmore Head	Y	2.42	Favourable
Arklow Head	11001	-	-	-	-	Unfavourable - bad
Bray Head	11003	714	Bray Head	Y	4.66	Unfavourable - Bad
Gaunagh Gap	12003	-	-	-	-	Unfavourable - inadequate

Comparison of results from rope survey techniques and the remote survey

A total of 23 relevés were recorded using the rope survey and also surveyed using the remote photograph method. A total of 242 species records were made using the rope techniques while 98 species records were recorded from the same relevés using the remote photograph method. On average, 10.52 species (s.d. = 6.38) were recorded from each rope survey relevé, whereas only 5.78 species (s.d. = 3.52) were recorded from remote relevés, indicating that some species are omitted from relevés recorded from photographs. The comparison showed that some frequently occurring species (*Armeria maritima, Anthyllis vulneraria, Festuca rubra/ovina* and *Silene uniflora*) were recorded with an accuracy of greater than 80%. The most frequently omitted species are *Plantago lanceolata* (omitted from seven remote relevés), *Plantago maritima*, *Plantago coronopus* and *Thymus polytrichus* (each omitted from six relevés), and these are also among the most commonly recorded species in rope survey relevés (see Table 23). Certain groups of species, most particularly mosses and lichens, are very difficult to identify with any degree of certainty from photographs, and they will be under-represented in the vegetation recorded remotely as a result.

Table 23: The 11 species most commonly recorded in the field using rope survey techniques (the only species that were located in 5 or more relevés), with an assessment of how accurately they could be scored remotely.

Species	Frequency in 22 relevés	No. of times scored remotely	% accuracy
Festuca rubra/ovina	20	17	85
Armeria maritima	16	15	94
Hypochaeris radicata	13	9	69
Plantago coronopus	11	5	45
Plantago lanceolata	10	3	30
Anthyllis vulneraria	9	8	89
Sedum anglicum	9	5	56
Jasione montana	8	5	63
Plantago maritima	7	1	14
Silene uniflora	7	6	86
Thymus polytrichus	7	1	14

The average total relevé cover is very similar in rope survey relevés (56.49%, s.d. = 37.72) and remote relevés (57.86%, s.d. = 39.21).

As stated in the methodology, when comparing the rope survey techniques with the remote relevé results, there was an assumption that the relevé collected by the botanist on the cliff was an accurate record of the composition of the relevé and the remote relevé would be compared with this. There were some species recorded during the remote survey which were not recorded by the botanist on the cliff face, and the assumption is therefore made that these were misidentifications. The average cover of species found in the remote survey relevés which were not found during the rope survey relevés is 7.96% (s.d. = 12.46).

Conservation status assessments

An assessment of the conservation status of the Annex I habitat *Vegetated sea cliffs of the Atlantic and Baltic coasts* (1230) at each site was made. Three parameters; extent, structure and function and future prospects were assessed and an overall assessment of the habitat at each site was made.

Extent

Extent was assessed through comparison of aerial photographs, the helicopter viewer and field evidence. Of the 32 sites surveyed during 2010, 29 had not declined in extent since 1994. These were scored as Favourable. The remaining three sites had declined in extent by less than 1% per annum and were scored as Unfavourable - Inadequate. The loss of extent as a percentage of each site is given in Table 24. For Moveen to Bridge of Ross there were 13 separate instances of gravel pits evident. Not all of these were viewed in the field and the photographic evidence was, in many instances, inconclusive as to whether the impacts had occurred since 1994. However, activities recorded from sites which were viewed in the field were on-going, and as such the impacts were considered to be current. No sites were considered to be Unfavourable - Bad for this parameter.

Table 24: Overall assessment of extent for site surveyed in 2010.

Site name	Site code	Length of cliff habitat	Assessment	Loss	Reason
Cliffs of Moher	01001	14.47	Favourable	-	na
Rineen	01002	3.38	Favourable	-	na
Moveen to Bridge of Ross	01005	31.36	Unfavourable - Inadequate	2.6 km (8.3%)	Sand / gravel extraction
Loop Head	01006	6.20	Favourable	-	na
Dursey Island	02003	17.17	Favourable	-	na
Bear Island	02006	14.02	Favourable	-	na
Preghane to Ballymacus	02023	6.23	Favourable	-	na
Cloddagh North, Sherkin Island	02060	2.18	Favourable	-	na
Hare Island West	02066	1.86	Favourable	-	na
Stookanillar & Five Fingers	03004	3.31	Favourable	-	na
Dunaff Head	03007	6.37	Favourable	-	na
Saldanha Head to Yellow Rock	03012	3.91	Favourable	-	na
St John's Point	03030	3.28	Favourable	-	na
Ballintra, Aranmore	03058	23.04	Favourable	-	na
Killiney	04004	0.78	Favourable	-	na
Shankill	04005	3.21	Favourable	-	na
Tully	05001	3.41	Favourable	-	na
Onaght, Inishmore	05006	17.38	Favourable	-	na
Rusheen	05008	1.94	Favourable	-	na
Kerry Head	06002	45.19	Favourable	-	na
Brandon to Ballydavid Head	06003	32.60	Favourable	-	na
Clogherhead to Slea	06005	27.84	Favourable	-	na
Great Blasket	06006	17.87	Favourable	-	na
Bulls Head to Inch	06010	25.09	Unfavourable - Inadequate	0.5 km (2%)	Sea defences
Clogher Head	07001	2.10	Favourable	-	na
Moyne	08001	4.23	Favourable	-	na
Kilcummin	08002	1.60	Favourable	-	na
Ballincar	09004	0.98	Unfavourable - Inadequate	0.017 m (1.7%)	Sea defences
Ardmore	10002	7.39	Favourable	-	na
Arklow Head	11001	3.05	Favourable	-	na
Bray Head	11003	4.66	Favourable	-	na
Gaunagh Gap	12003	5.78	Favourable	-	na

Structure and function

A total of 62 swaths were assessed in detail for structure and function. Four criteria (presence of sea defences, artificial structures, access points and non-native species) were applied to all swaths. The remaining 18 criteria were applied to the relevant habitat zones as appropriate. Table 25 gives a breakdown of the number of swaths assessed under each criterion, the pass rate and the pass rate expressed as a percentage of those surveyed.

Table 25: No. of swaths assessed under each structure and function criterion and the pass rate.

Vegetation zone	Assessment Criteria	No. of assessments	No. of assessments that passed	% of assessments that passed
All zones	Sea defences	62	52	83.9
All zones	Artificial structures	62	54	87.1
All zones	Access points	62	47	75.8
All zones	Non-native species	62	53	85.5
Splash zone	Positive indicator species	44	43	97.7
Crevice and ledge zone	Positive indicator species	42	35	83.3
Coastal grassland on hard or soft cliffs	Cover of *Pteridium aquilinum* and woody species	30	24	80
Coastal grassland on hard cliffs	Negative indicator species present	24	22	91.7
Grazed coastal grassland on hard cliffs	Sward height	5	3	60
Grazed coastal grassland on hard cliffs	Positive indicator species	5	3	60
Grazed coastal grassland on hard cliffs	Broadleaf herb component	5	3	60
Ungrazed coastal grassland on hard cliffs	Sward height	21	20	95.2
Ungrazed coastal grassland on hard cliffs	Positive indicator species	21	20	95.2
Coastal grassland on soft cliffs	Positive indicator species	6	6	100
Soft cliff pioneer	Positive indicator species	10	9	90
Flush on soft cliff	Hydrological processes and water quality	1	1	100
Flush on soft cliff	Positive indicator species	1	1	100
Coastal heath	Positive indicator species	9	7	77.8
Coastal heath	Negative indicator species	9	9	100
Coastal heath	Cover of *Pteridium aquilinum*	9	9	100
Coastal heath	Cover of scattered native trees & shrubs	9	9	100
Coastal heath	Signs of burning of heath habitat	9	7	77.8

In addition to the field assessments of the swaths, a number of factors were brought across from the desk-based survey. Also some information was collected in the field for sections of sites which were not surveyed in full. Examples of these include: evidence of burning, which was recorded during the desk survey at Clogherhead (section 07001 02); impacts on sections of Bray Head (11003; various sections) from the development of the railway line along the cliff face were recorded from the helicopter viewer; and invasive species were recorded in a section not surveyed in full while at Great Blasket (06005 01). These data are presented in Table 26.

Table 26: Assessment criteria applied to sections not fully assessed in the field.

Site name	Section code	Assessment failed	Data source
Great Blasket	06005 01	Artificial structures	Field survey
Great Blasket	06005 01	Invasive species	Field survey
Bulls Head to Inch	06010 03	Artificial structures	Field survey
Bulls Head to Inch	06010 09	Sea defences	Helicopter viewer
Bulls Head to Inch	06010 11	Sea defences	Helicopter viewer
Clogher Head	07001 02	Burning heath	Helicopter viewer
Arklow Head	11001 03	Sea defences Access points	Field survey
Arklow Head	11006 06	Sea defences Artificial structures Access points	Field survey
Bray Head	11003 02	Artificial structures	Helicopter viewer
Bray Head	11003 03	Sea defences	Helicopter viewer
Bray Head	11003 05	Sea defences Artificial structures	Helicopter viewer
Bray Head	11003 06	Sea defences Artificial structures	Helicopter viewer
Bray Head	11003 07	Sea defences Artificial structures	Helicopter viewer
Bray Head	11003 09	Sea defences Artificial structures	Helicopter viewer
Bray Head	11003 10	Sea defences Artificial structures	Field survey
Bray Head	11003 11	Sea defences Artificial structures	Field survey
Gaunagh Gap	12003 01	Sea defences	Field survey
Gaunagh Gap	12003 05	Sea defences	Field survey

A summary of the assessment made for each site is presented in Table 27 together with, where appropriate, the reasons for failure. Of the 32 sites surveyed during 2010, 56% (18 of 32) were assessed as Favourable, 31% (10 of 32) were assessed as Unfavourable - Inadequate and 13% (4 of 32) were assessed as Unfavourable - Bad.

Table 27: Overall assessment of structure and function for sites surveyed.

Site name	Site code	Assessment	Reason(s) and percentage of site affected
Cliffs of Moher	01001	Favourable	
Rineen	01002	Favourable	
Moveen to Bridge of Ross	01005	Unfavourable - Inadequate	Quarrying 8.6%, Invasive plant >1%
Loop Head	01006	Favourable	
Dursey Island	02003	Favourable	
Bear Island	02006	Favourable	
Preghane to Ballymacus	02023	Favourable	
Cloddagh North, Sherkin Island	02060	Unfavourable - Inadequate	Access points & pier 3.8%
Hare Island West	02066	Favourable	
Stookanillar & Five Fingers	03004	Favourable	
Dunaff Head	03007	Favourable	
Saldanha Head to Yellow Rock	03012	Favourable	
St John's Point	03030	Favourable	
Ballintra, Aran Island	03058	Favourable	
Killiney	04004	Unfavourable - Bad	Structures (walls supporting railway) 25%, Invasive plant 30%
Shankill	04005	Unfavourable - Bad	Sea defences 75%, Access points >1%
Tully	05001	Unfavourable - Bad	Invasive plant 28%
Onaght, Inishmore	05006	Favourable	
Rusheen	05008	Favourable	
Kerry Head	06002	Unfavourable - Inadequate	Sea defences 0.3%
Brandon to Ballydavid Head	06003	Unfavourable - Inadequate	Invasive plant 1.2%
Clogherhead to Slea	06005	Unfavourable - Inadequate	Access points & pier 0.3%
Great Blasket	06006	Unfavourable - Inadequate	Invasive plant 1%
Bulls Head to Inch	06010	Unfavourable - Inadequate	Sea defences 2%
Clogher Head	07001	Favourable	
Moyne	08001	Favourable	
Kilcummin	08002	Favourable	
Ballincar	09004	Unfavourable - Inadequate	Sea defences 1.8%, Invasive plant >1%
Ardmore	10002	Favourable	
Arklow Head	11001	Unfavourable - Bad	Sea defences 45.3%
Bray Head	11003	Unfavourable - Bad	Modifications for railway 51.3%, access points >1%
Gaunagh Gap	12003	Unfavourable - Inadequate	Sea defences 5.6% Access points >1%

Future prospects

Each of the impacts recorded at the sites surveyed is listed in Table 28. The most frequent impact recorded was erosion, which was recorded at 26 sites. In each instance this was considered a natural process which had not been influenced by anthropogenic activities and was therefore assessed as neutral. Paths were recorded at 13 sites. These ranged from informal footpaths across cliffs and along cliff tops, through to substantial access points for slipways or piers. A total of nine sites were thought to be susceptible to rises in sea level and storm events. Intensive sheep grazing was recorded at six sites.

Table 28 Pressures recorded according to Ssymank (2009) at each of the survey sites.

Site name	Site code	Impact code	Impact	% of site affected	Intensity	Quality	Source
Cliffs of Moher	01001	K01.01	Erosion	15	Low	Neutral	Internal
Rineen	01002	K01.01	Erosion	5	Low	Neutral	Internal
Moveen to Bridge of Ross	01005	H01.08	Sewage outflow	>1	Low	Neutral	Internal
Moveen to Bridge of Ross	01005	K01.01	Erosion	15	Medium	Neutral	Internal
Moveen to Bridge of Ross	01005	I01	Invasive plants	>1	Low	Negative	Internal
Moveen to Bridge of Ross	01005	D01.01	Paths	>1	Low	Negative	Internal
Moveen to Bridge of Ross	01005	C01.01	Gravel extraction	6	High	Negative	Internal
Moveen to Bridge of Ross	01005	J02.11.01	Sea defences	1	Medium	Negative	Internal
Loop Head	01006	K01.01	Erosion	15	Low	Neutral	Internal
Dursey Island	02003	K01.01	Erosion	5	Low	Neutral	Internal
Bear Island	02006	J01.01	Burning	1	Low	Neutral	Internal
Preghane to Ballymacus Point	02023	K01.01	Erosion	5	Low	Neutral	Internal
Cloddagh North, Sherkin Island	02060	K01.01	Erosion	5	Low	Neutral	Internal
Hare Island West	02066	K01.01	Erosion	10	Low	Neutral	Internal
Stookanillar & Five Fingers	03004	A04.02.02	Sheep grazing	70	Low	Neutral	Internal
Stookanillar & Five Fingers	03004	A04.02.04	Goat grazing	70	Low	Neutral	Internal
Dunaff Head	03007	X	No impacts				
Saldanha Head to Yellow Rock	03012	J01.01	Burning	1	Low	Neutral	Internal
St John's Point	03030	K01.01	Erosion	5	Low	Neutral	Internal
St John's Point	03030	D01.01	Paths	1	Low	Neutral	Internal
St John's Point	03030	D03.01.01	Slipway	1	Low	Negative	Internal

Site name	Site code	Impact code	Impact	% of site affected	Intensity	Quality	Source
Ballintra, Aran Island	03058	E03.02	Dumping inert material	1	Low	Negative	Internal
Ballintra, Aran Island	03058	E03.01	Household dumping	1	Low	Negative	Internal
Ballintra, Aran Island	03058	K01.01	Erosion	5	Low	Neutral	Internal
Ballintra, Aran Island	03058	A04.01.02	Sheep grazing	10	Low	Neutral	Internal
Killiney	04004	I01	Invasive plant	30	Low	Negative	Internal
Killiney	04004	E04	Structures	25	High	Negative	Internal
Shankill	04005	K01.01	Erosion	60	Medium	Neutral	Internal
Shankill	04005	D01.01	Paths	2	Low	Negative	Internal
Shankill	04005	J02.11.01	Sea defences	50	Medium	Negative	Internal
Shankill	04005	M01.03	Sea level rise	100	Low	Negative	External
Tully	05001	M01.03	Sea level rise	100	Low	Negative	External
Tully	05001	I01	Invasive plants	28	High	Negative	Internal
Tully	05001	K01.01	Erosion	55	Medium	Neutral	Internal
Onaght, Inishmore	05006	K01.01	Erosion	15	Low	Neutral	Internal
Rusheen	05008	I01	Invasive plants	1	Low	Negative	Internal
Rusheen	05008	K01.01	Erosion	15	Low	Neutral	Internal
Rusheen	05008	D01.01	Paths	>1	Low	Negative	Internal
Rusheen	05008	M01.03	Sea level rise	100	Low	Negative	External
Kerry Head	06002	H01.05	Agricultural pollution	5	Medium	Negative	Internal
Kerry Head	06002	K01.01	Erosion	15	Medium	Neutral	Internal
Kerry Head	06002	D01.01	Paths	>1	Low	Negative	Internal
Kerry Head	06002	J02.11.01	Sea defences	>1	Low	Negative	Internal
Kerry Head	06002	M01.03	Sea level rise	>1	Low	Negative	External
Brandon to Ballydavid Head	06003	K01.01	Erosion	15	Low	Neutral	Internal
Brandon to Ballydavid Head	06003	A04.02.02	Sheep grazing	20	Medium	Negative	Internal
Brandon to Ballydavid Head	06003	D01.01	Paths	>1	Low	Negative	Internal
Brandon to Ballydavid Head	06003	I01	Invasive plants	1.2	Medium	Negative	Internal
Clogherhead to Slea	06005	H01.08	Sewage outflow	1	Low	Negative	Internal
Clogherhead to Slea	06005	E03.01	Household dumping	1	Low	Negative	Internal
Clogherhead to Slea	06005	K01.01	Erosion	5	Low	Neutral	Internal
Clogherhead to Slea	06005	A04.02.02	Sheep grazing	5	Low	Negative	Internal
Clogherhead to Slea	06005	D01.01	Paths	>1	Medium	Negative	Internal
Clogherhead to Slea	06005	D03.01.02	Piers	>1	Low	Negative	Internal
Great Blasket	06006	K01.01	Erosion	10	Low	Neutral	Internal

Site name	Site code	Impact code	Impact	% of site affected	Intensity	Quality	Source
Great Blasket	06006	A04.02.02	Sheep grazing	1	Low	Negative	Internal
Great Blasket	06006	D01.01	Paths	>1	Medium	Negative	Internal
Great Blasket	06006	D03.01.02	Piers	>1	Low	Negative	Internal
Bulls Head to Inch	06010	K01.01	Erosion	15	Low	Neutral	Internal
Bulls Head to Inch	06010	D01.01	Paths	>1	Medium	Negative	Internal
Bulls Head to Inch	06010	J02.11.01	Sea defences	2	Medium	Negative	Internal
Bulls Head to Inch	06010	D03.01.01	Slipway	1	Low	Negative	Internal
Bulls Head to Inch	06010	M01.03	Sea level rise	>1	Low	Negative	External
Clogher Head	07001	J01.01	Burning	10	Medium	Neutral	Internal
Clogher Head	07001	D01.01	Paths	>1	Medium	Negative	Internal
Moyne	08001	K01.01	Erosion	15	Medium	Neutral	Internal
Moyne	08001	M01.03	Sea level rise	100	Low	Negative	External
Kilcummin	08002	K01.01	Erosion	10	Medium	Neutral	Internal
Kilcummin	08002	D01.01	Paths	1	Medium	Negative	Internal
Ballincar	09004	K01.01	Erosion	10	Low	Neutral	Internal
Ballincar	09004	J02.11.01	Sea defences	2	Medium	Negative	Internal
Ballincar	09004	E04	Structure	>1	Low	Negative	Internal
Ballincar	09004	I01	Invasive plants	1	Medium	Negative	Internal
Ballincar	09004	M01.03	Sea level rise	100	Low	Negative	External
Ardmore	10002	K01.01	Erosion	2	Low	Neutral	Internal
Ardmore	10002	D01.01	Paths	1	Low	Negative	Internal
Arklow Head	11001	K01.01	Erosion	10	Low	Neutral	Internal
Arklow Head	11001	I01	Invasive plants	>1	Low	Negative	Internal
Arklow Head	11001	D01.01	Paths	5	Medium	Negative	Internal
Arklow Head	11001	J02.11.01	Sea defences	45	Medium	Negative	Internal
Arklow Head	11001	M01.03	Sea level rise	100	Low	Negative	External
Bray Head	11003	H01.05	Agricultural pollution	10	Low	Negative	Internal
Bray Head	11003	K01.01	Erosion	20	High	Neutral	Internal
Bray Head	11003	E06	Urbanisation	1	High	Negative	Internal
Bray Head	11003	J02.11.01	Sea defences	50	High	Negative	Internal
Bray Head	11003	E04	Structures	30	High	Negative	Internal
Bray Head	11003	D01.04	Railway lines	40	High	Negative	Internal
Bray Head	11003	M01.03	Sea level rise	40	Low	Negative	External
Gaunagh Gap	12003	E03	Agricultural dumping	>1	Low	Negative	Internal
Gaunagh Gap	12003	K01.01	Erosion	55	Medium	Neutral	Internal
Gaunagh Gap	12003	J02.11.01	Sea defences	6	High	Negative	Internal
Gaunagh Gap	12003	M01.03	Sea level rise	100	Low	Negative	External

Of the pressures recorded in Table 28, many were not considered to negatively affect the future prospects of the sites under consideration. Those pressures which were considered relevant are indicated in Table 29 below. Consideration was then given to the long-term viability of cliff habitat

at each site and the future prospects os the site were determined accordingly. The results of the future prospects assessment are also presented in Table 29. It can be seen here that 59% (19 of 32) were considered Favourable and 40% (13 of 32) were considered Unfavourable - Inadequate. No sites were considered Unfavourable - Bad.

Table 29: Overall results of the future prospects assessment.

Site name	Site code	Assessment	Reason(s)
Cliffs of Moher	01001	Favourable	
Rineen	01002	Favourable	
Moveen to Bridge of Ross	01005	Unfavourable - Inadequate	Quarrying, invasive plant
Loop Head	01006	Favourable	
Dursey Island	02003	Favourable	
Bear Island	02006	Favourable	
Preghane to Ballymacus	02023	Favourable	
Cloddagh North, Sherkin Island	02060	Favourable	
Hare Island West	02066	Favourable	
Stookanillar & Five Fingers	03004	Favourable	
Dunaff Head	03007	Favourable	
Saldanha Head to Yellow Rock	03012	Favourable	
St John's Point	03030	Favourable	
Ballintra, Aran Island	03058	Unfavourable - Inadequate	Dumping
Killiney	04004	Unfavourable - Inadequate	Invasive plants, continued maintenance of railway
Shankill	04005	Unfavourable - Inadequate	Sea defences, recreational pressures
Tully	05001	Unfavourable - Inadequate	Invasive plant
Onaght, Inishmore	05006	Favourable	
Rusheen	05008	Favourable	
Kerry Head	06002	Unfavourable - Inadequate	Sea defences
Brandon to Ballydavid Head	06003	Unfavourable - Inadequate	Invasive plant
Clogherhead to Slea	06005	Favourable	
Great Blasket	06006	Unfavourable - Inadequate	Invasive plant
Bulls Head to Inch	06010	Unfavourable - Inadequate	Sea defences
Clogher Head	07001	Favourable	
Moyne	08001	Favourable	
Kilcummin	08002	Favourable	
Ballincar	09004	Unfavourable - Inadequate	Sea defences, invasive plant
Ardmore	10002	Favourable	
Arklow Head	11001	Unfavourable - Inadequate	Sea defences, recreational pressures
Bray Head	11003	Unfavourable - Inadequate	Sea defences, recreational pressures, continued maintenance of railway
Gaunagh Gap	12003	Unfavourable - Inadequate	Sea defences

Plate 8. Impacts affecting sea cliffs. Left to right from top: Development activity occurring on the cliff top, a sea wall at the cliff base, agricultural waste, quarrying at the cliff top, erosion due to heavy grazing and an access point with rock armour.

Overall conservation assessment

The results of each of the factors assessed were brought together to give an overall assessment of the habitat *Vegetated sea cliffs of the Atlantic and Baltic coasts* (1230) at each site. These are presented in Table 30. These results can be extrapolated from to give an overall assessment of the habitat when reporting on the conservation status of Irish sea cliffs to the European Commission under section 17 of the Habitats Directive. As can be seen from the Table 30 the overall assessment for 16 sites was Favourable (50%), 12 sites (38%) were assessed as Unfavourable - Inadequate and four sites (13%) were assessed as Unfavourable - Bad.

Table 30: Overall conservation assessment of sites surveyed in 2010.

Site name	Site code	Conservation status
Cliffs of Moher	1001	Favourable
Rineen	1002	Favourable
Moveen to Bridge of Ross	1005	Unfavourable - Inadequate
Loop Head	1006	Favourable
Dursey Island	2003	Favourable
Bear Island	2006	Favourable
Preghane to Ballymacus Point	2023	Favourable
Cloddagh North, Sherkin Island	2060	Unfavourable - Inadequate
Hare Island West	2066	Favourable
Stookanillar & Five Fingers	3004	Favourable
Dunaff Head	3007	Favourable
Saldanha Head to Yellow Rock	3012	Favourable
St John's Point	3030	Favourable
Ballintra, Aran Island	3058	Unfavourable - Inadequate
Killiney	4004	Unfavourable - Bad
Shankill	4005	Unfavourable - Bad
Tully	5001	Unfavourable - Inadequate
Onaght, Inishmore	5006	Favourable
Rusheen	5008	Unfavourable - Inadequate
Kerry Head	6002	Unfavourable - Inadequate
Brandon to Ballydavid Head	6003	Unfavourable - Inadequate
Clogher Head to Slea Head	6005	Unfavourable - Inadequate
Great Blasket	6006	Unfavourable - Inadequate
Bulls Head to Inch	6010	Unfavourable - Inadequate
Clogher Head	7001	Favourable
Moyne	8001	Favourable
Kilcummin	8002	Favourable
Ballincar	9004	Unfavourable - Inadequate
Ardmore	10002	Favourable
Arklow Head	11001	Unfavourable - Bad
Bray Head	11003	Unfavourable - Bad
Gaunagh Gap	12003	Unfavourable - inadequate

Vegetation analysis

Using expert judgement, the dendrogram derived from the cluster analysis was cut at the point where seven vegetation groups remained. The decision on where to cut the dendrogram was made taking into consideration ecological integrity and approximately comparable levels of resolution. Table 31 shows the number of relevés found in each vegetation type, and the zones in which they occurred. The vegetation groups identified are presented individually on the following pages. Tables 30-37 give the ten most frequently occurring species for each group, and the frequency and abundance of each of these species. Frequency refers to the percentage of relevés in which that species occurs, irrespective of how much is present, and is indicated by Roman numerals, where I = 0.1 – 20.0%, II = 20.1 – 40.0%, III = 40.1 – 60.0%, IV = 60.1 – 80.0% and V = 80.1 – 100%. Abundance refers to the mean cover that species provides within the samples, irrespective of frequency, and is in percent. Indicator species which were found to be significant are denoted with asterisks. The value of the species as an indicator is shown by the number of asterisks, so that * = 10 – 20.0%, * * = 20.1 – 40.0%, * * * = 40.1 – 60.0%, * * * * = 60.1 –80.0% and * * * * * = 80.1 – 100%. The NVC communities and the phytosociological groups which are most closely aligned to the groups identified in this project are described with reference to Rodwell (2000) and White & Doyle (1982) respectively.

Table 31: The main vegetation groups, the number of relevés in each and the zones in which they were recorded.

Vegetation Group	Bracken	Crevice & ledge	Grazed grassland	Heath	Pioneer	Quarry spoil	Scree	Scrub	Slump	Soft cliff grassland	Splash zone	Ungrazed grassland	Total
A	-	12	-	-	-	-	-	-	-	-	25	-	37
B	-	10	-	-	-	-	-	-	-	1	1	1	13
C	-	8	-	-	-	-	-	-	-	-	4	-	12
D	-	7	1	-	4	-	-	-	1	-	-	5	18
E	-	9	1	3	-	-	-	3	-	2	-	15	33
F	-	-	-	3	-	-	-	-	-	-	-	-	3
G	1	4	3	2	7	1	2	2	1	2	3	1	29

Group A. Verrucaria spp. splash zone community

This vegetation group is characterised by a high cover of salt-tolerant *Verrucaria* spp. (Dobson 2000) with very little vascular plant cover. The group comprises 37 relevés, most of which are located in the splash zone, along with some in the crevice and ledge zone (see Table 32 and Plate 9). No cliff community in the NVC is defined primarily by lichen species, and it is difficult to correlate this group with any of the communities described in that classification, as the vascular plant cover is very low. It occurs lower down the shore than the most similar identified phytosociological association, the Crithmo-Armerietalia maritimae (White & Doyle 1982).

Table 32: Most frequent species found in vegetation group A, showing frequency, abundance and significance of indicator species.

Species	Frequency	Abundance	Indicator
Verrucaria spp.	V	45.0	* * * * *
Armeria maritima	III	1.8	
Caloplaca spp.	I	1.1	
Festuca rubra/ovina	I	0.3	
Cochlearia maritima	I	0.3	
Plantago maritima	I	0.3	
Ramalina spp.	I	0.3	
Plantago coronopus	I	0.2	
Asplenium marinum	I	0.2	
Molinia caerulea	I	0.2	

Plate 9: Example of *Verrucaria* spp. splash community with *Verrucaria* spp. at Onaght, Inishmore, Co. Galway.

Group B. Ramalina spp. - Crithmum maritimum crevice and ledge community

This group is composed of 13 relevés which were primarily located in the crevice and ledge zone, as well as one in each of the splash zone, soft cliff grassland and ungrazed grassland zones. The cover of vascular plants is frequently very low, and lichens are an important component of the vegetation here. The vegetation group describes a community that is located above the high water mark but tolerant of salt spray. Plants found most frequently in this group (see Table 33 and Plate 10) which display tolerance to saline conditions include the vascular plants *Festuca rubra/ovina*, *Crithmum maritimum*, *Silene uniflora* and *Plantago coronopus* (Hill *et al.* 1999) and the lichens *Verrucaria* spp., *Caloplaca* spp. and to a lesser extent *Ramalina* spp. (Dobson 2000). This group corresponds to the MC1 *Crithmum maritimum-Spergularia rupicola* maritime rock-crevice community found in the NVC, and with the Crithmo-Spergularietum rupicolae association in the class Crithmo-Armerietalia maritimae (Malloch 1971).

Table 33: Most frequent species found in vegetation group B, showing frequency, abundance and significance of indicator species.

Species	Frequency	Abundance	Indicator
Festuca rubra/ovina	IV	3.8	
Armeria maritima	IV	3.0	
Ramalina spp.	III	6.3	* * *
Crithmum maritimum	II	4.6	* *
Plantago lanceolata	II	1.5	
Hypochaeris radicata	II	0.8	
Caloplaca spp.	II	5.3	* *
Verrucaria spp.	II	1.0	
Silene uniflora	II	0.7	
Plantago coronopus	II	0.5	

Plate 10: *Ramalina* spp. - *Crithmum maritimum* crevice and ledge vegetation with *Crithmum maritimum*, *Festuca rubra/ovina* and *Armeria maritima*, Ardmore, Co. Waterford.

Group C. Verrucaria spp. - Armeria maritima

This is a poorly defined group with low indicator scores and no significant indicator species (Table 34). Of the 12 relevés in this group, eight are located in the crevice and ledge zone and four are located in the splash zone. It is marked by very low cover of any species, including lichens. The most frequent species are similar to those occurring in groups A (the *Verrucaria* spp. splash community) and B (the *Ramalina* spp.-*Crithmum maritimum* crevice and ledge community), and this group is likely to represent a more sparsely vegetated version of those communities. The species cover is too low to compare it to another classification with any certainty.

Table 34: Most frequent species found in vegetation group C, showing frequency, abundance and significance of indicator species.

Species	Frequency	Abundance	Indicator
Verrucaria spp.	V	6.8	
Armeria maritima	III	1.1	
Festuca rubra/ovina	II	0.6	
Plantago coronopus	II	0.3	
Asplenium marinum	II	0.2	
Ramalina spp.	I	0.9	
Cochlearia maritima	I	0.7	
Plantago maritima	I	0.5	
Spergularia rupicola	I	0.3	
Lotus corniculatus	I	0.3	

Group D. Armeria maritima - Plantago maritima maritime grassland

This is the least open in structure of the vegetation groups described so far, but some bare soil or rock is generally clearly visible. The group includes 18 relevés, of which five are located in the ungrazed grassland zone on hard cliffs, seven in the crevice and ledge zone, four in the pioneer zone of soft cliffs and one in grazed grassland on hard cliffs. The vegetation group represents a community with some maritime influence, but less than that of the previous groups. Several of the species frequent here (Table 35 and Plate 11) display tolerance to salt spray (*Festuca rubra/ovina*, *Armeria maritima*, *Plantago maritima*, *Plantago coronopus*), although two frequent species, *Anthyllis vulneraria* and *Hypochaeris radicata*, do not. The group shares many features with the MC8 *Festuca rubra-Armeria maritima* maritime grassland community described in the NVC, but differs in its more open sward. This characteristic, along with the abundance of *Armeria maritima*, suggests that the MC8 *Armeria maritima*-dominated sub-community is similar to this group. It may represent a transitional type between the Crithmo-Armerietalia maritimae class (White & Doyle 1982), and the Silenion maritimae class (Malloch 1971).

Table 35: Most frequent species found in vegetation group D, showing frequency, abundance and significance of indicator species..

Species	Frequency	Abundance	Indicator
Festuca rubra/ovina	V	9.3	
Armeria maritima	IV	18.1	* * *
Plantago maritima	IV	6.6	* * *
Anthyllis vulneraria	III	2.6	* *
Hypochaeris radicata	III	1.6	
Plantago coronopus	III	0.8	
Holcus lanatus	I	1.1	
Plantago lanceolata	I	0.8	
Thymus polytrichus	I	0.6	
Tripleurospermum maritimum	I	0.5	

Plate 11: *Armeria maritima - Plantago maritima* maritime grassland vegetation in the lower centre of photograph, Blaskets, Co. Kerry

Group E. Festuca rubra/ovina - Agrostis stolonifera maritime grassland

This group is characterised by high cover of grass species and frequently a relatively tall, closed sward. Fifteen of the relevés in the group were located in ungrazed grassland on hard cliffs, nine in the crevice and ledge zone, three in each of the scrub and heath zones, two in soft cliff grassland and one relevé in grazed grassland. There are 33 relevés in the group in total. Frequent species (Table 36 and Plate 12) include *Festuca rubra/ovina*, *Armeria maritima* and *Silene uniflora*, which are tolerant of some salt input, along with other species which are not considered to be particularly associated with saline conditions (Hill *et al.* 1999). Again, this vegetation group most closely resembles the MC8 *Festuca rubra-Armeria maritima* maritime grassland group within the NVC, but fits most closely with the MC8 *Anthyllis vulneraria* sub-community. This is situated in very well-drained locations and is associated with less maritime conditions that the *Armeria maritima*-dominated sub-communities. Group E corresponds to the Festuco-Armerietum rupestris association described by Malloch (1971).

Table 36: Most frequent species found in vegetation group E, showing frequency, abundance and significance of indicator species.

Species	Frequency	Abundance	Indicator
Festuca rubra/ovina	V	41.8	* * * *
Armeria maritima	III	3.7	
Hypochaeris radicata	III	0.9	
Agrostis stolonifera	II	5.3	* *
Holcus lanatus	II	4.3	
Anthyllis vulneraria	II	1.8	
Silene uniflora	II	2.9	
Hedera helix	II	7.4	
Lotus corniculatus	II	0.6	
Plantago lanceolata	I	0.9	

Plate 12: *Festuca rubra/ovina- Agrostis stolonifera* maritime grassland, closed grassland community from the Blaskets, Co Kerry.

Group F. Calluna vulgaris - Hypochaeris radicata open heath

There are only three relevés in this vegetation group, and all of them were recorded in the heath zone. *Calluna vulgaris* and *Hypochaeris radicata* are constant species, and *C. vulgaris* is very abundant in the group (Table 37). The vegetation cover is variable, and can be quite open with plentiful bare rock (see Plate 13).

This *Calluna vulgaris*-dominated vegetation group is related to the Calluna-Ulicetea phytosociological group presented as tentative by White & Doyle (1982), and the Calluna-Scilletum vernae phytosociological association described by Malloch (1971). It is not, however, a good match for either group. The most similar groups identified in the NVC are H7 *Calluna vulgaris – Scilla verna* heath, H8 *Calluna vulgaris – Ulex gallii* heath and H10 *Calluna vulgaris – Erica cinerea* heath.

Table 37: Most frequent species found in vegetation group F, showing frequency, abundance and significance of indicator species.

Species	Frequency	Abundance	Indicator
Calluna vulgaris	V	67.0	* * * * *
Hypochaeris radicata	IV	1.2	
Lonicera periclymenum	III	1.0	**
Anthoxanthum odoratum	III	1.0	

Plate 13: *Calluna vulgaris - Hypochaeris radicata* open heath, Ballintra, Aran Island, Co. Donegal

Group G. Non-maritime residual group

This is a very poorly defined group (Table 38). It is composed of 29 relevés which occur in every zone type sampled during the field survey. No significant indicator species for the group was identified during analysis. Because of the lack of definition within the group, a comparison to vegetation types in other classifications would be misleading. The most frequent species in the group do not have a strong association with maritime conditions.

Table 38: Most frequent species found in vegetation group G, showing frequency, abundance and significance of indicator species.

Species	Frequency	Abundance	Indicator
Festuca rubra/ovina	IV	4.5	
Agrostis stolonifera	II	1.7	
Hypochaeris radicata	II	0.8	
Anthoxanthum odoratum	II	5.6	
Arrhenatherum elatius	II	0.7	
Pteridium aquilinum	I	4.8	
Erica cinerea	I	3.6	
Potentilla erecta	I	1.2	
Holcus lanatus	I	1.1	
Jasione montana	I	0.3	

Plate 14: Vascular plants which occur on sea cliffs. Left to right from top: *Plantago maritima, Armeria maritima, Crithmum maritimum, Tripleurospermum maritimum, Silene uniflora* and *Anthyllis vulneraria* with pink flowers.

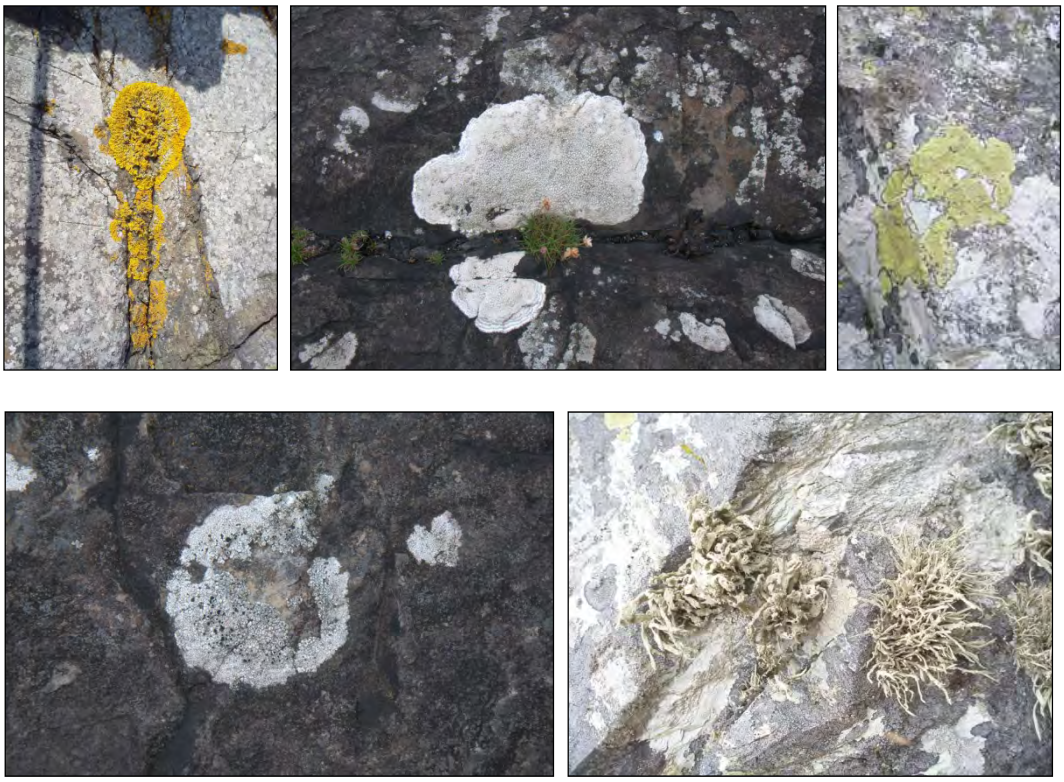

Plate 15: Lichens which occur on sea cliffs. Left to right from top: *Xanthoria parietina, Ochrolechia parella, Rhizocarpon geographicum, Tephromela atra* and *Ramalina* sp.

Discussion

Desk study

A larger number of sites (196 sites) were reviewed during the desk survey than the 123 initially planned on the basis of information from the pilot project (MERC/EirEco, 2009). This is due to some large sites identified by Browne (2005) being divided into several smaller sites following application of the methodology adopted for this study. The 20 sites which were reviewed in 2009 were included in the database and GIS shapefiles developed for this survey, with the information that was recorded for them in 2009. Because of differences in the desk study methodology between 2009 and 2010, the following information was not recorded for these sites: soil and substrate information, grid references, vegetation cover, non-cliff habitats adjacent to and within the cliff sites, coast type, wind and wave exposure, the cliff top habitat and type of boundary line at the cliff top and the number of the discovery map associated with the site.

The total length of cliff habitat included in the desk study (1,522.38 km) was less than the length of cliffs identified by Browne (2005) (1,634.41 km). A large part of the discrepancy is likely to be the result of using more refined techniques to establish where cliff habitat starts and ends, and allowing areas within the cliff site which are not composed of cliff habitat to be excluded from the desk study.

When considering the lengths given in this report, the results of the comparison made between the aerial photographs and the county boundary line dataset should be considered. There are many indentations on the coast which the county boundary line is simply not accurate enough to depict. As would be expected, in both instances the total length of the line digitised from the aerial photographs was longer. The two datasets for the south Wexford coast were relatively consistent, being within 8% of each other. The discrepancy between the datasets for the Dingle Peninsula was however 28%, reflecting the more indented structure of this section of coastline. There is therefore a considerable margin of error with an underestimate of the actual length of sea cliff habitat occurring. Indeed, for other parts of the coastline the margin of error may be even greater than 28%. It should be noted that, even with this margin of error, the county boundary line was still the best option available, as other datasets, including the 1:5000 vector maps, were unfit for purpose.

A total of 140 previously unidentified sites were identified during the desk study. This should be considered a preliminary figure, as the lack of oblique images, and sometimes aerial photographs, prevented investigation of parts of the Irish coast and off-shore islands. Cliffs which are less than ten metres in height were identified with the aid of the oblique images. It should be emphasised

that it is difficult to estimate the height and slope angle using the viewer images, and following field survey some of these sites may be found not to be high enough or steep enough to qualify as sea cliffs. However, an inclusive approach was taken when assessing the coastline, so sites were generally included if there was a doubt over the slope or height of a potential cliff. Soft cliffs were recorded with less frequency than hard cliffs. However, soft cliffs are often less than ten metres high and a disproportionate number of them may have been omitted from Browne (2005). When a full desk study of the newly identified cliffs has been completed, the proportion of soft to hard cliffs in Ireland is likely to be different from that recorded in this report. A further nine sites were omitted from the desk study due to a lack of oblique images. Until a desk study has been completed on these sites, it will be difficult to plan a field survey for them.

In general, sea cliffs are well represented in NPWS conservation sites. However, the vast majority of the habitat which is included in conservation sites is composed of hard cliff. Taking into account the fact that soft cliffs are less frequent than hard cliffs, only 40% of soft cliff habitat coincides with a cSAC, as compared with 55% of cliff habitat in general. Only 22% of the length of sea cliff habitat is listed as a qualifying interest in a cSAC as compared with 39% of the total sea cliff habitat. Soft cliffs are of value as a distinct variation of an Annex I habitat, and provide habitat for a range of fauna including sand martins and solitary bees.

It should be noted when considering the figures relating to the occurrence of cliff sites within cSACs that the addition of a 100m buffer has likely had an impact on the accuracy of the figures produced, and they should be taken as indicative figures only. Some cliff areas have still not been included despite the addition of the 100m boundary, especially where cliffs are very high. This issue stems from the habitat being represented by a line in GIS and the difficulties in overlapping this with existing datasets.

Field study

Summary data

Fifty natural or semi-natural habitats at cliff tops were recorded from the 62 swaths visited during this survey, compared to 17 non-natural habitats. All of the cliff base habitats were natural or semi-natural. Most of the swaths surveyed exist as part of a network of natural and semi-natural habitats, which adds to their value as a habitat.

The slope of hard cliffs and soft cliffs was generally found to be quite similar. This is not reflected in literature reviewed in preparation for the survey, which generally considers soft cliffs to be less steep (JNCC 2004, NPWS 2008). The slope of hard cliffs is affected by factors such as rock type,

rock structure and degree of exposure to wave action. In combination they can lead to a wide range of cliff slopes. The slope may be even, or broken up into several sheer faces separated by large ledges. It should, however, be noted that the slope of soft cliffs surveyed in 2010 may have been steeper than is usual as a result of the erosive effects of strong north-easterly winds over the preceding year. When measuring the slope of overhanging cliffs the Laser Rangefinder did not appear to give consistent readings to reflect this. This could, however, be due to a lack of familiarity with the full functionality of the meter by the survey team.

The distinction between hard and soft cliffs is not always clear. A layer of glacial till or some other unconsolidated parent material frequently overlies the bedrock of the cliff, and this can be several metres in depth. At section 14 of Loop Head (01006), the cliff face was composed of a nine-metre-thick layer of rock overlain by a ten-metre-deep layer of till. The vegetation associated with this type of soft substrate is different in structure and composition from that of cliffs which are soft at the base. The harder substrate located at the base of the cliff protects the softer material above it from much of the erosive power of the sea. The cliff as a whole is more stable, and large pioneer zones appear less frequently. As a result, the vegetation bears more resemblance to that of grass and herb-dominated parts of hard cliffs.

The occurrence of the same zone type more than once in a swath indicates a more complex cliff face structure, and is often associated with a structural change such as a change in slope or substrate. The two steepest and most frequent zones are crevice and ledge zone and splash zone. These are also the least vegetated zones and, according to the data analysis, contain the most maritime vegetation types. The pioneer zone has the most exposed bare ground as a result of slope instability, active erosion and soft substrate.

Nine bird species were observed to be nesting on cliff sections visited. This is likely to be an underestimate of the breeding birds which use the cliffs, as recording bird populations was not a primary focus of the study. The presence of two Annex I bird species, chough and peregrine, which are known to use cliffs as breeding sites, is positive. Other fauna recorded during the survey are likely to be taking advantage of the mosaic of natural habitats frequently found close to cliffs.

The priority Annex I habitat *Petrifying springs with tufa formation (Cratoneurion)* (7220) was the most frequently recorded feature of interest. These features are often point features on the cliff face but can also be more extensive. When lime-rich water seeps from between the rock strata and is exposed to the air, carbon dioxide is released from the water, which increases the pH and causes

the precipitation of tufa (NPWS 2008). The extent of the relationship between coastal cliffs and petrifying springs with tufa formation should be investigated, as it affects two Annex I habitats.

Reviewing the breakdown of NPWS designations covering the sites surveyed, it appears that a good proportion, 22 of 32, (68.8%) are at least partly covered by designation as a cSAC. Of these, 13 sites have the Annex I habitat *Vegetated sea cliffs of the Atlantic and Baltic Coasts* (1230) listed as a qualifying interest. Though this can be considered good coverage of the hard cliff sites, it is apparent that soft cliff sites are less well covered. During the 2010 field work there were seven soft cliff sites (Tully, Shankill, Rusheen, Moyne, Ballincar, Arklow Head and Gaunagh Gap), and three sites which had substantial soft cliff sections (Bulls Head to Inch, Bray Head and Kerry Head) visited. Of these, only Kerry Head and Bray Head occur within cSACs for which sea cliffs is a qualifying interest; both have extensive hard cliffs within the cSAC also. Rusheen and Ballincar are within cSACs which do not have *Vegetated sea cliffs of the Atlantic and Baltic Coasts* (1230) listed as a qualifying interest; the soft cliff section at Bulls Head is outside the designated area and the remaining sites are all undesignated. Gaunagh Gap, which is possibly the best example of soft cliff habitat surveyed to date, is undesignated. When the additional sites identified during this project, which are expected to include a significant number of soft cliffs, have been brought into the database, a clearer picture will be gained of the extent and location of soft sea cliffs and their designation under the cSAC network. However, it does appear that, although the Annex I habitat *Vegetated sea cliffs of the Atlantic and Baltic Coasts* (1230) is well represented within the cSAC network, soft cliffs are relatively under-represented.

As can be seen in Table 39 the number of sites in cSACs which received a favourable conservation assessment was almost equal to the number of sites in cSACs which received an unfavourable assessment. Though the numbers surveyed are quite small, particularly for sites outside of cSACs, 50% of sites coinciding with or outside cSACs were assessed as favourable. Only one site (5%) coinciding with a cSAC (11003 Bray Head) received the score Unfavourable - Bad while 3 sites (30%) of those outside of cSACs were assessed as Unfavourable - Bad. Given the small sample size, this may simply be a chance occurrence, or it may indicate that designation can have a positive effect on the conservation status of a site.

Table 39 A comparison of the conservation status of sites located within and outside of cSACs

	Favourable	Unfavourable - Inadequate	Unfavourable - Bad
Sites coinciding with cSACs	11 (50%)	10 (45%)	1 (5%)
Sites located outside of cSACs	5 (50%)	2 (20%)	3 (30%)

Conservation assessment

Of the 32 sites surveyed, 29 were assessed as having not declined in extent since 1994. Sea cliffs are often a landscape-scale feature and are defined more by geology and landform than by the species which they support. As such, they are generally perceived to be a relatively stable habitat and this is reflected in the data collected. Where loss in extent was recorded, this was through recent implementation of sea defences at two sites and quarrying at a third site. The quarrying at the Moveen to Bridge of Ross site (01005) was recorded from 13 separate locations. Sea defences had been positioned in two places within the Bulls Head to Inch site (06010). One of these was an area of soft cliff, while the other was a section of hard cliff where rock armour had been positioned to support a road located above the cliff. Recent sea defences were also recorded at Ballincar (09004), where it appeared rocks had been positioned to protect property located adjacent to a soft cliff.

Although 22 structure and function criteria were developed, the most important ones, and the ones which were applied in every instance, relate to the occurrence of sea defences, artificial structures, access points and invasive non-native species. The remaining criteria contribute to baseline data for each of the sites which can be utilised following forthcoming repeat visits. Sites which were assessed as Unfavourable - Bad were Tully, Co. Galway, (invasive non-native species), Shankill, Co. Dublin, (sea defences and access points), Killiney, Co. Dublin, (structures supporting railway and invasive plants), Arklow Head, Co. Wicklow, (sea defences) and Bray Head, Co. Wicklow (modification for the railway and access points). The cliffs at Killiney and Bray Head have experienced historical modification and disruption of their structure and function through the development of the railway along the east coast. At least some disruption is likely to continue here through continued maintenance of the railway. These sites are, however, unlikely to be representative of sites in general as it is only on the east coast that the railway occurs in such close proximity to sea cliff habitat. Extensive sea defences have been constructed at Shankill and Arklow Head, again some of this occurring in an historical context. These are relatively small sites which experience high levels of pressure through recreation. Due to the proximity of houses and a golf course at Shankill and caravan parks and recreational use by holiday-makers at Arklow Head, there is active management of the erosion occurring at these soft cliff sites. This is likely to be representative of other soft cliff sites around the country. *Gunnera tinctoria* is a serious issue at the soft cliff site of Tully, Co. Galway. This plant is found extensively in Mayo, Galway, and also Cork and Kerry, with records of it occurring on soft cliffs within Bantry Bay (www.botanicgardens,ie). As additional sites are surveyed, it will become evident how extensive the problem is and whether it occurs at hard cliff sites as well as on the soft cliff habitat where it has been recorded to date.

None of the sites were assessed as being Unfavourable - Bad for future prospects. A total of 13 of the sites were, however, assessed as Unfavourable - Inadequate. Reasons for these assessment results included quarrying, invasive plants, dumping, sea defences, recreational pressures and continued maintenance of the east coast railway. The issue of sea defences is primarily a concern for soft cliff sites. Rusheen, Co. Galway, is the only soft cliff site where no sea defences were evident. Sea defences were, however, also recorded as a pressure on the hard cliff sections of Bray Head, Co. Wicklow and Bulls Head to Inch, Co. Kerry, where infrastructure (railway and a road) was being protected. Invasive species are a concern on both soft and hard cliff sites. Recreational pressures are only considered to affect the future prospects of soft cliff sites, where footpaths and access points can cause damage to sites. Quarrying was recorded as a pressure for just one site, Moveen to Bridge of Ross, Co. Clare. This cliff is comprised of sediment (sand and gravel) overlaying a hard cliff base. Serious dumping of household waste was recorded as an issue at Ballintra, Aran Island, Co. Donegal. Though this may not impact the integrity of the cliff as a whole, it may be limiting the extent of habitat for rare species such as *Saxifraga rosacea* ssp. *hartii*.

Invasive species and dumping

Gunnera tinctoria is a serious invasive species on some sea cliff sites in Mayo and Galway (Plate 16). It has only been recorded from two sites: Tully (site 05001) was surveyed in 2010 and Doogorteast (site 08011) which is proposed for survey in phase 2. *G. tinctoria* was evident at these sites from viewing the oblique images. It should be noted that it is entirely possible for growth in some areas to have been missed and, as these images were taken seven years ago, plants may have spread to additional sites and the situation at the identified sites could be worse than is apparent on the oblique images. Removal of *G. tinctoria* would prove a significant challenge. As it occurs on soft cliff sites, digging into the slopes could destabilise the cliffs. Access for spraying and carrying a knapsack sprayer would also be difficult and may require ropes to access the cliff face from the top. A further challenge is that there is a perception among some local people that *G. tinctoria* is stabilising the cliffs, so any removal programme would need to include some public awareness.

Another invasive species recorded was *Hebe* sp. (Plate 17). This was recorded from three sites in the west, in Kerry and Clare. Review of Reynolds (2002) indicates that there are a number of species of *Hebe* which occur on sea cliffs. *Hebe elliptica* was recorded from Brandon Creek in 1985 (Reynolds 2002). *Hebe* sp. was noted from this site during the present survey, but no samples could be collected so it was not identified to species level. It does appear to have a preference for sheltered cliffs. Of some concern would be the record of *Hebe* sp. from Great Blasket. It was

relatively limited in extent here and management at this stage would be considerably easier than waiting until it has spread to other sections of the cliff.

Plate 16 *Gunnera tinctoria* occurring on the upper slopes at Tully, Co. Galway.

Plate 17: *Hebe* sp. at Brandon Creek, Brandon to Ballydavid Head, Kerry.

Senecio cineraria was recorded from one site: Killiney, Co. Dublin (site 04004). Reynolds (2002) notes that it has naturalised extensively in Killiney Bay for over a century. It is listed on the list of problematic terrestrial species compiled by the National Biodiversity Data Centre (NBDC)

(www.biodiversityireland.ie). Growth of this plant at additional locations would be a cause for concern.

Dumping of household and building waste was recorded at Ballintra, Aran Island, Co. Donegal (site 03058). Though not affecting the integrity of the cliff site, it may be impacting on niches for rare plants such as *Saxifraga rosacea* ssp. *hartii*, and it has wider conservation issues such as potential impacts on seabirds and sea mammals. Waste management on the island should be addressed to ensure that there are alternative and more acceptable disposal options.

Vegetation analysis

Of the 161 relevés recorded during the survey, 145 relevés were included in the analysis dataset. The degree of maritime influence varies greatly depending on substrate, altitude and degree of shelter on a cliff, and the vegetation is very varied as a result. The more common or distinctive vegetation types will be identified from a sample of this size. Rarer types may not be identified as a vegetation group if they were represented by only a few relevés. A larger sample size would generate a more complete picture of the communities associated with Irish sea cliffs.

Seven of the groups identified in the data analysis are well defined, with significant indicator species. Groups C (*Verrucaria* spp. - *Armeria maritima*) and G (Non-maritime residual group) are both poorly defined, but very different in character. Group C (*Verrucaria* spp. - *Armeria maritima*) is composed of relevés with a distinctly maritime character, but with very low cover of any lichen, bryophyte or vascular species. The species which do occur in these relevés are well represented in groups A (*Verrucaria* spp. splash zone community) and B (*Ramalina* spp. - *Crithmum maritimum* crevice and ledge community), where they are more abundant. Low cover of vascular plants may relate to the degree of exposure or the nature of the rock face on which they are growing. Vascular plants cannot become established where they are exposed to strong wave action on a frequent basis. They also require a physical niche in order to become established on cliffs. Rock faces with a massive structure, which were encountered during the survey, do not have the stratification or minor joints which provide those niches. In contrast, lichens are capable of growing on massive rock structures, and development of *Verrucaria* spp. is promoted by exposed conditions. The vegetation described by group C (*Verrucaria* spp. - *Armeria maritima*) is likely to relate to versions of vegetation groups A (*Verrucaria* spp. splash zone community) and B (*Ramalina* spp. - *Crithmum maritimum* crevice and ledge community) which are depauperate as a result of environmental conditions.

Group G (Non-maritime residual group) is a larger group, and the most frequent species do not have a distinct, unifying character. The single constant in the group is *Festuca rubra/ovina*. Festuca rubra is described as ubiquitous in Britain and Ireland by Preston (Preston *et al.* 2002). Group G contains relevés from every zone recorded in the survey, and the relevés are extremely varied. Relevés which are heathy (e.g. relevé 0200308a), scrubby (e.g. relevé 0500107a), and bracken-dominated (e.g. relevé 0600302a) are all included here. Increased sampling will bring clarity to the status of relevés in this group.

Lichens are an important element of the vegetation of sea cliffs, and were included in the analysis. Although five lichen genera were included as records to genus only, the inclusion of lichens in the dataset aided in the definition of the groups. Lichen species are important in the definition of different vegetation groups, as different species within each genus are associated with differing degrees of exposure to maritime influences. Recording lichens to species would be beneficial to the vegetation analysis. The lichen component was particularly important in groups A (*Verrucaria* spp. splash zone community) and B (*Ramalina* spp. - *Crithmum maritimum* crevice and ledge community).

The only significant indicator taxon for group A (*Verrucaria* spp. splash zone community) is the lichen genus *Verrucaria*. This vegetation group has not been described in any of the literature referenced in this report. Although some of the sources referred to lichens in their descriptions of vegetation, none of them used lichens in the data analysis, so it is probable that this lichen-dominated community was overlooked in other classifications.

Lichen genera also figure strongly in group B (*Ramalina* spp. - *Crithmum maritimum* crevice and ledge community), where both *Ramalina* spp. and *Caloplaca* spp. are significant indicators, and *Verrucaria* spp. are frequent. This group corresponds closely with the MC1 *Crithmum maritimum-Spergularia rupicola* maritime rock-crevice community of the NVC (Rodwell 2000) and with the Crithmo-Armerietalia maritimae phytosociological association (White & Doyle 1982). These communities have been recorded in Ireland previously, although group B (*Ramalina* spp. - *Crithmum maritimum* crevice and ledge community) resembles the *Armeria*-rich variant of the Crithmo-Spergularietum rupicolae, as opposed to the *Aster tripolium* sub-association previously recorded from the Burren (Malloch 1971).

Vegetation groups D (*Armeria maritima - Plantago maritima* maritime grassland) and E **(***Festuca rubra/ovina - Agrostis stolonifera* maritime grassland) both correspond to the MC8 *Festuca rubra-Armeria maritima* maritime grassland group within the NVC, but to differing sub-associations: the *Armeria maritima*-dominated sub-community (MC8) and the *Anthyllis vulneraria* sub-community

(MC8) respectively. Neither of these appears in the literature for Irish plant communities. The *Plantago coronopus* sub-community (MC9) has been described in Ireland, but was not isolated from the data recorded during this project.

Group F (*Calluna vulgaris - Hypochaeris radicata* open heath) is a coastal heath community. Only three relevés are located within this group, and with further sampling it will become clear if there is a particular cliff face variant of the habitat.

Some of the vegetation groups are reasonably faithful to one or two zones (e.g. group A *Verrucaria* spp. splash zone community), whereas others include relevés from several different zones. The vegetation zones are based on exposure to maritime influences, the location of the zone on the cliff face and the vegetation present. Zones provide a context for the vegetation group, but should not be taken as vegetation groups in themselves. Although the ungrazed grassland types described here are included in cliff top grassland categories in other classifications (Rodwell 2000, Malloch 1971), they are as likely to be found in the crevice and ledge zone on the cliff face as they are to be found in an ungrazed grassland zone or on the cliff top. Equally, it is to be expected that several vegetation groups may be present within a zone type, as the vegetation group will vary depending on geographic location and potentially with other factors such as rock type (Rodwell 2000).

Critical assessment of methods used

Limitations of the desk study

In every case, much of the information gathered was based on photographic imagery. The oblique images were taken in 2003, and the most up-to-date aerial photograph images available were released in 2005. It is likely that some details were missed due to the quality of the images, problems with which included partial coverage of cliff faces, the distance to the cliff and the angles from which they were taken. The oblique images are taken from a range of angles and distances and it was often difficult to determine if an area qualified as sea cliff. For instance, sections of horizontal littoral rock can look like a near vertical cliff when viewed obliquely. For higher sections of cliff, reference can be made to the contours to determine how close they are and how steep the ground is, but for sites less than 10 m in height this is not an option. With these resources, determining where cliffs are can therefore be quite subjective. Some attributes, such as the presence of flushes, are difficult to determine consistently, and there were no images available for some cliffs. Information was, however, recorded as fully and as consistently as possible within these constraints.

The sites surveyed during the desk study of the pilot phase of this project in 2009 (MERC/EirEco) were assessed under a different set of parameters. These data have been added to the database but there are some gaps in the dataset.

Limitations of the field survey

The main limitation of the field study was that the approach adopted did not allow for the full site to be viewed during fieldwork. It was shown in the results section that the full extent of only nine of the 32 sites visited were viewed during fieldwork. For one site, Kerry Head (site 06002), only 5% of the site was viewed in the field. Factors which limited the amount of the site which could be viewed included the amount of time available for the survey of each site, time involved in selecting a suitable and safe viewing point, the distance which could be walked carrying the equipment, access points, and the geography of the site. The length of the site was also a major factor, and all the sites which were viewed fully in the field were less than 3.3 km in length. Sections of soft cliff invariably had a beach at the base which allowed for easy access along the base of the cliff, although tide times were a consideration here. For many of the hard cliff sites, a view of additional sections of the cliff would entail walking across numerous different land parcels and negotiating land access would become a more onerous task. With only a limited view of many of the sites being assessed, it was necessary to rely on the helicopter viewer to extrapolate for the remainder of the site. As these images were taken in 2003, this must be considered a limitation of the approach. It is proposed to allow additional time for scouting the site prior to the collection of any swath data in future surveys. The ideal scenario would be for the whole site to be assessed in advance by either:

- walking the full length of the site,
- viewing the full site by boat, or
- viewing the site from as many access points as possible.

During this phase, a decision can be made on: the number of swaths necessary for accurately representing the variation on the cliff; the positioning of these swaths and the associated vantage points; the types of pressure impacting the cliff and the extent of these pressures; and assessing if any of the sites/sections can only be accurately surveyed by rope. There will be other considerations when deciding on the distribution of sites being surveyed in the future. For example, to make surveying sites by boat cost-effective, it may be necessary to group sites such that as many sites as possible are surveyed in one day. It should be noted that, for safety reasons, overhanging sections of cliff cannot be surveyed by rope.

The survey approach requires a vantage point to be established opposite, or as near opposite as is possible, the swath being surveyed. There was, therefore, a bias toward sections of cliff which were sheltered, as vantage points were often established across inlets and small bays, and sections of exposed, unindented coast were not easily surveyed. However, this was not generally a factor for soft cliffs when access to the base of the cliff at low tide allowed for a perpendicular view of the cliff. Only an oblique view of the swath could be achieved for many of the sites and this affected the reliability of the relevé photograph. With an oblique view, it is more difficult to assess what species are in the relevé as the likelihood of some species being obscured from view is increased. As an accurate area for obliquely photographed relevés cannot be calculated, relative species abundance cannot be accurately investigated.

There will be instances when it is not possible to use the swath methodology simply because it is not possible to establish swaths with a suitable viewing point. Site safety is, obviously, the main consideration here but distance is also a factor, as data collected (including photographic relevés) from a vantage point of greater than 250 m are limited in their reliability.

Surveying sites by rope is more expensive due to the number of people involved, and more time-consuming. Setting up the rope access points took 1.5 - 2 hours and this can increase if there is no vehicular access to the top of the cliff. Access by rope increases the accuracy and reliability of the relevé data and adds species to the swath species data, which can feed into the structure and function assessment. However, other aspects of the survey (cliff profiling, assessment of extent and assessment of pressures and threats) are not improved through rope access of a site. In addition the swath species list cannot be compiled fully while on ropes as access (and time) is limited on the cliff face. Of the five sites surveyed by rope, Clogherhead (site 07001) and Stookanillar and Five Fingers (03004) could have been adequately surveyed without the use of ropes as there were footpaths across the sites which would have allowed sufficient access to most areas. Additionally, one of the swaths surveyed at the Cliffs of Moher (01001) could have been surveyed adequately using remote techniques as there was a suitable vantage point. As it was a requirement to compare the results from the rope survey with results from the same locations taken remotely, the sites selected for rope survey during 2010 were limited to those which had a suitable vantage point. Future sites to be surveyed by rope could be selected on the basis of there being no alternative method possible other than a rope survey.

Recording the profile of the cliff requires some level of interpretation in the field. It is necessary to imagine a line running from the outer swath marker down (or up) the cliff face. This is extrapolated differently by different people and introduces some subjectivity when profiling the cliff and recording cover for species within the swath. Similarly, where one vegetation zone stops

and another begins is open to interpretation. Therefore, when repeat assessments are made, the cliff profiling data will need to be interpreted with some caution. Only where gross changes are apparent could these be interpreted with any degree of accuracy as being significant.

The amount of equipment involved, which weighs in the region of 36 kg, limits the locations which could be accessed for survey. Generally it was not possible for two people to carry the equipment further than 1.5 km within a reasonable amount of time.

Surveys of the islands were often limited by infrequent ferry times and the additional problems of having to arrange transport on the island, or there being no transport options other than walking. Camping on the islands was not considered practical due to the amount of additional equipment which would be required.

It was intended to record relevés on the cliff top away from the cliff face but there was insufficient time to complete this. Time should be allowed for the collection of data from this zone as otherwise it will be unrepresented in the sea cliff survey and under-represented in the Irish survey of semi-natural grasslands There have been, however, approximately 70 relevés collected from cliff top habitats to date during the on-going Irish Semi-natural Grasslands Survey (Martin *et al.* 2008, O'Neill *et al.* 2010) and there may be some benefit to the analysis of these data along with the relevés from the sea cliff survey.

As each of the sites surveyed during 2010 had been assessed as part of the desk study carried out by MERC/EirEco (2009) and all the parameters included in the current database had not been recorded, it was not possible to make a full comparison between the desk study information and the field study data. For instance, MERC/EirEco did not record threats or pressures for sites so it was not possible to make an assessment of how accurate the desk study was in identifying these occurrences.

An assessment was made of the relative shelter of the section during the desk study but information on the relative shelter of the swath was not collected during the field survey. This may be an additional environmental variable to consider when analysing and interpreting the relevé data. This could be done on a simple three-point scale of sheltered, partially sheltered and exposed, as was used during the desk study. Environmental variables were not assessed as part of the vegetation analysis. Variables such as location on the cliff face, degree of shelter/exposure and ecological preferences of species (Ellenberg indices) (Hill *et al.* 1999) could be included in future analyses. The value of including these factors is increased when larger datasets are available.

When recording species cover for the swath and the remote relevés, it was not always possible to identify all species. In future surveys, a cover score of unidentified species should be recorded as

this will give an indication of any missing data and a decision can be made at the vegetation analysis stage as to whether or not a particular relevé should be included. Where possible, lichen samples should be taken with their substrate for identification at a later stage.

Comparison of results from field survey and remote survey

On average, about half as many species (54%) were recorded in remote relevés than were recorded in relevés surveyed by a botanist using rope techniques to access the relevés. In a comparison using data recorded during the pilot survey (MERC/EirEco 2009), an average of four species were recorded from the remote relevés and seven from the relevés recorded using the rope techniques. This total of 57% is comparable to the findings of the current survey. The average total relevé vegetation cover is approximately equal for rope and remotely surveyed relevés. This indicates that the more abundant species are being over-estimated in remote surveys at the expense of less abundant species.

The results indicated that some frequently occurring species (*Armeria maritima, Anthyllis vulneraria, Festuca rubra/ovina* and *Silene uniflora*) were recorded with an accuracy of greater than 80%. Of these it may only be possible to determine *S. uniflora* consistently with remote methods during the flowering period of the plant. The remaining plants are considered to be more straightforward to identify remotely throughout the survey season. Of the frequently occurring species, *Plantago* spp. and *Thymus polytrichus* were the most difficult to score remotely. This may to be due to the fact that these species lack an obvious colourful flower and/or are low growing. The fact that these species often occur in more vegetated habitats such as grassland may also be a factor. It was generally found that, in more open, less vegetated habitats, it was easier to score species more accurately using the remote method. More species were overlooked in species-rich, densely vegetated communities. Grass-dominated swards are less accurately scored using remote methods due to the high cover of vegetation and the difficulties in identifying grasses remotely. Though not recorded as frequently occurring species during the comparison of results from field survey and remote survey, it can be generally considered that *Calluna vulgaris*, *Crithmum maritimum* and *Verrucaria* spp. would also be accurately recorded. This suggests that certain vegetation types such as ungrazed grassland are likely to be recorded less accurately than others.

It was found that species were overlooked in remotely recorded relevés when their cover was low. In each instance when a vascular species in the field scored Domin 7 or over, it was always also scored remotely with a score of 7 or over. As a general rule, when the cover of a species recorded in the field was lower, the chances of the species being scored accurately using the remote methods decreased.

Of the indicator species for the vegetation groups identified following the vegetation analysis for this project, the majority can be readily recognised using remote methods (*Festuca rubra/ovina, Verrucaria* spp., *Armeria maritima, Crithmum maritimum, Calluna vulgaris* and *Anthyllis vulneraria*). There are, however, some which can be difficult to identify, particularly when the photograph quality is poor (*Ramalina* spp., *Caloplaca* spp., *Agrostis stolonifera* and *Plantago maritima*). It should be stated that three botanists were involved in identifying the species in the relevé photographs for this comparison, only one of whom had recent experience of surveying cliff habitat. It was felt by those involved in this comparison that species identification accuracy would be improved through greater familiarity with the habitat. It should be emphasised that all remote relevés used in the vegetation analysis were completed by the botanist who had completed the majority of the rope survey work for this project and had visited all of the sites surveyed in 2010. This familiarity with the habitat will improve the accuracy above those presented in the results section and the comparison results should be considered the worst-case scenario utilised to test the methodology.

In order to maximise the usefulness of remotely recorded relevés, the ecologist who surveyed the cliff in the field should carry out the analysis of the relevé photographs. He or she should be familiar with cliff habitats and species. A comprehensive swath species list should be made in the field using a high-quality scope. Where possible, lichens should be sampled in the field, as in general it is not possible to identify them to species from photographs.

Usefulness of the criteria and targets used for assessing conservation status

It was necessary to develop conservation criteria which could be applied consistently from a remote vantage point and which were applicable in a sea cliff context. Relevant literature was reviewed as stated in the methodology section of this report but a number of parameters were modified or dropped from the criteria. For example, the parameter for cover of bare ground within coastal heath (Perrin *et al.* 2010) was dropped, as the bare ground was consistently thought to be due to instability and erosion, rather than as a direct result of over-grazing by sheep. Emphasis was placed on the maritime therophyte community within the JNCC guidelines (JNCC 2004) but this was considered a part of the crevice and ledge community, and the parameters for this zone were removed from the assessment.

Ungrazed maritime grassland was originally assessed for cover of *Festuca rubra*, with a target of >90% cover of this species. This target was seldom reached due to the natural variation within the grassland communities. This target as described in JNCC (2004) is likely to be a measure to encourage nesting by burrowing seabirds. This parameter was dropped.

Grazed grassland was only recorded from five swaths during 2010 and the parameters set in JNCC (2004) may be more appropriate to the cliff top rather than the cliff face. However, parameters for this habitat type are retained and, as additional data are gathered, an assessment can be made of the appropriateness of these. Similarly, soft cliff flush communities are under-represented in the survey and efforts should be made in subsequent surveys to assess the appropriateness of these parameters.

As only four of the structure and function parameters automatically go forward for consideration in the conservation assessment of the swath/site, the remaining parameters are effectively applied on a site-by-site basis when it is considered appropriate to do so. As additional data are acquired for particular sites through re-assessment, the suitability of these criteria can be fully considered.

Some effort has been made in the survey approach to distinguish between grasslands on soft cliff and hard cliff. The distinction is clearly evident most of the time, but there are instances when a swath is comprised of both hard rock and soft sediment and the distinction is less clear. This scenario is generally soft sediment overlying rock, though examples were noted in the field of sediment and hard rock occurring as vertical bands; these were not surveyed in detail. Generally the vegetation of grassland occurring on soft sediment overlaying rock appeared to have more in common with grassland of hard cliffs, possibly through the stability afforded to the grassland. As more relevés are collected, the nature of and reasons for this relationship should become clearer.

Recommendations for future survey work

Desk survey

A future desk-based study should be conducted to include in the database the 140 additional, undocumented sea cliff sites identified during this project. It must however be emphasised that these additional sites may not represent the full resource of sea cliffs in Ireland, and a complete, detailed assessment of the whole coast should be carried out. Assessment should also be completed for the off-shore islands which are not covered by the oblique images. These could be assessed using available GIS resources (aerial photographs and OSI Discovery Series maps) with a proportion of them being viewed during field work. As many occur in bays, some could be viewed using a telescope from a nearby headland, or viewing a selection of island sites could be incorporated into a survey by boat.

These additional, undocumented sites should be incorporated into the current database using the parameters described in this report. In addition, the 20 sites assessed during the pilot survey (MERC/EirEco, 2009) were not assessed as described in this report and there are some gaps in the

database. These sites should be reassessed and fully incorporated into the database. If new oblique images of the Irish coast are due to be shot in the short term, a full desk study of the nine island sites which have been omitted from the desk study should be undertaken. If no such photos are due to be taken, then a partial desk study should be completed to facilitate survey of those sites.

The priority Annex I habitat *Petrifying springs with tufa formation (Cratoneurion)* (7220) was recorded as a feature of interest at a number of sites. If further review of the national resource of this habitat were being completed, it is possible that additional sites could be identified through review of the oblique images.

Field survey

The following modifications should be incorporated into further monitoring of sea cliffs:

- A view of as much of the site as possible, either by boat by walking the full site, should be obtained prior to selecting locations for detailed survey. It would be more cost-effective to survey larger sites by boat and to select for survey a number of sites within a certain area during the same day using this approach. Time should be allowed within the survey for this important aspect of survey.
- When viewing sites by boat, nearby island cliff sites not covered by the oblique images should be viewed to provide data about these sites.
- Vantage points for remote survey should only be established when a view of less than 30° from directly opposite can be obtained. Where such a view cannot be obtained, these sites should be recommended for survey by rope. It should be noted that a vantage point will still be necessary in order to record cliff profiling and other swath data.
- Only select for survey by rope those sites which have been assessed in the field and where other options for survey have been considered inappropriate. This will maximise the usefulness of this approach.
- Sites which are inaccessible (i.e. those greater than 1.5 km walk from the nearest road) could be accessed with the aid of an extra person for carrying equipment. In such instances, bringing an additional tripod, laser rangefinder and PDA would also make collection of field data more efficient upon arrival at the swath.
- Additional time should be allowed to record a relevé at the top of cliffs which have a substantial area of semi-natural habitat (at least 20 m). This will generally not be practical for sites being viewed from the base.

- The relative shelter of the vegetation occurring within the swath, in relation to wind and waves, should be recorded on a three-point scale: sheltered, partially sheltered and exposed. This should be a single entry reflecting the situation for the whole swath.
- Relevé data collected from remote photographs should be compiled by one person with knowledge of sea cliff habitats. This will minimise errors in species identification.
- If there are unidentified species within the zone or within remotely recorded relevés a cover score for the unidentified species should be recorded.
- When a site is overhanging this should be recorded during the field survey. It should however be noted that this is not always apparent when viewing sites remotely.
- Where it is possible to access cliffs directly, samples of lichens and their substrate should be taken. The use of a small hammer and chisel will be necessary to take rock and crustose lichen samples.
- For rope surveys, the use of chalk to mark the relevé should be considered for marking relevés on crevice and ledge habitat as it was generally impractical to attach standard relevés made of rope and tent pegs. A 5 m retractable tape would also be required for measuring the distance.
- Include ecological preferences of species (Ellenberg indices) (Hill *et al.* 1999) in future analyses including the relative shelter of each swath based on a three point scale.

A future national monitoring programme and survey plan for Irish sea cliffs

The next phase of a national monitoring programme for Irish sea cliffs should incorporate a number of factors. Ideally the full range of variation which occurs within the habitat type, such as geology, height, exposure and vegetation cover, should be covered. Unlike other habitats such as woodland or grassland, there is not the perception with sea cliffs that larger (or in the instance of sea cliffs, longer and/or higher) sites are of more intrinsic value than smaller ones. Therefore, emphasis is put toward incorporating the range of variation which sea cliffs have. The monitoring programme should be widely distributed across the country. Though over half of the total lengths of all cliffs identified occur in counties Cork, Donegal and Kerry, it is not proposed that half the survey effort be spent in these counties. Counties Wicklow, Dublin, Louth and Clare appear to have been well represented in the present survey, while counties Mayo, Galway, Waterford and the south coast of Cork are, arguably, under-represented. Though soft cliffs are proportionately less common, they are generally found to be more susceptible to impacts. Additional survey effort

being given toward this habitat would assist in understanding the variation within this habitat type and the communities which they support.

Due to the cost of the equipment required for the project, the number of survey teams which can work on the project is limited to one. There are 21 weeks from May to September and, allowing an average of four survey days per week, this equates to 84 survey days being available. Assuming each site takes an average of 2.65 days to survey, 32 sites can be completed in a survey season. Based on this assumption, a list of the approximate number of sites to be surveyed for each county was developed (see Table 40). This is based on the number of cliffs within each county as a percentage of the overall number of sites in the country and on the assumption that 64 sites can be surveyed in two survey seasons . The number of sites surveyed for each county during 2010 is taken from this total, giving the indicative number of sites to be surveyed for each county during phase two. There were, however, a number of other factors to be incorporated into the selection of sites to be surveyed.

The methodology for surveying sea cliffs requires some subjective decisions to be made and requires the surveyor to be trained in using complex equipment. It is recommended that a single team survey all of the sites in any one season in order to ensure that the data are recorded consistently, the equipment is used correctly and the training time is kept to a minimum. If the decision is made to increase the size of the survey team, a technical handbook which explains the most efficient approach and gives clear and detailed instructions for using the equipment should be produced.

Table 40: Indicative breakdown of sites to be surveyed in each county.

County	**No. sites**	**No. sites as %**	**Total no. sites to be surveyed in phases 1 & 2**	**Number of sites completed 2010 (phase 1)**	**Indicative no. of sites to be completed in phase 2**
Clare	7	3.6	2	4	0
Cork	66	34.0	22	5	16
Donegal	49	25.3	16	5	11
Dublin	2	1.0	1	2	0
Galway	9	4.6	3	3	0
Kerry	23	11.9	8	5	3
Louth	1	0.5	>1	1	0
Mayo	16	8.2	5	2	3
Sligo	6	3.1	2	1	0
Waterford	7	3.6	2	1	1
Wicklow	3	1.5	1	2	0
Wexford	5	2.6	2	1	1
Total	**194**	**100**	**64**	**32**	**34**

It is not considered appropriate to indicate further sites which should be surveyed in subsequent years at this time, as the priorities are likely to change when the additional sites identified during this survey have been incorporated into the database. The list presented in Table 41 can be considered provisional, with additional sites being added if pertinent information about the site is known.

It is recommended that sites surveyed during 2010 be re-surveyed after six years using the techniques described in this report (including cliff profiling). From this assessment it will become apparent if the approach has identified any changes in the structure of the survey sites. If no changes, or only minor differences, are being identified it may be considered more appropriate for sites to be assessed once every 12 years.

Table 41: Provisional list of sites to be surveyed in during phase 2 of the national survey

Site code	Site name	County	Length (km)	Max height (m)	Cliff type	Natura 2000	Reason
02001	Cod's Head	Cork	27.68	90	Hard & soft	N	High cliffs. Includes soft cliff on west coast.
02012	Sheep's Head	Cork	16.61	210	Hard	Y	Range of aspects. Very high cliffs.
02014	Barley Cove	Cork	3.78	70	Hard	Y	Range of aspects
02018	Goat's Head	Cork	4.91	70	Hard	Y	Range of aspects, slopes and heights.
02021	Old Head of Kinsale	Cork	12.47	90	Hard & soft	N	Includes soft cliff on south coast. High cliffs. Development pressures. Range of aspects; exposed.
02026	Whitegate to Ballycotton	Cork	26.79	50	Hard & soft	N	Near Cork City, recreational pressures. Undesignated. Soft cliff.
02031	Dunworly	Cork	4.62	40	Hard & soft	N	Undesignated soft cliff.
02035	Seven Heads Bay	Cork	5.55	100	Hard	N	High. Undesignated cliffs.
02041	Bawnlahan	Cork	1.89	40	Hard	Y	Low vegetation cover.
02054	Ballyieragh, Cape Clear	Cork	7.16	70	Hard	Y	Island site, exposed. Designated
03020	Knockfola	Donegal	2.33	40	Hard & soft	Y	Uncommon rock type. Designated. Includes soft cliff.
03021	Inishinny	Donegal	0.65	20	Hard & soft	Y	Soft cliff site, sheltered, high vegetation cover.
03026	Malinbeg	Donegal	21.98	400	Hard & soft	Y	Very high. May include records of *Arbutus unedo* (John Cross pers. comm.)
03031	Aughrus Point	Donegal	1.39	20	Hard & soft	N	Soft cliff site, sheltered, high vegetation cover.
03034	Tory Island	Donegal	9.49	80	Hard	N	Uncommon rock type. Island site.
03048	Crocknamurleog	Donegal	0.88	30	Hard & soft	Y	Soft cliff site, exposed, low vegetation cover.
03051	Mullaghderg	Donegal	2.41	20	Hard	Y	Sheltered, designated site.
05002	Knock	Galway	16.95	60	Hard & soft	Y	Uncommon rock types, Low vegetation cover. Island site.
05005	Cleggan	Galway	8.80	50	Hard & soft	N	Includes soft cliff. Undesignated.

Site code	Site name	County	Length (km)	Max height (m)	Cliff type	Natura 2000	Reason
06014	Drumgour to Puffin Sound	Kerry	15.56	280	Hard	N	Very high cliffs. Uncommon rock type
08008	Slievemore	Mayo	41.11	670	Hard & soft	Y	Very high cliffs. Includes soft cliff.
08011	Doogorteast	Mayo	2.33	30	Hard & soft	N	Soft cliff site with *Gunnera tinctoria*.
08017	Capnagower	Mayo	24.40	430	Hard & soft	Y	Island site. Very high cliffs. Uncommon rock types.
09002	Streedagh	Sligo	1.96	10	Hard & soft	Y	Includes soft cliff. Designated site.
09003	Ballineden	Sligo	1.67	30	Hard & soft	N	Exposed site. Uncommon rock type. Includes soft cliff.
10001	Monatray	Waterford	5.51	20	Hard & soft	N	Includes soft cliffs. Uncommon rock type.
10004	Clonea Strand to Ballymahon	Waterford	19.16	70	Hard & soft	N	Uncommon rock type. Development and recreational pressures. Includes soft cliffs.
10007	Nymphhall to Creaden Head	Waterford	6.24	40	Hard	N	Development pressure, undesignated.
11002	Wicklow Head	Wicklow	8.54	70	Hard & soft	N	Uncommon rock types. Development & recreational pressures
12004	Loftushall	Wexford	0.63	10	Hard	Y	Unvegetated headland site. Compares with 12004
12005	Hook Head	Wexford	2.35	20	Hard	Y	Low vegetation. Compares with 12005.

Conclusions

Current threats to Irish sea cliffs

Invasive species are a concern but possibly not as significant a problem as in other countries such as the UK. Experience elsewhere suggests that removal of invasive species is best done before they become well established, as removing large areas of invasive species on cliffs can result in slope instability and failure. This is an issue which, though a significant challenge, should be tackled in order to redress in some way the structure and function assessments at particular sites and the assessment at a national level.

Sea defences were found to be another considerable concern. They were found to be a greater concern at soft cliff sites than on hard cliff sites. They are likely to continue as a threat and to be exacerbated through sea level rise concerns, with land managers being under increased pressure to address erosion, which is as a result of, or perceived to be as a result of, sea level rise. On-going maintenance of railways was an issue at two sites surveyed this year, but this is not considered likely to be a factor at other locations. A more frequent occurrence is likely to be sea defences protecting roads on cliff tops, such as was recorded at Bulls Head to Inch, Co. Kerry.

Erosion was considered to be a neutral pressure as no instances of erosion being exacerbated by anthropogenic activities were recorded. It must, however, be acknowledged that this is very difficult to assess during a one-day site visit.

Dumping of household waste was recorded as extensively occurring on one site located on one of the off-shore islands. Waste management is an issue for many island communities but it was not recorded as an impact to sea cliff habitat on other island sites within the survey. Surveying additional sites will contribute to assessing if this was an isolated incidence.

General Conclusions

A detailed desk study has been completed on 176 cliff sites in Ireland. The 140 additional sites identified during this study, the nine island sites which do not have oblique and the 20 sites assessed by MERC/EirEco (2009) are excluded or only partially included in the database. This gives a total of 169 sites outstanding which do not have a detailed desk study completed.

The oblique view images have been an integral component of this assessment. NPWS should ensure they have continued access to this valuable resource and consideration should be given to arranging funding for a repeat run of these images for future assessment and comparison. As

these images were recorded in 2003 it would seem appropriate for this to be completed no later than 2013.

Steps can be taken to remediate the impacts and pressures experienced by many sea cliffs, particularly where dumping or invasive species are affecting the future prospects of a cliff. Coastal protection works are a more complex issue which are of particular relevance to soft cliffs.

Despite the practical difficulties and constraints associated with surveying sea cliffs, the methodology adopted was successful. Remote survey techniques inevitably result in some unavoidable sacrifices, particularly in the areas of species recording and identification. However these have been reduced wherever possible through this project. Further improvements to the methodology have been suggested above, the most significant being to view, where possible, the entire cliff in the field during the survey.

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Appendix I: Desk study parameters

Appendix Ia: Categories of information recorded for sea cliff sites

Category	Aerial photographs	Oblique photographs	OSI Discovery maps	NPWS information
Site identification code				
Site name			✓	
County			✓	
Ecologist's initials				
Discovery map number			✓	
Length (km)	✓	✓	✓	
Extent	✓	✓		
Adjacent habitat (Fossitt level 2)	✓	✓		
Internal habitat (Fossitt level 2)	✓	✓		
Bird colonies				✓

Appendix Ib: Categories of information recorded for sea cliff sections

Category	Aerial photos	Oblique photos	OSI Discovery maps	GSI survey of Ireland shapefile	Teagasc soil data	NPWS shapefiles
Section identification code						
Start point grid reference	✓	✓	✓			
End point grid reference	✓	✓	✓			
Section length (km)	✓	✓	✓			
Extent	✓	✓				
Aspect	✓		✓			
Slope	✓	✓				
Maximum height (m)	✓	✓	✓			
NPWS Conservation site type, number and name						✓
Bedrock				✓		
Soil parent material					✓	
Soil type					✓	
Stratification	✓	✓				
Cliff-face features	✓	✓				
Hydrological features	✓	✓	✓			
Cliff-base features	✓	✓				
Cliff top heritage council habitats	✓	✓				
Boundary	✓	✓				
Anthropogenic influences	✓	✓	✓			
Extent of anthropogenic influences	✓	✓				
Adjacent anthropogenic influences	✓	✓	✓			
Wave Exposure	✓	✓				
Wind Exposure	✓	✓				
Vegetation upper	✓	✓				
Vegetation centre	✓	✓				
Vegetation lower	✓	✓				
Cliff type	✓	✓			✓	
Slope failure	✓	✓				
Coast type	✓		✓			
Erosion features	✓	✓	✓			
Comments	✓	✓	✓			

Appendix Ic: Cliff characteristics recorded as an estimated range

Vegetation cover (section)	Extent of impact (section)	Extent (site & section)	Slope (section)
1-20%	<1%	0-60%	0-30
21-40%	1-25%	61-70%	31-45
41-60%	26-50%	71-80%	46-60
61-80%	51-75%	81-90%	61-75
81-100%	75-99%	91-100%	75-90
None visible	100%		>90
	None		

Appendix II: Field recording sheets

The following tables (IIa-IIe) have been filled in with example data to illustrate the type of information required for each field.

Appendix IIa: Swath structural information

Site ID	00000	00000
Site name	Example site	Example site
Swath ID	1	7
Ecologist ID	SB AD	SB AD
Date	11/08/2010	11/08/2010

Grid references

Vantage point	X 16551 77007 3.0	X 19745 76701 4.1
Swath centre	X 16563 77054 13.7	X 19673 76722 4.5
Swath LHS	X 16556 77029	X 19666 76716 4.7
Swath RHS	X 16567 77018 8.5	X 19681 76728 2.8

Cliff profiling

Markers @ top/base	Base	Top
Azimuth	92.9	294.3
Cliff slope	73.8	67
Height of cliff	12.7	45.1
Slope distance	15.6	49
Cliff aspect	SE	SE

Cliff type

Hard cliff	Hard	Hard
Soft cliff		

Adjacent habitats (Fossitt level 2)

Cliff top	GS	HH
Cliff base	LS	LR

Fauna

Rabbits		
Hares		
Anthills		
Solitary bee		

Solitary wasp		
Sand martin		c.5
Annex I bird	5 Chough	2 Chough
Other		
Other		

Bird colonies

Species	House martins	Rock dove
Count (nests)	8	c.20

Impacts

Impact code	K01.01	K01.01
% area affected	2	1
Intensity (H/M/L)	L	L
+ / - / 0	Neutral	Neutral
Internal/External	Internal	Internal
Notes		Erosion at top

Appendix IIb: Swath zone information

Site ID	00000	00000	00000	00000	00000
Swath ID	1	1	7	7	7
Swath structure	Zone 1 (top)	Zone 2	Zone 1	Zone 1	Zone 1
Zone type	Crevice ledge	Splash	Heath	Crevice ledge	Splash
Bare soil	2	0	2	2	0
Bare rock	9	10	6	8	10
Litter	2	0	3	3	0
Bryophyte layer	2	0	0	0	0
Lichen layer	4	8	4	8	8
Field layer	4	0	3	5	0
Dwarf shrub layer	3	0	6	2	0
Shrub layer	0	0	0	0	0
Canopy layer	0	0	0	0	0
Broadleaf herbs	4	0	3	5	0
Median vasc height (cm)	25	0	40	20	0
Vegetation cover	4	0	5	5	0
Width (LHS)	12.4	1.3	22.3	13.3	1.3
Width (centre)	11.4	2.9	22.9	12.8	2.9
Width (RHS)	5.5	3.3	23.3	14.3	3.3
Slope (LHS)	87.4	33.5	50.5	60.5	80.5
Slope (centre)	64.5	64.3	54.3	64.3	77.3
Slope (RHS)	54.9	69	55	50	75
Photo distance					
Slope distance	62.8	66.9	77.9	75.9	76.9
Horizontal distance	61.6	66.8	76.1	74.1	75.1

Appendix IIc: Swath species

Species	Swath	Zone	Degee of certainty	Domin
Agrostis stolonifera	1	Crevice ledge	2	3
Anthyllis vulneraria	1	Crevice ledge	1	2
Armeria maritima	1	Crevice ledge	1	2
Asplenium marinum	1	Crevice ledge	1	2
Plantago coronopus	1	Crevice ledge	1	3
Plantago lanceolata	1	Crevice ledge	1	2
Plantago maritima	1	Crevice ledge	1	2
Ramalina sp.	1	Crevice ledge	1	2
Sedum anglicum	1	Crevice ledge	1	4
Silene uniflora	1	Crevice ledge	1	0.1
Spergularia rupicola	1	Crevice ledge	1	4
Tripleurospermum maritimum	1	Crevice ledge	1	2
Ulex europaeus	1	Crevice ledge	1	2
Verrucaria maura	1	Crevice ledge	3	3
Verrucaria maura	1	Crevice ledge	1	2
Anthyllis vulneraria	1	Splash	1	3
Armeria maritima	1	Splash	1	3
Asplenium marinum	1	Splash	1	8
Aster tripolium	7	Crevice ledge	1	2
Beta vulgaris	7	Crevice ledge	1	3
Crithmum maritimum	7	Crevice ledge	2	0.1
Festuca rubra	7	Crevice ledge	1	2
Tripleurospermum maritimum	7	Crevice ledge	1	3
Erica cinerea	7	Crevice ledge	1	1
Festuca rubra	7	Crevice ledge	2	1
Jasione Montana	7	Crevice ledge	1	2
Ramalina sp.	7	Heath	1	5
Sedum anglicum	7	Heath	1	3
Silene uniflora	7	Heath	1	2
Tripleurospermum maritimum	7	Heath	1	5
Ulex gallii	7	Heath	2	2
Agrostis stolonifera	7	Heath	1	4
Spergularia rupicola	7	Heath	1	2
Tripleurospermum maritimum	7	Heath	1	7
Verrucaria maura	7	Splash	2	2
Agrostis stolonifera	7	Splash	1	1
Crithmum maritimum	7	Splash	1	2
Verrucaria maura	7	Splash	1	8

Appendix IId: Relevé information

Site no	00000	00000	00000	00000	00000
Site name	Example site	Example site	Example site	Example site	Example site
Swath no	1	1	7	7	7
Plot no	1	2	1	2	3
Recorder	AD	AD	AD	AD	AD
Date	22/06/2010	22/06/2010	23/06/2010	23/06/2010	23/06/2010
Photo plot	n	n	n	n	n
Rope plot	y	y	y	y	y
Field plot	n	n	n	n	n
Photo dist	na	na	na	na	na
Photo no	04, 05	8	03, 04, 05	13	14, 15
Grid reference	X 30710 02444	X 30705 02441	X 35974 97637	X 35961 97619	X 35957 97607
Grid error	7.8	6.2	5.4	12.3	15.4
Zone type	Crevice ledge	Splash lichen	Crevice ledge	Ungrazed grassland	Splash lichen
Bare soil	6	1	3	0	1
Bare rock	8	10	10	2	10
Litter	4	0	2	7	1
Surface water	0	0	0	0	0
Lichen cover	4	5	5	0	8
Bryophytes	0	0	2	0	0
Field	6	0.1	3	10	3
Dwarf shrub	3	0	0	2	0
Shrub layer	0	0	0	0	0
Canopy	0	0	0	0	0
Forbs	5	0.1	3	5	3
Med vasc ht	7	5	10	25	4
Additional relevé notes					

Appendix IIe: Relevé species

Species	Swath	Relevé	Zone	Degree of certainty	Domin
Silene uniflora	1	1	Crevice	1	0.1
Anthyllis vulneraria	1	1	Crevice	1	2
Armeria maritima	1	1	Crevice	1	2
Asplenium marinum	1	1	Crevice	1	2
Aster tripolium	1	1	Crevice	1	2
Beta vulgaris	1	1	Crevice	1	2
Plantago lanceolata	1	1	Crevice	1	2
Plantago maritima	1	1	Crevice	1	2
Ramalina sp.	1	1	Crevice	1	2
Tripleurospermum maritimum	1	1	Crevice	1	2
Ulex europaeus	1	1	Crevice	1	2
Anthyllis vulneraria	1	2	Splash	1	3
Armeria maritima	1	2	Splash	1	3
Asplenium marinum	1	2	Splash	1	8
Aster tripolium	7	1	Crevice	1	2
Festuca rubra	7	1	Crevice	1	2
Plantago coronopus	7	1	Crevice	1	2
Sedum anglicum	7	1	Crevice	1	2
Jasione montana	7	1	Crevice	1	2
Hedera helix	7	1	Crevice	1	3
Plantago maritima	7	1	Crevice	1	3
Sonchus sp.	7	1	Crevice	1	3
Tripleurospermum maritimum	7	1	Crevice	1	3
Silene uniflora	7	1	Crevice	2	2
Spergularia rupicola	7	1	Crevice	2	2
Inula crithmoides	7	1	Crevice	2	4
Ulex gallii	7	2	Heath	2	2
Sedum anglicum	7	2	Heath	1	3
Agrostis stolonifera	7	2	Heath	1	4
Ramalina sp.	7	2	Heath	1	5
Verrucaria maura	7	3	Splash	1	8

Appendix IIf: Structure and function assessment criteria

Site name:	Example site	**Site number**	00000 Swath 1
Vegetation zone	**Target**	**Scale of assessment**	**Pass/fail**
All zones	No sea defences such as rock armour, sea walls or fences affecting the zonation, geomorphology or natural hydrology of the cliff are present. If target is failed record the cliff section(s) this occurs in.	Within visible area of the site.	P
All zones	No artificial structures including piers and slipways affecting the zonation, geomorphology or natural hydrology of the cliff are present. If target is failed record the cliff section(s) this occurs in.	Within visible area of the site.	P
All zones	No access points such as paths or tracks which affect the zonation, geomorphology or natural hydrology of the cliff are present. If target is failed record the cliff section(s) this occurs in.	Within visible area of the site.	P
All zones	No non-native species are present. If target is failed record the cliff sections(s) this occurs in, the non-native species occurring and the approximate extent.	Within the visible area of the site.	P
Splash zone	Number of positive indicator species present ≥ 1.	Within zone in swath.	P
Crevice and ledge zone	Number of positive indicator species present ≥ 4.	Within zone in swath.	P
Coastal grassland on hard or soft cliffs	Combined cover of *Pteridium aquilinum* and woody species (inc. *Rubus fruticosus* agg., *Ulex europaeus, Prunus spinosa, Calluna vulgaris, Hedera helix* etc.) is <5%.	Within zone in swath.	na
Coastal grassland on hard cliffs	No negative indicator species present.	Within zone in swath.	na
Grazed coastal grassland on hard cliffs	Average grassland sward height is <10 cm.	Within zone in swath.	na
Grazed coastal grassland on hard cliffs	Number of positive indicator species present ≥ 3.	Within zone in swath.	na
Grazed coastal grassland on hard cliffs	Broadleaf herb component is 20 – 90%.	Within zone in swath.	na
Ungrazed coastal grassland on hard cliffs	Ungrazed grassland sward height is ≥ 10 cm.	Within zone in swath.	na
Ungrazed coastal grassland on hard cliffs	Number of positive indicator species present ≥ 2.	Within zone in swath.	na
Coastal grassland on soft cliffs	Number of positive indicator species present ≥ 2.	Within zone in swath.	na
Soft cliff pioneer	Number of positive indicator species present ≥ 1.	Within zone in swath.	na
Flush on soft cliff	No evidence of anthropogenic impacts on the	Within zone in swath.	na
Flush on soft cliff	Number of positive indicator species present ≥ 1.	Within zone in swath.	na
Coastal heath	Number of positive indicator species present ≥ 2.	Within zone in swath.	na
Coastal heath	No negative indicator species present.	Within zone in swath.	na
Coastal heath	Cover of *Pteridium aquilinum* < 10%.	Within zone in swath.	na
Coastal heath	Cover of scattered native trees, shrubs and woody climbers < 20%.	Within zone in swath.	na
Coastal heath	No signs of burning of heath habitat on the cliff. If target is failed record the cliff section(s) this occurs in.	Within visible area of the site.	na

Appendix III: Positive and negative indicator species

Appendix IIIa Positive indicators

Splash zone (hard cliffs)

Ramalina spp.
Verrucaria maura
Xanthoria spp.

Crevice & ledge (hard cliffs)

Anthyllis vulneraria
Asplenium marinum
Armeria maritima
Aster tripolium
Atriplex prostrata
Beta vulgaris ssp. *maritima*
*Cerastium diffusum**
*Catapodium marinum**
Crithmum maritimum
Festuca rubra
Inula crithmoides
Lavatera arborea
Ligusticum scoticum
Limonium sp.
Plantago coronopus
Plantago maritima
Sedum anglicum
Sedum rosea
Silene uniflora
Spergularia rupicola

Pioneer slopes (soft cliffs)

Agrostis stolonifera
Daucus carota
Equisetum sp.
Lotus corniculatus
Tussilago farfara

Flush (soft cliffs)

Equisetum sp.
Orchid species
Schoenus nigricans

Coastal heath

Calluna vulgaris
Daboecia cantabrica
Empetrum nigrum
Erica cinerea
Erica tetralix
Scilla verna
Ulex gallii
Vaccinium myrtillus

Coastal grassland on hard cliffs

Anthyllis vulneraria
Armeria maritima
Crithmum maritimum
Daucus carota
Festuca rubra
Hyacinthoides non-scripta
Plantago coronopus
Plantago maritima
Scilla verna
Sedum anglicum
Silene uniflora
Spergularia rupicola

Coastal grassland on soft cliffs

Agrostis stolonifera
Anthyllis vulneraria
Arrhenatherum elatius
Dactylis glomerata
Daucus carota
Elytrigia repens
Festuca rubra
Lotus corniculatus
Tussilago farfara

* Indicates potential therophyte community

Appendix IIIb Negative indicators

Splash zone (hard cliffs)
Any non-native species

Crevice & ledge (hard cliffs)
Any non-native species

Pioneer slopes (soft cliffs)
Any non-native species

Flush (soft cliffs)
Any non-native species

Coastal heath
Cirsium arvense
Cirsium vulgare
Ranunculus repens
Rumex spp.
Senecio jacobaea
Urtica dioica

Coastal grassland on hard cliffs
Cirsium arvense
Cirsium vulgare
Rumex obtusifolius
Senecio jacobaea
Trifolium repens
Urtica dioica

Coastal grassland on soft cliffs
Any non-native species

Appendix IV: impacts and codes for future prospects assessment

Taken from Ssymank (2009).

Code	Impact
A	***Agriculture***
A01	Cultivation
A02	modification of cultivation practices
A02.01	agricultural intensification
A02.02	crop change
A02.03	grassland removal for arable land
A03	mowing / cutting of grassland
A03.01	intensive mowing or intensification
A03.02	non intensive mowing
A03.03	abandonment / lack of mowing
A04	grazing
A04.01	intensive grazing
A04.01.01	intensive cattle grazing
A04.01.02	intensive sheep grazing
A04.01.03	intensive horse grazing
A04.01.04	intensive goat grazing
A04.01.05	intensive mixed animal grazing
A04.02	non intensive grazing
A04.02.01	non intensive cattle grazing
A04.02.02	non intensive sheep grazing
A04.02.03	non intensive horse grazing
A04.02.04	non intensive goat grazing
A04.02.05	non intensive mixed animal grazing
A04.03	abandonment of pastoral systems, lack of grazing
A05	livestock farming and animal breeding (without grazing)
A05.01	Animal breeding,
A05.02	stock feeding
A05.03	Lack of animal breeding
A06	annual and perennial non-timber crops
A06.01	annual crops for food production
A06.01.01	intensive annual crops for food production/ intensification
A06.01.02	non- intensive annual crops for food production
A06.02	perennial non-timber crops
A06.02.01	intensive perennial non-timber crops/intensification
A06.02.02	non-intensive perennial non-timber crops
A06.03	biofuel-production
A06.04	abandonment of crop production
A07	use of biocides, hormones and chemicals
A08	Fertilisation
A09	Irrigation
A10	Restructuring agricultural land holding

Code	Impact
A10.01	removal of hedges and copses or scrub
A10.02	removal of stone walls and embankments
A11	Agriculture activities not referred to above
B	***Sylviculture, forestry***
B01	forest planting on open ground
B01.01	forest planting on open ground (native trees)
B01.02	artificial planting on open ground (non-native trees)
B02	Forest and Plantation management & use
B02.01	forest replanting
B02.01.01	forest replanting (native trees)
B02.01.02	forest replanting (non native trees)
B02.02	forestry clearance
B02.02	removal of forest undergrowth
B02.04	removal of dead and dying trees
B02.05	non- intensive timber production (leaving dead wood/ old trees untouched)
B02.06	thinning of tree layer
B03	forest exploitation without replanting or natural regrowth
B04	use of biocides, hormones and chemicals (forestry)
B05	use of fertilizers (forestry)
B06	grazing in forests/ woodland
B07	Forestry activities not referred to above
C	***Mining, extraction of materials and energy production***
C01	Mining and quarrying
C01.01	Sand and gravel extraction
C01.01.01	sand and gravel quarries
C01.01.02	removal of beach materials
C01.02	Loam and clay pits
C01.03	Peat extraction
C01.03.01	hand cutting of peat
C01.03.02	mechanical removal of peat
C01.04	Mines
C01.04.01	open cast mining
C01.04.01	underground mining
C01.05	Salt works
C01.05.01	abandonment of saltpans (salinas)
C01.05.02	conversion of saltpans
C01.06	Geotechnical survey
C01.07	Mining and extraction activities not referred to above
C02	Exploration and extraction of oil or gas
C02.01	exploration drilling
C02.02	production drilling
C02.03	jack-up drilling rig
C02.04	semi-submersible rig
C02.05	drill ship
C03	Renewable abiotic energy use
C03.01	geothermal power production

Code	Impact
C03.02	solar energy production
C03.03	wind energy production
C03.04	tidal energy production
D	***Transportation and service corridors***
D01	Roads, paths and railroads
D01.01	paths, tracks, cycling tracks
D01.02	roads, motorways
D01.03	car parks and parking areas
D01.04	railway lines, TGV
D01.05	bridge, viaduct
D01.06	tunnel
D02	Utility and service lines
D02.01	electricity and phone lines
D02.01.01	suspended electricity and phone lines
D02.01.02	underground electricity and phone lines
D02.02	pipe lines
D02.03	communication masts and antennas
D02.09	other forms of energy transport
D03	shipping lanes, ports, marine constructions
D03.01	port areas
D03.01.01	slipways
D03.01.02	piers
D03.01.03	fishing harbours
D03.01.04	industrial ports
D03.02	Shipping
D03.03	marine constructions
D04	airports, flightpaths
D04.01	airport
D04.02	aerodrome, heliport
D04.03	flight paths
D05	Improved access to site
D06	Other forms of transportation and communication
E	***Urbanisation, residential and commercial development***
E01	Urbanised areas, human habitation
E01.01	continuous urbanisation
E01.02	discontinuous urbanisation
E01.03	dispersed habitation
E01.04	other patterns of habitation
E02	Industrial or commercial areas
E02.01	factory
E02.02	industrial stockage
E02.03	other industrial / commercial area
E03	Discharges
E03.01	disposal of household waste
E03.02	disposal of industrial waste
E03.03	disposal of inert materials

Code	Impact
E03.04	Other discharges
E03.04.01	coastal sand suppletion / beach nourishment
E04	Structures, buildings in the landscape
E04.01	Agricultural structures, buildings in the landscape
E04.02	Military constructions and buildings in the landscape
E05	Storage of materials
E06	Other urbanisation, industrial and similar activities
E06.01	demolishment of buildings & human structures
E06.02	reconstruction, renovation of buildings
F	***Biological resource use other than agriculture & forestry***
F01	Marine and Freshwater Aquaculture
F01.01	intensive fish farming, intensification
F01.02	suspension culture
F01.03	bottom culture
F02	Fishing and harvesting aquatic resources
F02.01	Professional passive fishing
F02.01.01	potting
F02.01.02	netting
F02.01.03	demersal longlining
F02.01.04	pelagic longlining
F02.02	Professional active fishing
F02.02.01	benthic or demersal trawling
F02.02.02	pelagic trawling
F02.02.03	demersal seining
F02.02.04	purse seining
F02.02.05	benthic dredging
F02.03	Leisure fishing
F02.03.01	bait digging
F03	Hunting and collection of wild animals (terrestrial)
F03.01	Hunting
F03.01.01	damage caused by game (excess population density)
F03.02	Taking and removal of animals (terrestrial)
F03.02.01	collection of animals (insects, reptiles, amphibians.....)
F03.02.02	taking from nest (e.g. falcons)
F03.02.03	trapping, poisoning, poaching
F03.02.04	predator control
F03.02.05	accidental capture
F03.02.09	other forms of taking animals
F04	Taking / Removal of terrestrial plants, general
F04.01	pillaging of floristic stations
F04.02	collection (fungi, lichen, berries etc.)
F04.02.01	hand raking
F04.02.02	hand collection
F05	Hunting, fishing or collecting activities not referred to above
F05.01	game/ bird breeding station
G	***Human intrusions and disturbances***

Code	Impact
G01	Outdoor sports and leisure activities, recreational activities
G01.01	nautical sports
G01.01.01	motorized nautical sports
G01.01.02	non-motorized nautical sports
G01.02	walking, horse-riding and non-motorised vehicles
G01.03	motorised vehicles
G01.03.01	regular motorized driving
G01.03.02	off-road motorized driving
G01.04	mountaineering, rock climbing, speleology
G01.04.01	mountaineering & rock climbing
G01.04.02	speleology
G01.05	gliding, delta plane, paragliding, ballooning
G01.06	skiing, off-piste
G01.07	other outdoor sports and leisure activities
G02	Sport and leisure structures
G02.01	golf course
G02.02	skiing complex
G02.03	stadium
G02.04	circuit, track
G02.05	hippodrome
G02.06	attraction park
G02.06	sports pitch
G02.07	camping and caravans
G02.08	wildlife watching
G02.09	other sport / leisure complexes
G03	Interpretative centres
G04	Military use and civil unrest
G04.01	Military manoeuvres
G04.02	abandonment of military use
G05	Other human intrusions and disturbances
G05.01	Trampling, overuse
G05.02	Vandalism
G05.03	intensive maintenance of public parks
G05.04	tree surgery, felling for public safety, removal of roadside trees
G05.05	missing or wrongly directed conservation measures
G05.06	closures of caves or galleries
G05.07	fences, fencing
G05.08	overflying with aircrafts (agricultural)
H	***Pollution***
H01	Pollution to surface waters (limnic & terrestrial)
H01.01	pollution to surface waters by industrial plants
H01.02	pollution to surface waters by storm overflows
H01.03	other point source pollution to surface water
H01.04	diffuse pollution to surface waters via storm overflows or urban run-off
H01.05	diffuse pollution to surface waters due to agricultural and forestry activities
H01.06	diffuse pollution to surface waters due to transport and infrastructure without

Code	Impact
H01.07	diffuse pollution to surface waters due to abandoned industrial sites
H01.08	diffuse pollution to surface waters due to household sewage and waste waters
H01.09	diffuse pollution to surface waters due to other sources not listed
H02	Pollution to groundwater (point sources and diffuse sources)
H02.01	groundwater pollution by leakages from contaminated sites
H02.02	groundwater pollution by leakages from waste disposal sites
H02.03	groundwater pollution associated with oil industry infrastructure
H02.04	groundwater pollution by mine water discharges
H02.05	groundwater pollution by discharge to ground such as disposal of contaminated water
H02.06	diffuse groundwater pollution due to agricultural and forestry activities
H02.07	diffuse groundwater pollution due to non-sewered population
H02.08	diffuse groundwater pollution due to urban land use
H03	Marine water pollution
H03.01	oil spills in the sea
H04	Air pollution, air-borne pollutants
H04.01	Acid rain
H04.02	Nitrogen-input
H04.03	other air pollution
H05	Soil pollution and solid waste (excluding discharges)
H05.01	garbage and solid waste
H06	excess energy
H06.01	Noise nuisance, noise pollution
H06.01.01	point source or irregular noise pollution
H06.01.02	diffuse or permanent noise pollution
H06.02	Light pollution
H06.03	Thermal heating of water bodies
H07	Other forms of pollution
I	***Invasive, other problematic species and genes***
I01	invasive non-native species
I02	problematic native species
I03	introduced genetic material, GMO
I03.01	genetic pollution (animals)
I03.02	genetic pollution (plants)
J	***Natural System modifications***
J01	fire and fire suppression
J01.01	burning down
J01.02	suppression of natural fires
J01.03	lack of fires
J02	human induced changes in hydraulic conditions
J02.01	Landfill, land reclamation and drying out, general
J02.01.01	polderisation
J02.01.02	reclamation of land from sea, estuary or marsh
J02.01.03	infilling of ditches, dykes, ponds, pools, marshes or pits
J02.01.04	recultivation of mining areas
J02.02	Removal of sediments (mud...)

Code	Impact
J02.02.01	dredging/ removal of limnic sediments
J02.02.02	estuarine and coastal dredging
J02.03	Canalisation & water deviation
J02.03.01	large scale water deviation
J02.03.02	canalisation
J02.04	Flooding modifications
J02.04.01	flooding
J02.04.02	lack of flooding
J02.05	Modification of hydrographic functioning, general
J02.05.01	modification of marine currents
J02.05.02	modifying structures of inland water courses
J02.05.03	modification of standing water bodies
J02.05.04	reservoirs
J02.05.05	small hydropower projects, weirs
J02.06	Water abstractions from surface waters
J02.06.01	surface water abstractions for agriculture
J02.06.02	surface water abstractions for public water supply
J02.06.03	surface water abstractions by manufacturing industry
J02.06.04	surface water abstractions for the production of electricity (cooling)
J02.06.05	surface water abstractions by fish farms
J02.06.06	surface water abstractions by hydro-energy
J02.06.07	surface water abstractions by quarries/ open cast (coal) sites
J02.06.08	surface water abstractions for navigation
J02.06.09	surface water abstractions for water transfer
J02.06.10	other major surface water abstractions
J02.07	Water abstractions from groundwater
J02.07.01	groundwater abstractions for agriculture
J02.07.02	groundwater abstractions for public water supply
J02.07.03	groundwater abstractions by industry
J02.07.04	groundwater abstractions by quarries/open cast (coal)sites
J02.07.05	other major groundwater abstractions from groundwater for agriculture
J02.08	Raising the groundwater table /artificial recharge of groundwater
J02.08.01	discharges to groundwater for artificial recharge purposes
J02.08.02	returns of groundwater to GWB from which it was abstracted
J02.08.03	mine water rebound
J02.08.04	other major groundwater recharge
J02.09.	Saltwater intrusion of groundwater
J02.09.01	saltwater intrusion
J02.09.02	other intrusion
J02.10	management of aquatic and bank vegetation for drainage purposes
J02.11	Dumping, depositing of dredged deposits
J02.11	Dykes, embankments, artificial beaches, general
J02.11.01	sea defence or coast protection works, tidal barrages
J02.11.02	dykes and flooding defence in inland water systems
J02.12	Abandonment of management of water bodies
J02.13	Other human induced changes in hydraulic conditions
J03	Other ecosystem modifications

Code	Impact
J03.01	reduction or loss of specific habitat features
J03.01.01	reduction of prey availability (including carcasses)
J03.02	anthropogenic reduction of habitat connectivity
J03.02.01	reduction in migration/ migration barriers
J03.02.02	reduction in dispersal
J03.02.03	reduction in genetic exchange
J03.03	reduction, lack or prevention of erosion
J03.04	applied (industrial) destructive research
K	***Natural biotic and abiotic processes (without catastrophes)***
K01	abiotic (slow) natural processes
K01.01	Erosion
K01.02	Silting up
K01.03	Drying out
K01.04	Submersion
K01.05	Soil salinization
K02	Biocenotic evolution, succession
K02.01	species composition change (succession)
K02.02	accumulation of organic material
K02.03	eutrophication (natural)
K02.04	acidification (natural)
K03	Interspecific faunal relations
K03.01	competition (fauna)
K03.02	parasitism (fauna)
K03.03	introduction of disease
K03.04	predation
K03.05	antagonism arising from introduction of species
K03.06	antagonism with domestic animals
K03.07	other forms of interspecific faunal competition
K04	Interspecific floral relations
K04.01	competition (flora)
K04.02	parasitism (flora)
K04.03	introduction of disease
K04.04	lack of pollinating agents
K04.05	damage by herbivores (including game species)
K05	reduced fecundity/ genetic depression
K05.01	reduced fecundity/ genetic depression in animals (inbreeding)
K05.02	reduced fecundity/ genetic depression in plants (incl. endogamy)
K06	other forms or mixed forms of interspecific floral competition
L	***Geological events, natural catastrophes***
L01	volcanic activity
L02	tidal wave, tsunamis
L03	earthquake
L04	avalanche
L05	collapse of terrain, landslide
L06	underground collapses

Code	Impact
L07	storm, cyclone
L08	inundation (natural processes)
L09	fire (natural)
L10	other natural catastrophes
M	***Climate change***
M01	Changes in abiotic conditions
M01.01	rise of temperature & extremes
M01.02	droughts and less precipitations
M01.03	flooding and rising precipitations
M02	Changes in biotic conditions
M02.01	habitat shifting and alteration
M02.02	desynchronisation of processes
M02.03	decline or extinction of species
M02.04	migration of species (natural newcomers)
X	***No threats or pressures***
XO	Threats and pressures from outside the Member State
XE	Threats and pressures from outside the EU territory

Appendix V: Site 03007 data records

Appendix Va: site 03007 summary

Site summary

Site ID: 03007 Site name: Dunaff

Ecologist initials: BD County: Donegal Date of desk study: January - March 2010

Cliff types present: Hard cliff No. sections in the site: 5 Discovery map no.: 2, 3

Section which coincide with NPWS conservation sites

Section	Site type	Site code	NPWS site name	1230 QI
01	pNHA	002012	North Inishowen Coast	☐
01	SAC	002012	North Inishowen Coast	☑
02	pNHA	002012	North Inishowen Coast	☐
02	SAC	002012	North Inishowen Coast	☑
03	pNHA	002012	North Inishowen Coast	☐
03	SAC	002012	North Inishowen Coast	☑
04	pNHA	002012	North Inishowen Coast	☐
04	SAC	002012	North Inishowen Coast	☑
05	pNHA	002012	North Inishowen Coast	☐
05	SAC	002012	North Inishowen Coast	☑

Sections included in the field survey: 01

Sections where swaths were recorded: Swath ID 01 Number of releves 3

Additional releves

Conservation status: Favourable

Appendix Vb: Site 03007 desk study information

General site information

Site ID	03007	BEC name	Dunaff
Amanda Browne code	D7	Ecologist initials	BD
County	Donegal	Length (km)	6.372
Extent	91-100%	Date recorded	January - March 2010

Internal habitat (HC)
FW
LS

Adjacent habitat (HC)
BL
GA
LR
LS

Discovery Map no.
2
3

Total no. sections in the site: 5

Conservation status

Overall assessment
Favourable

Section General Information

Site ID	03007	Section ID	01	Cliff type	Hard cliff
Start easting	231902	Start northing	449208		
End easting	232342	End northing	448818	Aspect	NE
Length (km)	0.798	Slope (deg)	75-90	Wind exposure	Sheltered
Extent	91-100%	Max height (m)	20-30	Wave exposure	Partially sheltered
Veg upper	41-60%	Veg centre	41-60%	Veg lower	1-20%
Coast type	Indented	Cliff base	Open water, Sand or shingle	Cliff top (HC)	GA, GS, HH

Cliff face features

Type	Feature
Cliff face features	Crevices
Hydrological features	Gully
Cliff face features	Outcrops
Cliff face features	Stepped slope

Erosion features

Substrate

Substrate code	8
Bedrock	Granite, granodiorite
Substrate code	MGs
Parent material	Raised beach sands and gravels
Substrate code	RckNCa
Parent material	Bedrock at surface-Non calcareous
Substrate code	AminSW
Soil type	Shallow well drained mineral (parent material mainly non-calcareous)
Substrate code	MarSands
Soil type	Beach sand and gravels

NPWS conservation sites

Site type	Site code	NPWS site name	1230 QI
pNHA	002012	North Inishowen Coast	☐
SAC	002012	North Inishowen Coast	☑

Impacts

Section comments

Section General Information

Site ID	03007	Section ID	02	Cliff type	Hard cliff
Start easting	230409	Start northing	448954		
End easting	231902	End northing	449208	Aspect	NW
Length (km)	1.896	Slope (deg)	75-90	Wind exposure	Sheltered
Extent	91-100%	Max height (m)	170-180	Wave exposure	Partially sheltered
Veg upper	41-60%	Veg centre	61-80%	Veg lower	21-40%
Coast type	Indented	Cliff base	Open water, Gravel or boulders, Bedrock	Cliff top (LIC)	ED, GS, LIU

Cliff face features

Type	Feature
Cliff face features	Boulder slopes
Stratification	Horizontal thick
Cliff face features	Ledges
Slope failure	Present
Cliff face features	Scree slopes
Cliff face features	Undercut

Erosion features

Substrate

Substrate code	26
Bedrock	Argyll Group; Quartzite
Substrate code	RckNCa
Parent material	Bedrock at surface-Non calcareous
Substrate code	AminSRPT
Soil type	Shallow, lithosolic-podzolic type soils potentially with peaty topsoil (parent material mainly non-calcareous)

NPWS conservation sites

Site type	Site code	NPWS site name	1230 QI
pNHA	002012	North Inishowen Coast	☐
SAC	002012	North Inishowen Coast	☑

Impacts

Section comments

Section General Information

Site ID	03007	Section ID	03	Cliff type	Hard cliff
Start easting	230283	Start northing	448379		
End easting	230409	End northing	448954	Aspect	W
Length (km)	1.079	Slope (deg)	75-90	Wind exposure	Partially sheltered
Extent	91-100%	Max height (m)	130-140	Wave exposure	Partially sheltered

Veg upper	61-80%	Veg centre	41-60%	Veg lower	21-40%
Coast type	Indented	Cliff base	Open water	Cliff top (HC)	ER, GS, HH, FW

Cliff face features

Type	Feature
Stratification	Horizontal thick
Cliff face features	Ledges
Cliff face features	Overhangs
Hydrological features	Stream or cascade

Erosion features

Erosion feature
Cave

Substrate

Substrate code	26
Bedrock	Argyll Group; Quartzite
Substrate code	RckNCa
Parent material	Bedrock at surface-Non calcareous
Substrate code	AminSRPT
Soil type	Shallow, lithosolic-podzolic type soils potentially with peaty topsoil (parent material mainly non-calcareous)

NPWS conservation sites

Site type	Site code	NPWS site name	1230 QI
pNHA	002012	North Inishowen Coast	☐
SAC	002012	North Inishowen Coast	☑

Impacts

Section comments

Section General Information

Site ID	03007	Section ID	04	Cliff type	Hard cliff
Start easting	230690	Start northing	447561		
End easting	230283	End northing	448379	Aspect	SW
Length (km)	2.147	Slope (deg)	75-90	Wind exposure	Exposed
Extent	91-100%	Max height (m)	30-40	Wave exposure	Partially sheltered
Veg upper	61-80%	Veg centre	41-60%	Veg lower	1-20%
Coast type	Indented	Cliff base	Open water, Bedrock, Gravel or boulders	Cliff top (HC)	GS, HD, ER, FW

Cliff face features

Type	Feature
Slope failure	Present
Cliff face features	Scree slopes
Hydrological features	Stream or cascade
Cliff face features	Undercut
Stratification	Vertical thick

Erosion features

Erosion feature
Wave-cut notch

Substrate

Substrate code	26
Bedrock	Argyll Group; Quartzite
Substrate code	RckNCa
Parent materia	Bedrock at surface-Non calcareous
Substrate code	AminSRPT
Soil type	Shallow, lithosolic-podzolic type soils potentially with peaty topsoil (parent material mainly non-calcareous)
Substrate code	AminSW
Soil type	Shallow well drained mineral (parent material mainly non-calcareous)

NPWS conservation sites

Site type	Site code	NPWS site name	1230 QI
pNHA	002012	North Inishowen Coast	☐
SAC	002012	North Inishowen Coast	☑

Impacts

Section comments

Section General Information

Site ID	03007	Section ID	05	Cliff type	Hard cliff
Start easting	230982	Start northing	447354		
End easting	230690	End northing	447561	Aspect	SW
Length (km)	0.452	Slope (deg)	75-90	Wind exposure	Exposed
Extent	91-100%	Max height (m)	30-40	Wave exposure	Partially sheltered
Veg upper	61-80%	Veg centre	41-60%	Veg lower	1-20%
Coast type	Indented	Cliff base	Open water	Cliff top (HC)	GS, ER, HH, GA

Cliff face features

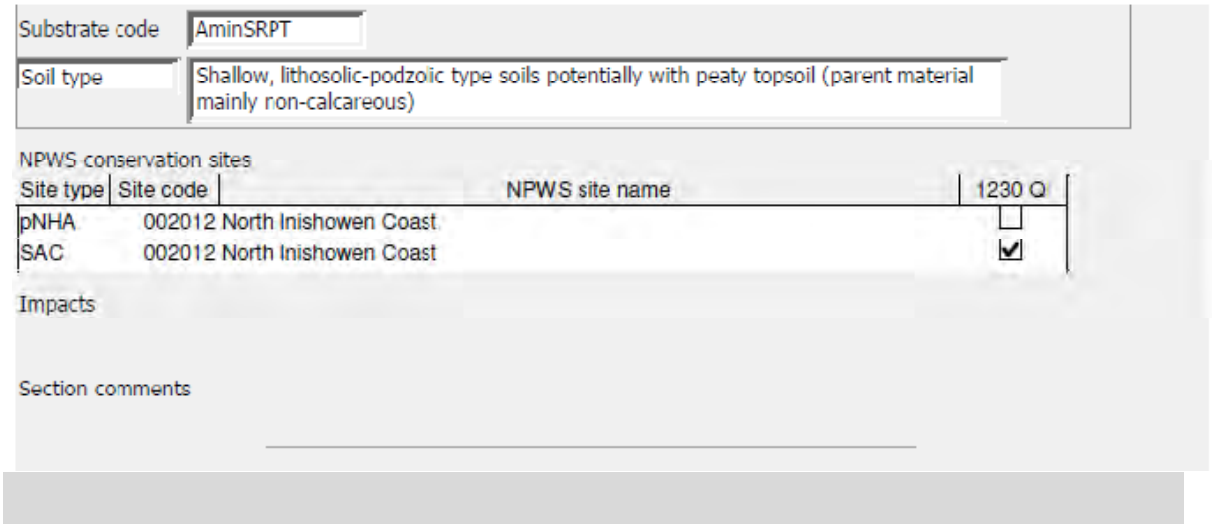
Type	Feature
Hydrological features	Gully
Cliff face features	Overhangs
Cliff face features	Scree slopes
Hydrological features	Stream or cascade

Erosion features

Erosion feature
Wave-cut notch

Substrate

Substrate code	8
Bedrock	Granite, granodiorite
Substrate code	RckNCa
Parent materia	Bedrock at surface-Non calcareous



Substrate code	AminSRPT
Soil type	Shallow, lithosolic-podzoic type soils potentially with peaty topsoil (parent material mainly non-calcareous)

NPWS conservation sites

Site type	Site code	NPWS site name	1230 Q
pNHA	002012	North Inishowen Coast	☐
SAC	002012	North Inishowen Coast	☑

Impacts

Section comments

Appendix Vc: Site 03007 field survey information

Site Information

Site ID: 03007

Total number of sections

Sections
5

Sections included in survey

Section ID
01

Sections with surveyed swaths

Section ID
01

Conservation assessment

Site ID	03007	cSAC code	002012
HD Code	1230	cSAC name	North Inishowen Coast
Area	Stable		
Structure and function	Favourable		
Future prospects	Favourable	1230 QI	☑
Overall assessment	Favourable		

Section information

Site ID	Section ID	Survey date	Ecologist initials	Year
03007	01	26-May	AD LS	2010

Features of interest if present

Type	Feature	Grid reference
Uncommon native species	Sedum rosea	

Fauna records if present

Bird colonies if present

Additional releves if recorded

Swath Information

Site ID	Section ID	Ecologists	Date surveyed	Year
03007	01	AD LS	26-May	2010

Cliff top habitat	Cliff base habitat	Marker location	Azimuth (deg)
HH	LR	Top	301.7

Cliff slope (deg)	Height of cliff (m)	Slope distance (m)	Cliff aspect
58.8	57	67	E

Notes
No general notes on the swath recorded.

Grid references

Site ID	Section ID	Marker type	Eastings	Northings	GPS error (m)
03007	01	Swath centre	231981	449138	6.1
03007	01	Swath LHS	231980	449130	4.48
03007	01	Swath RHS	231984	449147	4.7
03007	01	Vantage point	232122	449073	8.3

Number of zones 3 Number of releves 3

Zone information

Site ID	Section ID
03007	01

Zone structure

Zone number	Zone type	Releve ID
1	Crevice ledge	a

Left height (m)	Centre height (m)	Right height (m)
11	15	30

Left slope (deg)	Centre slope (deg)	Right slope (deg)
47.9	75	75.5

Bare soil (Domin)	Bare rock (Domin)	Vegetation height (cm)
2	8	25

Notes
No notes on the zone recorded.

Vegetation cover

Site ID	Section ID	Zone number	Zone feature	Domin
03007	01	1	Broadleaf herbs	6
03007	01	1	Field layer	6
03007	01	1	Lichen layer	7
03007	01	1	Litter	5

Zone structure

Zone number	Zone type	Releve ID
2	Ungrazed coastal grassland on hard cliffs	b

Left height (m)	Centre height (m)	Right height (m)
24	27	14
Left slope (deg)	**Centre slope (deg)**	**Right slope (deg)**
38.8	38.9	26.7
Bare soil (Domin)	**Bare rock (Domin)**	**Vegetation height (cm)**
0	5	25

Notes
No notes on the zone recorded.

Vegetation cover

Site ID	Section ID	Zone number	Zone feature	Domin
03007	01	2	Broadleaf herbs	5
03007	01	2	Dwarf shrub layer	2
03007	01	2	Field layer	8
03007	01	2	Lichen layer	2
03007	01	2	Litter	7

Zone structure

Zone number	Zone type	Releve ID
3	Splash zone	c

Left height (m)	Centre height (m)	Right height (m)
6	7	12
Left slope (deg)	**Centre slope (deg)**	**Right slope (deg)**
32.5	78	76.1
Bare soil (Domin)	**Bare rock (Domin)**	**Vegetation height (cm)**
0	10	0

Notes
No notes on the zone recorded.

Vegetation cover

Site ID	Section ID	Zone number	Zone feature	Domin
03007	01	3	Lichen layer	8

Appendix Vd: Site 03007 swath species list

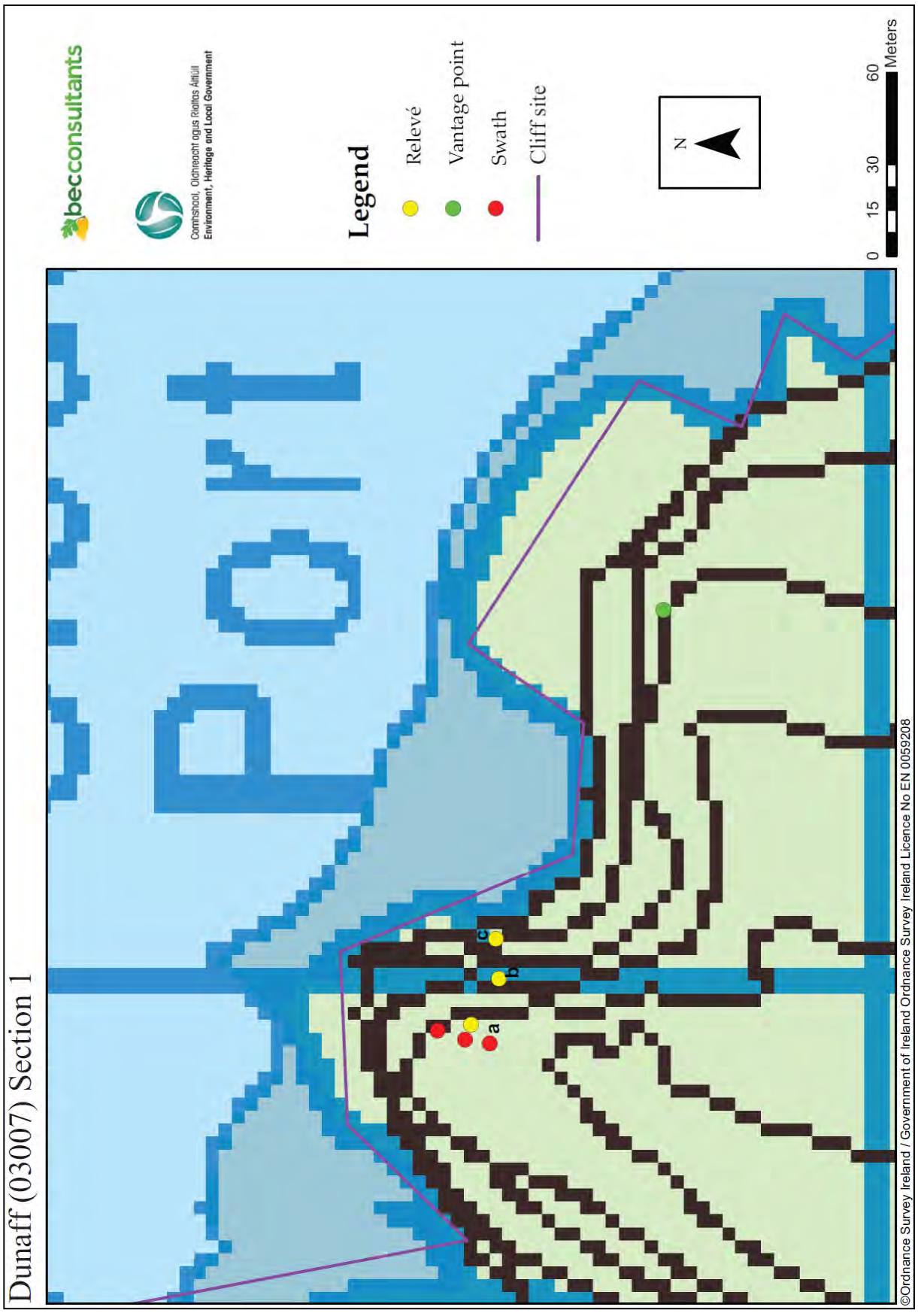
Swath species list

Site 03007 Swaths surveyed Section ID 01

Site	Section	Zone type	Species	Domin	Certainty	Year
03007	01	Crevice ledge	Anthyllis vulneraria	2	1	2010
03007	01	Crevice ledge	Armeria maritima	3	1	2010
03007	01	Crevice ledge	Festuca rubra/ovina	3	2	2010
03007	01	Crevice ledge	Ochrolechia parella	5	3	2010
03007	01	Crevice ledge	Plantago lanceolata	1	1	2010
03007	01	Crevice ledge	Plantago maritima	1	2	2010
03007	01	Crevice ledge	Ramalina sp.	6	2	2010
03007	01	Crevice ledge	Sedum anglicum	2	2	2010
03007	01	Crevice ledge	Sedum rosea	1	2	2010
03007	01	Crevice ledge	Silene uniflora	3	1	2010
03007	01	Crevice ledge	Xanthoria sp.	2	3	2010
03007	01	Splash zone	Armeria maritima	0.1	1	2010
03007	01	Splash zone	Ramalina sp.	2	1	2010
03007	01	Splash zone	Verrucaria sp.	8	1	2010
03007	01	Ungrazed coastal grassland on hard cliffs	Anthyllis vulneraria	2	1	2010
03007	01	Ungrazed coastal grassland on hard cliffs	Armeria maritima	2	1	2010
03007	01	Ungrazed coastal grassland on hard cliffs	Calluna vulgaris	2	2	2010
03007	01	Ungrazed coastal grassland on hard cliffs	Festuca rubra/ovina	8	2	2010
03007	01	Ungrazed coastal grassland on hard cliffs	Hedera helix	2	1	2010
03007	01	Ungrazed coastal grassland on hard cliffs	Lotus corniculatus	2	2	2010
03007	01	Ungrazed coastal grassland on hard cliffs	Primula vulgaris	2	1	2010
03007	01	Ungrazed coastal grassland on hard cliffs	Silene uniflora	2	1	2010

Appendix Ve: Map of site 03007 based on aerial photographs

Appendix Vf: Map of site 03007 based on the Discovery Series maps



Appendix VI: Inventory of sites in database

Site ID	BEC name	Recorded	County	Length	Extent	Date recorded	Easting	Northing
01001	Cliffs of Moher	MERC	Clare			2009	0	0
01002	Rineen	MERC	Clare			2009	0	0
01003	Ballard	BD	Clare	9.54	91-100%	Jan - Mar 2010	93443	167692
01004	Corbally	BD	Clare	11.35	81-90%	Jan - Mar 2010	89690	163591
01005	Moveen to Bridge of Ross	MERC	Clare			2009	0	0
01006	Loop Head	MERC	Clare			2009	0	0
01007	Kilcloher	BD	Clare	5.2	91-100%	Jan - Mar 2010	78607	147971
02001	Cod's Head	FPB	Cork	29.26	91-100%	Jan - Mar 2010	63626	49849
02002	Garnish Pt. & Crow Head	FPB	Cork	30.46	91-100%	Jan - Mar 2010	57526	44018
02003	Dursey Island	AD	Cork	15.7	91-100%	Jan - Mar 2010	50195	41072
02004	Black Ball Head to Fair Head	FPB	Cork	14.46	91-100%	Jan - Mar 2010	58785	39245
02005	Dogs Bay to Kilcatherine Point	FPB	Cork	23.18	91-100%	Jan - Mar 2010	70016	58443
02006	Bear Island	MERC	Cork			2009	0	0
02008	Coosard	AD	Cork	1.98	61-70%	Jan - Mar 2010	84615	47910
02012	Sheep's Head	AD	Cork	18.12	81-90%	Jan - Mar 2010	76154	37364
02013	Three Castle to Mizen Head	AD	Cork	32.42	81-90%	Jan - Mar 2010	78536	31364
02014	Barley Cove	AD	Cork	3.92	81-90%	Jan - Mar 2010	77150	24017
02015	Carhoona, Clear Island	AD	Cork	0.96	91-100%	Jan - Mar 2010	97226	23148
02016	Baltimore	AD	Cork	4.2	71-80%	Jan - Mar 2010	103553	25506
02018	Goat's Head	AD	Cork	5.25	91-100%	Jan - Mar 2010	123847	33604
02019	Galley Head	AD	Cork	19.51	81-90%	Jan - Mar 2010	133697	32873
02020	Clonakilty Bay	AD	Cork	7.66	91-100%	Jan - Mar 2010	141840	38250
02021	Old Head of Kinsale	AD	Cork	12.92	91-100%	Jan - Mar 2010	161061	42866
02022	Hake Head	AD	Cork	5.82	91-100%	Jan - Mar 2010	162560	44522
02023	Preghane to Ballymacus Point	MERC	Cork			2009	0	0
02024	Oysterhaven to Ringabella	AD	Cork	26.57	91-100%	Jan - Mar 2010	169123	48605
02026	Whitegate to Ballycotton	AD	Cork	27.86	91-100%	Jan - Mar 2010	181838	62566

Site ID	BEC name	Recorded	County	Length	Extent	Date recorded	Easting	Northing
02027	Knockadoon Head	AD	Cork	13.01	91-100%	Jan - Mar 2010	202663	68503
02030	Lehenagh	AD	Cork	0.24	91-100%	Jan - Mar 2010	147305	37549
02031	Dunworly	AD	Cork	4.77	91-100%	Jan - Mar 2010	147688	37110
02032	Foilareal Bay	AD	Cork	0.86	91-100%	Jan - Mar 2010	148225	35893
02033	Seven Heads	AD	Cork	3.23	61-70%	Jan - Mar 2010	149660	35837
02034	Ballymacshoneen	AD	Cork	1.18	61-70%	Jan - Mar 2010	151255	36154
02035	Seven Heads Bay	AD	Cork	5.55	91-100%	Jan - Mar 2010	151376	38276
02036	Ballylinchy	AD	Cork	3.6	71-80%	Jan - Mar 2010	105403	25039
02037	Ballinard	AD	Cork	0.23	91-100%	Jan - Mar 2010	108692	26285
02038	Glannafeen	AD	Cork	0.28	71-80%	Jan - Mar 2010	109922	27011
02039	Barloge	AD	Cork	0.36	71-80%	Jan - Mar 2010	110078	27471
02040	Ballyally	AD	Cork	1.38	81-90%	Jan - Mar 2010	111275	27461
02041	Bawnlahan	AD	Cork	1.89	91-100%	Jan - Mar 2010	112018	26992
02042	Gokane	AD	Cork	0.21	91-100%	Jan - Mar 2010	111749	26489
02043	Reendacussane	AD	Cork	1.16	71-80%	Jan - Mar 2010	113149	27262
02044	Toe Head	AD	Cork	5.97	81-90%	Jan - Mar 2010	114731	26013
02045	Scobaun	AD	Cork	0.51	91-100%	Jan - Mar 2010	116149	28551
02046	Castlehaven	AD	Cork	1.64	91-100%	Jan - Mar 2010	116923	28782
02047	Pouladav West	AD	Cork	1.76	91-100%	Jan - Mar 2010	126670	33838
02048	Pouladav East	AD	Cork	4.78	81-90%	Jan - Mar 2010	127943	33923
02049	Ballynaule	AD	Cork	1.32	91-100%	Jan - Mar 2010	78653	24368
02051	Crookhaven West	AD	Cork	1.93	71-80%	Jan - Mar 2010	79637	24566
02052	Crookhaven East	AD	Cork	2.45	61-70%	Jan - Mar 2010	81235	25462
02053	Lissamona, Clear Island	AD	Cork	1.42	91-100%	Jan - Mar 2010	95717	22133
02054	Ballyieragh, Cape Clear	AD	Cork	7.46	81-90%	Jan - Mar 2010	94653	21632
02055	Ballyieragh South, Cape Clear	AD	Cork	0.43	91-100%	Jan - Mar 2010	95401	21113
02056	Glen West, Clear Island	AD	Cork	0.64	91-100%	Jan - Mar 2010	95920	20288
02057	Glen East, Clear Island	AD	Cork	0.4	71-80%	Jan - Mar 2010	97155	21205
02058	Comillane South	AD	Cork	0.11	91-100%	Jan - Mar 2010	98111	22382
02059	Comillane North	AD	Cork	0.3	91-100%	Jan - Mar 2010	98297	22882

Site ID	BEC name	Recorded	County	Length	Extent	Date recorded	Easting	Northing
02060	Cloddagh North, Sherkin Island	AD	Cork	2.18	91-100%	Jan - Mar 2010	100362	25767
02061	Cloddagh South, Sherkin Island	AD	Cork	1.98	61-70%	Jan - Mar 2010	101041	25536
02062	Slievemore North, Sherkin Island	AD	Cork	0.92	71-80%	Jan - Mar 2010	100644	24455
02063	Slievemore South, Sherkin Island	AD	Cork	2.23	61-70%	Jan - Mar 2010	100336	23053
02064	Kilmoon, Sherkin	AD	Cork	0.51	91-100%	Jan - Mar 2010	102375	24507
02065	Harboursmouth, Sherkin Island	AD	Cork	1.97	91-100%	Jan - Mar 2010	103097	25519
02066	Hare Island West	AD	Cork	1.86	81-90%	Jan - Mar 2010	98971	27234
02067	Hare Island South	AD	Cork	0.55	81-90%	Jan - Mar 2010	100335	27174
02068	Skeam West	AD	Cork	0.22	91-100%	Jan - Mar 2010	98467	28588
02069	Skeam East	AD	Cork	0.38	91-100%	Jan - Mar 2010	99262	28966
02070	Foilakilly	AD	Cork	4.82	81-90%	Jan - Mar 2010	85359	42906
02071	Killeen North	AD	Cork	2.8	71-80%	Jan - Mar 2010	80524	39950
02072	Ballyroon	AD	Cork	0.84	91-100%	Jan - Mar 2010	78010	35459
02073	Ballynatra	AD	Cork	0.91	81-90%	Jan - Mar 2010	78913	35604
02074	Roosk	AD	Cork	0.32	71-80%	Jan - Mar 2010	84202	47767
02075	White Ball Head	FPB	Cork	2.05	91-100%	Jan - Mar 2010	57899	40219
03001	Mossy Glen	BD	Donegal	15.93	81-90%	Jan - Mar 2010	268574	443816
03002	Altnadarrow	BD	Donegal	4.17	91-100%	Jan - Mar 2010	239643	459758
03003	Binbane	BD	Donegal	1.23	91-100%	Jan - Mar 2010	239975	457183
03004	Stookanillar and Five Fingers	MERC	Donegal			2009	0	0
03005	Carrickabraghy	BD	Donegal	2.22	91-100%	Jan - Mar 2010	241116	452327
03006	Binnion	BD	Donegal	3.31	91-100%	Jan - Mar 2010	238306	449712
03007	Dunaff	BD	Donegal	6.37	91-100%	Jan - Mar 2010	231902	449208
03008	Lenan	BD	Donegal	2.08	91-100%	Jan - Mar 2010	230093	445040
03009	Lederg	BD	Donegal	6.2	91-100%	Jan - Mar 2010	230359	443252
03010	Ballynarry	BD	Donegal	1.35	91-100%	Jan - Mar 2010	232930	434211
03011	Annyfar and near	BD	Donegal	0.91	81-90%	Jan - Mar 2010	228744	434203
03012	Saldanha Head to Yellow Rock	MERC	Donegal			2009	0	0
03013	Croaghross	BD	Donegal	4.26	91-100%	Jan - Mar 2010	224755	440814
03014	Doagh Beg	BD	Donegal	1.01	81-90%	Jan - Mar 2010	224489	444349

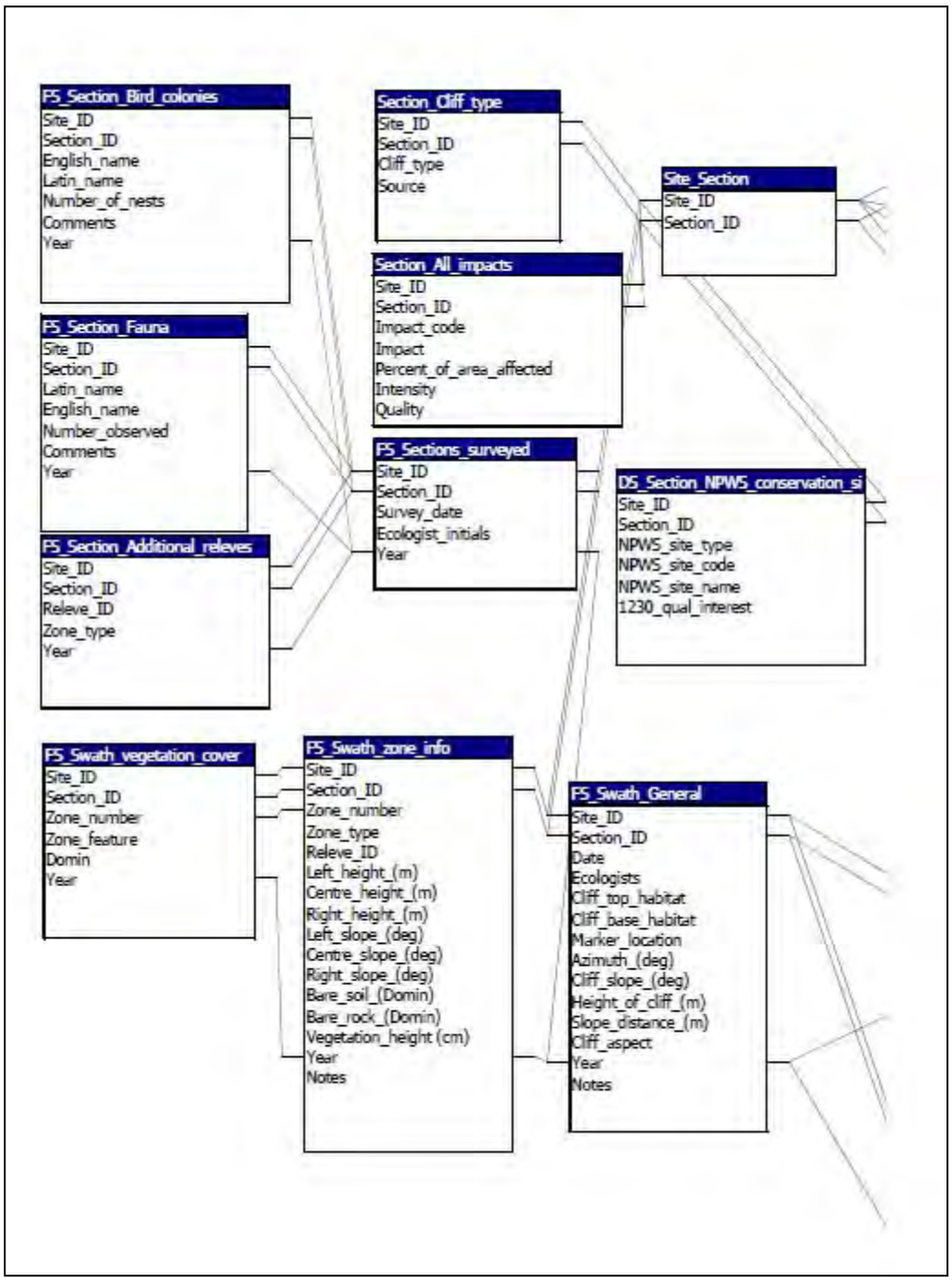
Site ID	BEC name	Recorded	County	Length	Extent	Date recorded	Easting	Northing
03015	Gortnalughoge	BD	Donegal	4.12	71-80%	Jan - Mar 2010	213472	443562
03017	Clonmass	BD	Donegal	1.11	91-100%	Jan - Mar 2010	207838	436268
03018	Largatreany	BD	Donegal	18.79	91-100%	Jan - Mar 2010	203335	438808
03020	Knockfola	BD	Donegal	2.33	91-100%	Jan - Mar 2010	181125	433738
03021	Inishinny	BD	Donegal	0.65	91-100%	Jan - Mar 2010	178573	425519
03022	Crohy	BD	Donegal	7.92	91-100%	Jan - Mar 2010	171354	408713
03023	Lackagh	BD	Donegal	14.53	91-100%	Jan - Mar 2010	168883	400113
03024	Drumirrin	BD	Donegal	2.92	81-90%	Jan - Mar 2010	164716	393405
03025	Malinmore	BD	Donegal	15.36	91-100%	Jan - Mar 2010	150623	384597
03026	Malinbeg	BD	Donegal	21.98	91-100%	Jan - Mar 2010	149310	379887
03027	Kilbeg	BD	Donegal	1.75	81-90%	Jan - Mar 2010	161104	375574
03028	Tawny	BD	Donegal	3.48	81-90%	Jan - Mar 2010	159966	374680
03029	Muckross	BD	Donegal	9.98	81-90%	Jan - Mar 2010	162355	373347
03030	St. John's Point	MERC	Donegal			2009	0	0
03031	Finner	BD	Donegal	1.39	81-90%	Jan - Mar 2010	181721	359946
03032	Kildoney Glebe	BD	Donegal	5.71	81-90%	Jan - Mar 2010	186448	366738
03033	Drumanoo	BD	Donegal	8.99	81-90%	Jan - Mar 2010	168839	373344
03034	Tory Island	BD	Donegal	9.49	91-100%	Jan - Mar 2010	187648	445433
03038	Illion	BD	Donegal	1.1	91-100%	Jan - Mar 2010	167952	414043
03041	Tirmacroragh	BD	Donegal	5.73	91-100%	Jan - Mar 2010	257821	448628
03042	Glengad	BD	Donegal	21.56	81-90%	Jan - Mar 2010	253440	451403
03043	Pollet	BD	Donegal	4.52	91-100%	Jan - Mar 2010	224073	445755
03044	Rinboy	BD	Donegal	0.73	81-90%	Jan - Mar 2010	217002	444988
03045	Melmore	BD	Donegal	1.22	81-90%	Jan - Mar 2010	212873	444731
03046	Dundooan Lower	BD	Donegal	3.57	81-90%	Jan - Mar 2010	211487	443444
03047	Downies	BD	Donegal	12.85	81-90%	Jan - Mar 2010	208594	440852
03048	Crocknamurleog	BD	Donegal	0.88	91-100%	Jan - Mar 2010	209664	438150
03049	Glashagh	BD	Donegal	1.24	61-70%	Jan - Mar 2010	180162	430085
03050	Carnboy	BD	Donegal	2.36	71-80%	Jan - Mar 2010	177902	424056
03051	Mullaghderg	BD	Donegal	2.4	81-90%	Jan - Mar 2010	175015	421756

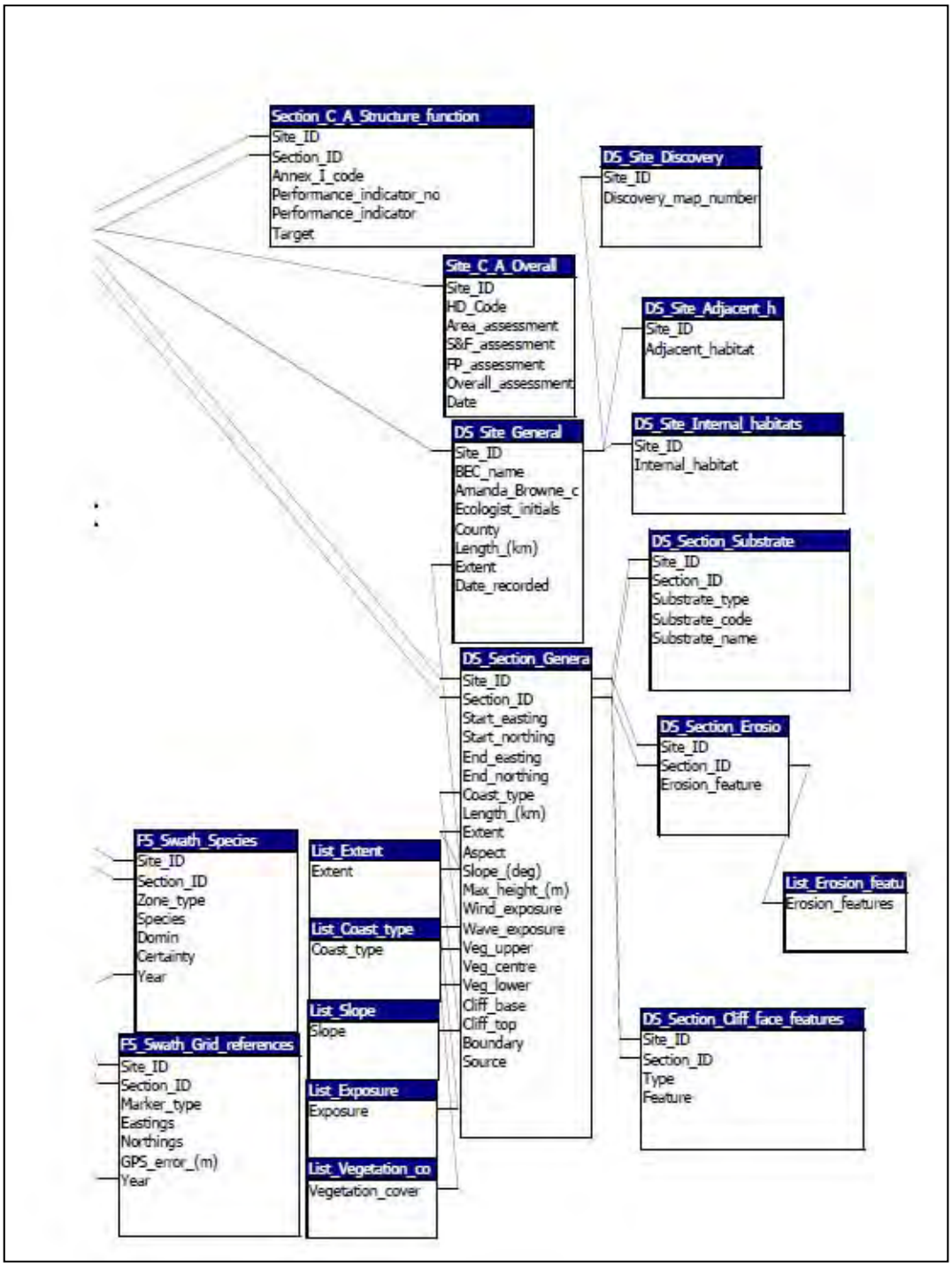
Site ID	BEC name	Recorded	County	Length	Extent	Date recorded	Easting	Northing
03052	Cruit Lower	BD	Donegal	1.43	0-60%	Jan - Mar 2010	172506	422523
03053	Scalpachore	BD	Donegal	0.96	81-90%	Jan - Mar 2010	173076	421165
03054	Aughnish Point	BD	Donegal	3.6	71-80%	Jan - Mar 2010	172621	419962
03055	Bent Island	BD	Donegal	0.47	81-90%	Jan - Mar 2010	171512	418114
03057	Glenlough	BD	Donegal	27.63	91-100%	Jan - Mar 2010	165264	391055
03058	Ballintra	BD	Donegal	23.03	91-100%	Jan - Mar 2010	165639	414053
04004	Killiney	MERC	Dublin			2009	0	0
04005	Shankill	MERC	Dublin			2009	0	0
05001	Tully	MERC	Galway			2009	73339	262876
05002	Knock	BD	Galway	23.49	81-90%	Jan - Mar 2010	55914	266822
05003	Letterbeg	BD	Galway	5.41	81-90%	Jan - Mar 2010	64757	263105
05004	Ardkyle	BD	Galway	2.05	81-90%	Jan - Mar 2010	64625	259891
05005	Cleggan	BD	Galway	9.72	81-90%	Jan - Mar 2010	62774	260216
05006	Onaght	BD	Galway	17.38	91-100%	Jan - Mar 2010	78237	211108
05007	Carrowntemple	BD	Galway	2.67	91-100%	Jan - Mar 2010	92019	204985
05008	Rusheen Bay	MERC	Galway			2009	0	0
05009	Inishshark	BD	Galway	11.09	81-90%	Jan - Mar 2010	49582	264953
06001	Ballybunion	AD	Kerry	16.73	91-100%	Jan - Mar 2010	88591	147881
06002	Kerry Head	AD	Kerry	45.19	91-100%	Jan - Mar 2010	84021	137964
06003	Brandon to Ballydavid	AD	Kerry	32.6	91-100%	Jan - Mar 2010	52881	117112
06004	Smerwick	AD	Kerry	17.84	91-100%	Jan - Mar 2010	34922	106496
06005	Clogher Head to Slea Head	AD	Kerry	27.84	91-100%	Jan - Mar 2010	31370	103392
06006	Great Blasket Island	AD	Kerry	17.87	91-100%	Jan - Mar 2010	27320	98242
06008	Paddock to Reenbeg Point	AD	Kerry	13.87	91-100%	Jan - Mar 2010	39997	99099
06009	Beenbane	AD	Kerry	6.36	91-100%	Jan - Mar 2010	45884	98690
06010	Bull's Head to Inch	AD	Kerry	25.09	91-100%	Jan - Mar 2010	48982	98766
06011	Rossbehy to Feaklecally	AD	Kerry	9.81	91-100%	Jan - Mar 2010	63403	90354
06012	Kells to Killurly Commons	AD	Kerry	10.73	91-100%	Jan - Mar 2010	53848	87973
06013	Valentia Island Cliffs West	AD	Kerry	12.28	91-100%	Jan - Mar 2010	35243	76194
06014	Drumgour to Puffin Sound	AD	Kerry	15.61	91-100%	Jan - Mar 2010	35353	71926

Site ID	BEC name	Recorded	County	Length	Extent	Date recorded	Easting	Northing
06015	Puffin Island	AD	Kerry	5.24	91-100%	Jan - Mar 2010	34185	68037
06017	Bolus Head	AD	Kerry	19.85	91-100%	Jan - Mar 2010	39306	67668
06018	Hog's Head	AD	Kerry	1.34	91-100%	Jan - Mar 2010	47235	60383
06020	Lamb's Head	AD	Kerry	4.42	91-100%	Jan - Mar 2010	53164	56152
06094	Cooncrome Harbour to Doulus Bay	AD	Kerry	10.2	91-100%	Jan - Mar 2010	43882	81649
06095	Coonanna Harbour to Cooncrome Harbour	AD	Kerry	7.75	91-100%	Jan - Mar 2010	47261	85042
06096	Reenearagh	AD	Kerry	0.5	91-100%	Jan - Mar 2010	51882	58697
06097	Coomatloukane West	AD	Kerry	0.56	91-100%	Jan - Mar 2010	50631	58985
06098	Coomatloukane East	AD	Kerry	1.87	91-100%	Jan - Mar 2010	50012	59398
06099	Darrynane More	AD	Kerry	1.01	91-100%	Jan - Mar 2010	48351	60471
07001	Clogher Head	MERC	Louth			2009	0	0
08001	Moyne	BD	Mayo	4.23	71-80%	Jan - Mar 2010	122278	329363
08002	Kilcummin Head	MERC	Mayo			2009	0	0
08003	Creevagh	BD	Mayo	11.49	91-100%	Jan - Mar 2010	118687	338922
08005	Glinsk	BD	Mayo	71.21	91-100%	Jan - Mar 2010	104854	341157
08007	Glenlara	BD	Mayo	32.29	91-100%	Jan - Mar 2010	74085	337353
08008	Slievemore	BD	Mayo	41.39	91-100%	Jan - Mar 2010	66801	309221
08009	Mweelin	BD	Mayo	13.32	91-100%	Jan - Mar 2010	65807	302981
08010	Salia	BD	Mayo	1.05	91-100%	Jan - Mar 2010	72321	302855
08011	Doogorteast	BD	Mayo	2.33	91-100%	Jan - Mar 2010	68555	309188
08012	Dooega	BD	Mayo	8.78	81-90%	Jan - Mar 2010	67964	297692
08013	Achillbeg Island	BD	Mayo	7.25	81-90%	Jan - Mar 2010	71905	292372
08014	Boilinlanna	BD	Mayo	5.33	81-90%	Jan - Mar 2010	75157	292296
08015	Oldhead	BD	Mayo	3.93	81-90%	Jan - Mar 2010	83380	282773
08016	Carrowmore	BD	Mayo	1.54	81-90%	Jan - Mar 2010	79385	281601
08017	Capnagower	BD	Mayo	25.43	81-90%	Jan - Mar 2010	71922	285886
08018	Craggy	BD	Mayo	15.33	81-90%	Jan - Mar 2010	61823	275882
09001	Kilkilloge	BD	Sligo	4.6	81-90%	Jan - Mar 2010	170546	358381
09002	Streedagh	BD	Sligo	2.01	71-80%	Jan - Mar 2010	163141	351403

Site ID	BEC name	Recorded	County	Length	Extent	Date recorded	Easting	Northing
09003	Ballineden	BD	Sligo	1.67	91-100%	Jan - Mar 2010	155903	344731
09004	Ballincar	MERC	Sligo			2009	0	0
09005	Aughris	BD	Sligo	3.31	91-100%	Jan - Mar 2010	150909	336801
09006	Killeenduff	BD	Sligo	2.73	91-100%	Jan - Mar 2010	140630	337833
09007	Cloonagh	BD	Sligo	3.12	91-100%	Jan - Mar 2010	158422	347138
10001	Monatray	AD	Waterford	5.78	91-100%	Jan - Mar 2010	211564	77412
10002	Ardmore	AD/MERC	Waterford	6.26	91-100%	Jan - Mar 2010	0	0
10003	Ballyquin to Helvick Head	AD	Waterford	22.53	91-100%	Jan - Mar 2010	220458	79890
10004	Clonea Strand to Bunmahon	AD	Waterford	19.86	91-100%	Jan - Mar 2010	232827	94831
10005	Tramore to Dunmore East	AD	Waterford	16.75	91-100%	Jan - Mar 2010	261181	98256
10006	Knockmahon to Kilmurrin	AD	Waterford	24.06	91-100%	Jan - Mar 2010	244295	98576
10007	Nymphhall to Creadan	AD	Waterford	6.24	91-100%	Jan - Mar 2010	271814	103604
11001	Arklow Head	MERC	Wicklow			2009	0	0
11002	Wicklow Head	AD	Wicklow	8.88	91-100%	Jan - Mar 2010	334013	191550
11003	Bray Head	MERC	Wicklow			2009	0	0
12001	Broomhill	AD	Wexford	10.05	91-100%	Jan - Mar 2010	274963	105620
12003	Gaunagh Gap	MERC	Wexford			2009	0	0
12004	Loftushall	AD	Wexford	0.85	81-90%	Jan - Mar 2010	273330	98702
12005	Hook Head	AD	Wexford	3.42	91-100%	Jan - Mar 2010	273354	97300
12006	Baginbun Head	AD	Wexford	10.49	91-100%	Jan - Mar 2010	276100	100778

Appendix VII: Relationships between tables in the Irish sea cliffs database

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FP_assessment
Overall_assessment
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Site_ID
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Site_ID
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Amanda_Browne_c
Ecologist_initials
County
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Extent
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Start_northing
End_easting
End_northing
Coast_type
Length_(km)
Extent
Aspect
Slope_(deg)
Max_height_(m)
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Wave_exposure
Veg_upper
Veg_centre
Veg_lower
Cliff_base
Cliff_top
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