NPWS

Keel Machair/Menaun Cliffs SAC (site code: 001513)

Conservation objectives supporting document- Coastal habitats

Version 1

May 2018

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Please note that the opinions expressed in the site report from the Vegetated Shingle Monitoring Project (VSM) are those of the authors and do not necessarily reflect the opinion or policy of NPWS.

Please note that this document should be read in conjunction with the following report: NPWS (2018) Conservation Objectives: Keel Machair/Menaun Cliffs SAC 001513. Version 1.0. National Parks and Wildlife Service, Department of Culture, Heritage and the Gaeltacht.

1 Introduction

Achieving Favourable Conservation Status (FCS) is the overall objective to be reached for all Annex I habitat types and Annex II species of European Community interest listed in the Habitats Directive 92/43/EEC (European Commission, 2013). It is defined in positive terms such that a habitat type or species must be prospering and have good prospects of continuing to do so.

Keel Machair/Menaun Cliffs SAC is a medium-sized Special Area of Conservation (SAC) located directly adjacent to the village of Keel and approximately 9.5km north-west of Achill Sound, Co. Mayo. It is located on the southern coast of Achill Island and encompasses a machair plain which runs from Trawmore beach northwards to Keel Lough. The machair habitat and damp hollows within the dunes are noteworthy for a number of rare and scarce bryophytes including the *Endangered* mosses *Bryum calophyllum* and *Tortella inclinata* and the *Near Threatened* moss *Catoscopium nigritum* (Lockhart *et al*., 2012); all three are listed on the Flora (Protection) Order, 2015 (FPO; Statutory Instrument No. 356 of 2015). The *Vulnerable* liverwort *Fossombronia fimbriata* (Lockhart *et al*., 2012) is also found. Petalwort (*Petalophyllum ralfsii*), a small liverwort that is rare in Europe and listed on Annex II of the EU Habitats Directive and on the FPO, has been recorded within these sand dune habitats in the SAC (NPWS, 2013a; Campbell *et al*., 2015).

Other noteworthy species include the Annex I bird species whooper swan (*Cygnus cygnus*), which winters at Keel Lough, and chough (*Pyrrhocorax pyrrhocorax*). The machair habitat also provides a good habitat for breeding ringed plover (*Charadrius hiaticula*) (NPWS, 2013a).

Keel Machair/Menaun Cliffs SAC (site code: 001513) is selected for perennial vegetation of stony banks, machair, Alpine and Boreal heaths and petalwort. The following two coastal habitats are included in the list of Qualifying Interests for the SAC (* denotes a priority habitat) and are dealt with in this supporting document:

1220	Perennial vegetation of stony banks
21A0	Machairs (* in Ireland)

The mapped distribution of the sand dune habitats, including machair, in Keel Machair/Menaun Cliffs SAC is presented in Appendix I.

2 Conservation Objectives

A conservation objective aims to define the favourable conservation condition of a habitat or species at a particular site. Implementation of the objective will help to ensure that the habitat or species achieves favourable conservation status at a national level.

This supporting document sets out the conservation objectives for the two coastal habitats listed above in Keel Machair/Menaun Cliffs SAC, which are defined by a list of parameters, attributes and targets. The main parameters are (a) Range (b) Area and (c) Structure and Functions, the last of which is broken down into a number of attributes, including physical structure, vegetation structure and vegetation composition.

The targets set for **perennial vegetation of stony banks** (vegetated shingle) are based in part on the findings of the Vegetated Shingle Monitoring Project (VSM) (Martin *et al*., 2017), which was carried out in 2016 on behalf of the National Parks and Wildlife Service (NPWS). This document should be read in conjunction with that report.

Vegetated shingle within Keel Machair/Menaun Cliffs SAC was recorded during the National Shingle Beach Survey (NSBS), which was carried out in 1999 on behalf of NPWS (Moore and Wilson, 1999).

The SAC was also visited during the Coastal Monitoring Project (CMP) which ran from 2004 to 2006, also on behalf of NPWS (Ryle *et al*., 2009). However, vegetated shingle habitat was not recorded during the CMP (Ryle *et al*., 2009) or during the VSM (Martin *et al*., 2017). Both the CMP (Ryle *et al*., 2009) and VSM (Martin *et al*., 2017) did note extensive areas of shingle beach and both projects stated that the absence of perennial vegetation of stony banks was probably due to the exposed and highly mobile nature of the habitat and perennial vegetation may again become established on the shingle in the future.

The targets set for the **machair** are based primarily on the results of the VSM (Martin *et al*., 2017) and again, this document should be read in conjunction with that report. It is also recommended that this document be read in conjunction with the final report from the Coastal Monitoring Project (CMP) (Ryle *et al*., 2009) and the Sand Dunes Monitoring Project (SDM) (Delaney *et al*., 2013). The CMP was a comprehensive national baseline survey of all known sand dune systems in Ireland, which included the sand dunes habitats associated with Keel Machair/Menaun Cliffs SAC. The SDM subsequently reviewed and modified the methodology used during the CMP to map and assess the conservation status of dune habitats. A subset of 40 sites was selected as a representative sample of the national dune resource for the SDM survey, but did not include any sites within Keel Machair/Menaun Cliffs SAC. Bassett (1983), Crawford *et al*. (1998) and Gaynor (2006, 2008) provide additional information on machair in Ireland.

The VSM surveyed, mapped and assessed a single sub-site associated with Keel Machair/Menaun Cliffs SAC (Martin *et al*., 2017):

Trawmore, Keel (VSM site code 006)

As part of the VSM, a detailed individual site report and habitat maps were produced for the Trawmore, Keel sub-site and these are included in Appendix II at the end of this document.

The conservation objectives for perennial vegetation of stony banks and machair in Keel Machair/Menaun Cliffs SAC are based on the findings of the VSM (Martin *et al*., 2017).

3 Perennial vegetation of stony banks

The following definition of perennial vegetation of stony banks habitat in Ireland is based on the data collected during the VSM (Martin *et al*., 2017) and is an adaptation of the definitions used in European Commission (2013) and NPWS (2013b).

Perennial vegetation of stony backs occurs along the coast where shingle (cobbles, pebbles, and gravel ≥2mm) has accumulated to form elevated ridges or banks above the high tide mark. The majority of the rocky material should be between 2mm and 256mm in diameter to be considered in this habitat category. On the upper beach, the pioneer community can be characterised by perennial species such as sea beet (*Beta vulgaris* subsp. *maritima*), sea-kale (*Crambe maritima*), rock samphire (*Crithmum maritimum*), cleavers (*Galium aparine*), yellow-horned poppy (*Glaucium flavum*), sea pea (*Lathyrus japonicus*), wild radish (*Raphanus raphanistrum* subsp. *maritimus*), curled dock (*Rumex crispus*), sea campion (*Silene uniflora*), perennial sow-thistle (*Sonchus arvensis*) and sea mayweed (*Tripleurospermum maritimum*). The majority of the area within this pioneer community is usually bare shingle. At the top of the beach, and moving inland, a wider range of vegetation types can be found at larger shingle sites including a lichen-rich community and coastal forms of grassland, heath and scrub. The grassland community can be characterised by grass species such as common bent-grass (*Agrostis capillaris*), creeping bent-grass (*A*. *stolonifera*), false oat-grass (*Arrhenatherum elatius*), cock's-foot (*Dactylis glomerata*), spreading meadow-grass (*Poa humilis*), sand couch (*Elytrigia repens*), red fescue (*Festuca rubra*), Yorkshire fog (*Holcus lanatus*) and crested hair-grass (*Koeleria macrantha*), field wood-rush (*Luzula campestris*), and broadleaf herbs such as yarrow (*Achillea millefolium*), thrift (*Armeria maritima*), common mouse-ear (*Cerastium fontanum*), wild carrot (*Daucus carota*), autumn hawkbit (*Leontodon autumnalis*), common bird's-foot trefoil (*Lotus corniculatus*), buck's-horn plantain (*Plantago coronopus*), ribwort plantain (*P*. *lanceolata*), silverweed (*Potentilla anserina*), common sorrel (*Rumex acetosa*), dandelion (*Taraxacum officinale* agg.), lady's bedstraw (*Galium verum*), red clover (*Trifolium pratense*) and white clover (*T*. *repens*). The scrub community can be characterised by the woody species honeysuckle (*Lonicera periclymenum*), blackthorn (*Prunus spinosa*), bramble (*Rubus fruticosus* agg.), gorse (*Ulex europaeus*) and the climber hedge bindweed (*Calystegia sepium*). These more inland communities have less bare shingle and vegetative cover usually dominates. The majority of the grassland and scrub communities are rooted within soil, whereas the pioneer community is usually rooted in gravel, sand or organic matter (e.g. decomposing seaweed and other plant material). Once the soil layer on top of the shingle is more than 30cm deep the community is no longer defined as perennial vegetation of stony banks.

3.1 Overall Objective

The overall objective for 'Perennial vegetation of stony banks' in Keel Machair/Menaun Cliffs SAC is to '*maintain the favourable conservation condition'*.

This objective is based on an assessment of the recorded condition of the habitat under a range of attributes and targets. The assessment is divided into three main headings: (a) Range, (b) Area and (c) Structure and Functions.

3.2 Area

3.2.1 Habitat area

Habitat extent is a basic attribute to be assessed when determining the condition of a particular habitat. The target for favourable condition is that there is no decrease from the established baseline. Bearing in mind that coastal systems are naturally dynamic and subject to change, even within a season, this target is assessed subject to natural processes, including erosion and succession.

The exact current extent of perennial vegetation of stony banks in Keel Machair/Menaun Cliffs SAC is unknown. The VSM (Martin *et al*., 2017) and the CMP (Ryle *et al*., 2009) did not record any vegetated shingle habitat in the sub-site Trawmore, Keel. The NSBS (Moore and Wilson, 2009) had recorded the presence of perennial vegetation of stony banks in NSBS sub-site Trawmore, Keel, but did not map habitat extent.

The NSBS classified the perennial vegetation of stony banks in the Trawmore, Keel sub-site as a vegetated shingle ridge and vegetated fringing beach (Moore and Wilson, 1999). The NSBS (Moore and Wilson, 1999) ranked each surveyed site as either High, Medium or Low interest, based on site representativity, species diversity, habitat diversity and the presence of rare or scarce species. Trawmore, Keel was ranked as a 'High interest' site by the NSBS due to its size and diversity. A 'High interest' ranking denoted a site that is of high conservation value and perhaps of interest botanically or geomorphologically (Moore and Wilson, 1999).

The VSM did note extensive areas of shingle beach in the Trawmore, Keel sub-site; however, no areas of the shingle were vegetated (Martin *et al*., 2017).

The target is that the habitat area should be stable or increasing, subject to natural processes, including erosion and succession.

3.3 Range

3.3.1 Habitat distribution

The full distribution of perennial vegetation of stony banks in Keel Machair/Menaun Cliffs SAC is currently unknown.

It is possible that the habitat on the shingle beach at Trawmore, Keel has been temporarily lost due to natural erosion and will re-establish in the future (Martin *et al*., 2017).

The target is that there should be no decline or change in the distribution of the habitat, unless it is the result of natural processes, including erosion and succession.

3.4 Structure and Functions

A fundamental aim of shingle conservation is to facilitate natural mobility. Shingle beaches are naturally dynamic systems, making them of geomorphological interest, as well as ecological interest. They are constantly changing and shingle features are rarely stable in the long-term.

3.4.1 Physical structure: functionality and sediment supply

The health and on-going development of the habitat relies on a continuing supply of shingle sediment. This may occur sporadically as a response to storm events rather than continuously. Interference with the natural coastal processes, through offshore (or onshore) extraction or coastal defence structures in particular, can interrupt the supply of sediment and lead to beach starvation.

Rock armour is present within the Trawmore, Keel sub-site, but its impact on the formation of perennial vegetation of stony banks habitat is considered to be minimal (Martin *et al*., 2017).

The target is to maintain, or where necessary restore, the natural circulation of sediment and organic matter, without any physical obstructions.

3.4.2 Physical structure: disturbance

Damage to the habitat due to disturbance was assessed as a negative indicator by Martin *et al*. (2017). Disturbance can include damage from heavy trampling, vehicle damage and removal of substrate.

The target is that no more than 20% of the habitat is affected by disturbance.

3.4.3 Vegetation structure: zonation

Ecological variation within this habitat type depends on stability, the amount of fine material accumulating between the pebbles, climatic conditions, width of the foreshore and past management of the site. The ridges and lows also influence the vegetation patterns, resulting in characteristic communities and zonations of bare and vegetated shingle. In the frontal, less stable areas of shingle, the vegetation tends to be dominated by short-lived salt-tolerant perennials (pioneer community). Where the shingle is more stable, it becomes more vegetated and may include grassland, heathland and scrub communities, depending on the exact nature of the site. The presence of lichens indicates long-term stability of the shingle structure. Further information on the communities of perennial vegetation of stony banks is found in Martin *et al*. (2017).

Vegetated shingle is part of a naturally dynamic coastal system. In order to ensure the ecological functioning of all of the vegetated shingle communities present, it is vital to maintain the zonations and transitions to other habitats, including lagoon, saltmarsh and sand dune habitats.

The target is to maintain the range of coastal habitats, including transitional zones, subject to natural processes, including erosion and succession.

3.4.4 Vegetation composition: communities and typical species

The degree of exposure, as well as the coarseness and stability of the substrate, determines species diversity. Typical species lists for the three main vegetated shingle communities (pioneer, grassland and scrub) are presented in Martin *et al*. (2017).

Ryle *et al.* (2009) stated that the notable shingle species sea pea (*Lathyrus japonicus*) had previously been recorded within the perennial vegetation of stony banks habitat in this SAC. This FPO listed species is classified as *Vulnerable* in Ireland (Wyse Jackson *et al*., 2016). Sea pea was not recorded in the habitat during the VSM (Martin *et al*., 2017).

The target for this attribute is to ensure that the occurrence of typical species within the range of vegetated shingle communities is maintained.

3.4.5 Vegetation composition: negative indicator species

Negative indicator species can include species indicative of changes in nutrient status, e.g. nettle (*Urtica dioica*), and species not considered to be typical of the habitat, e.g. bracken (*Pteridium aquilinum*). The list of negative indicator species commonly found in the habitat is presented in Appendix I of Martin *et al*. (2017).

The target for negative indicator species is that no species is present in more than 60% of stops and the combined cover in any individual stop is 25% or less.

3.4.6 Vegetation composition: non-native species

Non-native species can be invasive and have deleterious effects on native vegetation. Low targets are set as non-native species can spread rapidly and are most easily dealt with when still at lower abundances.

The target for non-native species is that no species is present in more than 20% of stops, the combined cover in any individual stop is 1% or less, and the cover across the whole site 1% or less. At a site level, if a non-native species has been under-recorded, or not recorded, via the stops the percentage cover for the species across the site should be recorded and assessed.

4 Sand dune habitats

Sand dunes are hills of wind-blown sand that have become progressively more stabilised by a cover of vegetation. In general, most sites display a progression through strandline, foredunes, mobile dunes and fixed dunes. Where the sandy substrate is decalcified, fixed dunes may give way to dune heath. Wet hollows, or dune slacks, occur where the dunes have been eroded down to the level of the water table. Transitional communities can occur between dune habitats and they may also form mosaics with each other. Dune systems are in a constant state of change and maintaining this natural dynamism is essential to ensure that all of the habitats present at a site achieve favourable conservation condition.

In Ireland, there are nine sand dune habitats (including annual vegetation of drift lines) listed under Annex I of the EU Habitats Directive (92/43/EEC) (* denotes a priority habitat):

- Annual vegetation of drift lines (1210)
- Embryonic shifting dunes (2110)
- Shifting dunes along the shoreline with *Ammophila arenaria* (white dunes) (2120)
- Fixed coastal dunes with herbaceous vegetation (grey dunes) (2130) *
- Decalcified dunes with *Empetrum nigrum* (2140) *
- Atlantic decalcified fixed dune (Calluno-Ulicetea) (2150) *
- Dunes with *Salix repens* subsp. *argentea* (Salicion arenariae) (2170)
- Humid dune slacks (2190)
- **Machairs (21A0) ***

The habitat in bold, machairs, is listed as a Qualifying Interest for Keel Machair/Menaun Cliffs SAC and was recorded by Martin *et al*. (2017). Two other sand dune habitats, shifting dunes along the shoreline with *Ammophila arenaria* (2120) and fixed coastal dunes with herbaceous vegetation (2130) were also recorded by Martin *et al*. (2017) in Keel Machair/Menaun Cliffs SAC, but they are not Qualifying Interests for the SAC. These habitats include mobile areas at the front as well as more stabilised parts of dune systems.

Where sand accumulation is more rapid than in embryonic dunes, marram grass (*Ammophila arenaria*) invades, initiating the transition from embryonic dunes to mobile dunes (Shifting dunes along the shoreline with *Ammophila arenaria*). Marram growth is actively stimulated by sand accumulation. These unstable and mobile areas are sometimes referred to as 'yellow dunes' (or 'white dunes' in some European countries), owing to the areas of bare sand visible between the tussocks of marram.

Fixed dunes refer to the more stabilised area of dune systems, generally located in the shelter of the mobile dune ridges, where the wind speed is reduced and the vegetation is removed from the influence of tidal inundation and salt spray. This leads to the development of a more or less closed or 'fixed' carpet of vegetation dominated by a range of sand-binding species (Gaynor, 2008).

Machair is a highly specialised and complex dune habitat that is confined globally to the north-west coasts of Ireland and Scotland. It comprises a flat or gently undulating sandy plain that develops in an oceanic location with a cool moist climate. Machair systems are highly calcareous, the sediments usually containing a high percentage of shell fragments and having pH values in excess of 7. The

vegetation is herbaceous, with a low frequency of sand-binding species (Gaynor, 2006). Irish machair is a priority habitat under the EU Habitats Directive.

All of the dune habitats indicated above occur as a complex mosaic of constantly changing and evolving vegetation communities. They are inextricably linked in terms of their ecological functioning and should be regarded as single geomorphological units. As such, no dune habitat should be considered in isolation from the other dune habitats present at a site, or the adjoining semi-natural habitats with which they often form important transitional communities.

Detailed descriptions from the VSM (Martin *et al*., 2017) of each sand dune habitat found in the Trawmore, Keel sub-site are presented in Appendix II. A total of 86ha of sand dune habitat was mapped within the boundary of Keel Machair/Menaun Cliffs SAC, 79.52ha (92.5%) of which represents the habitat that is listed as a Qualifying Interest for this particular SAC, i.e. machair.

4.1 Overall objectives

The overall objective for 'Machairs' in Keel Machair/Menaun Cliffs SAC is to '*restore the favourable conservation condition*'.

This objective is based on an assessment of the recorded condition of the habitat under a range of attributes and targets. The assessment is divided into three main headings: (a) Area (b) Range and (c) Structure and Functions.

4.2 Area

4.2.1 Habitat area

Habitat extent is a basic attribute to be assessed when determining the condition of a particular habitat. Habitat maps were produced for the sand dune habitats in the Trawmore, Keel sub-site during the VSM (Martin *et al*., 2017). These maps are included with the individual site report in Appendix II at the end of this document.

The total area of machair habitat within the Trawmore, Keel sub-site, as estimated by Martin *et al.* (2017), was 87.60ha, of which 79.52ha lies within the boundary of Keel Machair/Menaun Cliffs SAC.

The area of machair decreased from 92.83ha during the CMP (Ryle *et al*., 2009) to 87.60ha during the VSM (Martin *et al*., 2017). This decrease is due to a change in the machair habitat to both mobile dunes (white dunes) and fixed dunes (grey dunes), and also from natural erosion along the seaward edge of the site. There was also a small natural increase of machair area since the CMP, though not enough to offset the loss (Martin *et al*., 2017).

The general target is that the area of machair should be stable, or increasing. Bearing in mind that coastal systems are naturally dynamic and subject to change, this target is always assessed subject to natural processes, including erosion and succession.

4.3 Range

4.3.1 Habitat distribution

The distribution of sand dune habitats, including machair, within Keel Machair/Menaun Cliffs SAC, as mapped by Martin *et al.* (2017), is presented in Appendix I.

Machair is the most extensive sand dune habitat mapped at Trawmore, Keel. It extends from Keel village in the west to just short of the foothills of Menaun cliffs in the south-east along the coast, and landwards to the shores of Keel Lough (Martin *et al*., 2017).

The target is that there should be no decline or change in the distribution of machair, unless it is the result of natural processes, including erosion, accretion and succession.

4.4 Structure and Functions

The location, character and dynamic behaviour of sand dunes are governed by a combination of geographic, climatic, edaphic and anthropogenic factors. Sand dunes are highly complex, dynamic systems, where the habitats occur in a complex and constantly evolving and changing mosaic. They function as systems in terms of geomorphology and hydrology, and maintaining the favourable conservation condition of the habitats present depends on allowing these processes to continue unhindered. Maintaining the favourable conservation condition of all of the sand dune habitats in Keel Machair/Menaun Cliffs SAC in terms of structure and functions depends on a range of attributes for which targets have been set as outlined below.

4.4.1 Physical structure: functionality and sediment supply

Coastlines naturally undergo a constant cycle of erosion and accretion. There are two main causes of erosion: (a) those resulting from natural causes and (b) those resulting from human interference. Natural causes include the continual tendency towards a state of equilibrium between coasts and environmental forces, climatic change (particularly an increase in the frequency of storms or a shift in storm tracks), relative sea level rise and natural changes in the sediment supply. Human interference is usually associated with changes in the sediment budget, either directly, through the removal of beach or inshore sediment, or indirectly, by impeding or altering sediment movement. It is important to recognise that the process of coastal erosion is part of a natural tendency towards equilibrium. Natural shorelines attempt to absorb the energy entering the coastal zone by redistributing sediment.

Dunes are naturally dynamic systems that require continuous supply and circulation of sand. Sediment supply is especially important in embryonic dunes and mobile dunes, as well as strandline communities where accumulation of organic matter in tidal litter is essential for trapping sand and initiating dune formation. The construction of physical barriers such as sea defences can interrupt longshore drift, leading to beach starvation and increased rates of erosion. Sediment circulation and erosion also has a role to play in the more stabilised dune habitats. Cycles of erosion and stabilisation are part of a naturally functioning dune system, where the creation of new bare areas allows pioneer species and vegetation communities to develop, thus increasing biodiversity. The

construction of physical barriers can interfere with the sediment circulation by cutting the dunes off from the beach resulting in fossilisation or over-stabilisation of dunes. It should be borne in mind that natural processes such as erosion, deposition and succession are primary drivers of change on coastal habitats.

The target for this attribute is to maintain the natural circulation of sediment and organic matter throughout the entire dune system, without any physical obstructions.

4.4.2 Physical structure: hydrological and flooding regime

Typically, the true machair plain represents the area where wind erosion has eroded a dune system to a level just above the water table, where the wet consistency of the sand prevents further erosion. In general, the degree of flatness depends on the age of the system, as well as the underlying topography, geology, outcropping of local rocks and historical management. Machair plains can be terminated on the landward side by a lake or associated marsh/fen (Gaynor, 2006). Consequently, the condition and conservation of the machair habitat can be inextricably linked to the local hydrology.

Wet machair can essentially be compared to humid dune slacks due to the periodic fluctuations and the proximity of the groundwater table to the surface throughout the year. The frequency and duration of periods of flooding or inundation determines the vegetation composition. The water table depth has been identified as the primary determining factor in vegetation variation, followed by weak trends in calcium and sodium availability. Other contributing factors include stage of development, precipitation, distance from the sea, the grazing regime, recreational pressure, nature of the sediment, soil pH and the porosity of the sediment.

Machair is highly sensitive to human influences on hydrology, either through water abstraction, drainage works or increased nutrient inputs. Water abstraction interferes with the local hydrology, potentially having serious implications for the plant and animal communities of wet machair communities.

The target is to ensure that the hydrological regime continues to function naturally and that there are no increased nutrient inputs in the groundwater.

4.4.3 Vegetation structure: zonation

The range of vegetation zones on a dune system should be maintained. Gaynor (2008) highlights the highly transitional nature of much of the vegetation; therefore, it is important that the transitional communities are also conserved, including those to saltmarsh communities.

The target is to maintain the range of coastal habitats, including transitional zones, subject to natural processes, including erosion and succession.

4.4.4 Vegetation structure: bare ground

This target applies to machair. It does not apply to the other habitats present, apart from fixed dunes, where high levels of bare sand are a natural component of the habitat. In the less exposed areas, some degree of instability is vital. Constant cycles of erosion and stabilisation provide the

necessary conditions for the establishment of pioneer species and species that favour open conditions such as petalwort (*Petalophyllum ralfsii*) and a range of invertebrates, helping to increase biodiversity.

Bare sand can be exposed from the actions of grazing animals; however, it must be borne in mind that, even with a moderate grazing regime, some localised damage is to be expected because the impact of grazing animals is not applied at the same intensity throughout the site.

The target for machair is not to exceed 5% bare sand. This target is assessed subject to natural processes.

4.4.5 Vegetation structure: sward height

A varied vegetation structure is important for maintaining species diversity and is particularly important for invertebrates and birds. The ecological benefits of moderate levels of grazing on dunes have been well-documented (Gaynor, 2008). Moderate grazing regimes lead to the development of a species-rich vegetation cover. The animals increase biodiversity by creating micro-habitats through their grazing, dunging and trampling activities. Grazing slows down successional processes, and in some cases reverses them, helping to achieve a diverse and dynamic landscape. The effects of trampling assist the internal movement of sand through the development of small-scale blowouts, while dunging can eutrophicate those dune habitats whose nutrient-poor status is crucial for the survival of certain vegetation types. Many species, from plants to invertebrates, benefit immensely from the open and diverse system created by a sustainable grazing regime. Many dune species are small in size and have relatively low competitive ability. Consequently, the maintenance of high species diversity on a dune system is dependent on the existence of some control to limit the growth of rank coarse vegetation (Gaynor, 2008).

Machairs are extensively used in both Ireland and Scotland as commonage areas for grazing. Many machair sites are grazed by cattle, or sheep, or both. In Scotland, sheep are the most common grazing animal, but the grazing density and sheep to cattle ratio is vital in determining the quality and diversity of the machair (Angus, 1994).

A mean vegetation height of 2.2cm was recorded by the VSM in the habitat in the Trawmore, Keel sub-site indicating that grazing levels are too high (Martin *et al*., 2017).

The broad target for this attribute is to maintain structural variation within the sward. The specific target for machair is that the mean sward height is greater than 8cm in July/August.

4.4.6 Vegetation composition: flowering/fruiting

The health of the dune plants species is assessed by the plant parts above the ground (they should be green) and by the presence of flowering heads.

The target for this attribute for machair is that positive indicator species, such as red fescue (*Festuca rubra*) or common bird's-foot trefoil (*Lotus corniculatus*), are flowering or fruiting in more than 40% of the monitoring stops. See Delaney *et al*. (2013) for the list of positive indicator species.

4.4.7 Vegetation composition: typical species and sub-communities

Species diversity and plant distribution in dunes is strongly controlled by a range of factors, including mobility of the substrate, grazing intensities, moisture gradients, nutrient gradients and human disturbance. In the younger, more mobile dunes, marram (*Ammophila Arenaria*) and sand couch (*Elytrigia juncea*) are common, while groundsel (*Senecio vulgaris*), sea rocket (*Cakile maritima*) and dandelion (*Taraxacum* sp.) are also present. The fixed, more stable dune vegetation includes lady's bedstraw (*Galium verum*), common bird's-foot trefoil (*Lotus corniculatus*), wild thyme (*Thymus polytrichus*), kidney vetch (*Anthyllis vulneraria*), wild pansy (*Viola tricolor*) and biting stonecrop (*Sedum acre*).

The vegetation of machair is often composed of both wet and dry communities and although there is generally an obvious distinction between the dry and wet types, transitional communities are common (Gaynor, 2008). No suite of species is unique to machair and the vegetation can best be described as a mosaic of calcareous fixed dune, mesotrophic grassland and dune slack communities (Gaynor, 2008).

The following table lists the dominant species listed in dry and wet Irish machair from Gaynor (2006). Differences in the dominant species between the two types of machair plain are indicated by *.

Dry machair	**Wet machair**
Festuca rubra	*Trifolium repens*
Plantago lanceolata	*Agrostis stolonifera*
Trifolium repens	*Calliergonella cuspidata*
Lotus corniculatus	*Festuca rubra*
Bellis perennis	*Bellis perennis*
*Galium verum**	*Plantago lanceolata*
Carex arenaria	*Carex arenaria*
*Rhytidiadelphus squarrosus**	*Potentilla anserina*
*Leontodon taraxacoides**	*Hydrocotyle vulgaris*
Poa pratensis (*subcaerulea*)*	*Lotus corniculatus*
*Homalothecium lutescens**	*Prunella vulgaris*

Other species typically recorded on Irish machair include common yarrow (*Achillea millefolium*), early hair-grass (*Aira praecox*), common mouse-ear (*Cerastium fontanum*), smooth hawksbeard (*Crepis capillaris*), common stork's-bill (*Erodium cicutarium*), eyebright (*Euphrasia officinalis*), common flax (*Linum catharticum*), red bartsia (*Odontites verna*), yellow rattle (*Rhinanthus minor*), biting stonecrop (*Sedum acre*), wild thyme (*Thymus polytrichus*) and violets (*Viola* spp.) (Ryle *et al*., 2009). The calcareous nature of the substrate can be reflected by the presence of thyme-leaved sandwort (*Arenaria serpyllifolia*), crested hair-grass (*Koeleria macrantha*), ox-eye daisy (*Leucanthemum vulgare*) and squinancywort (*Asperula cynanchica*).

The target for this attribute is to maintain a typical flora for the machair habitat.

4.4.8 Vegetation composition: negative indicator species

Negative indicators include species indicative of changes in nutrient status, e.g. nettle (*Urtica dioica*), and species not considered characteristic of the habitat, e.g. bracken (*Pteridium aquilinum*).

No negative indicator species were recorded within the machair habitat by the VSM (Martin *et al*., 2017)

The target for negative indicators is that no species is present in more than 60% of stops and the combined cover of negative indicators throughout any one habitat is 5% or less and the highest cover score within any one stop in 25% or less.

4.4.9 Vegetation composition: non-native species

Non-native species can have a negative impact on sand dune habitats. Sea buckthorn (*Hippophae rhamnoides*) should be absent or effectively controlled.

The non-native species New Zealand willowherb (*Epilobium brunnescens*) was recorded by the VSM (Martin *et al*., 2017) in one monitoring stop within the machair habitat in the Trawmore, Keel sub-site.

The target is that non-native species, such as New Zealand willowherb (*Epilobium brunnescens*), should not be present in more than 20% of stops.

4.4.10 Vegetation composition: scrub/trees

Scrub encroachment leads to reduction in dune biodiversity and needs to be controlled. The presence of scrub and trees which have deep roots can also lower the groundwater table which can have significant impacts on the machair communities.

The target for this attribute therefore is that the cover of scrub and tree species should be under control or represent no more than 5% of the vegetation cover.

4.4.11 Vegetation composition: bryophytes

Bryophytes are an important element of the machair flora. Frequently occurring species include *Campylium stellatum, Scorpidium revolvens, Ctenidium molluscum* and *Philontis fontana*, most of which are indicative of wet, base-rich conditions.

The Annex II and FPO listed liverwort petalwort (*Petalophyllum ralfsii*) has been recorded in Keel Machair/Menaun Cliffs SAC on tightly sheep-grazed turf on the edges of channelised and semi-natural water tracks and on small, partly bare patches of damp unshaded sand on the western and more calcareous side of the machair plain (see Campbell *et al*., 2015). Petalwort is a Qualifying Interest species for Keel Machair/Menaun Cliffs SAC.

The target for this attribute is that the cover of bryophytes should and should always be at least an occasional component of the vegetation, with a minimum cover of 1% within each monitoring stop.

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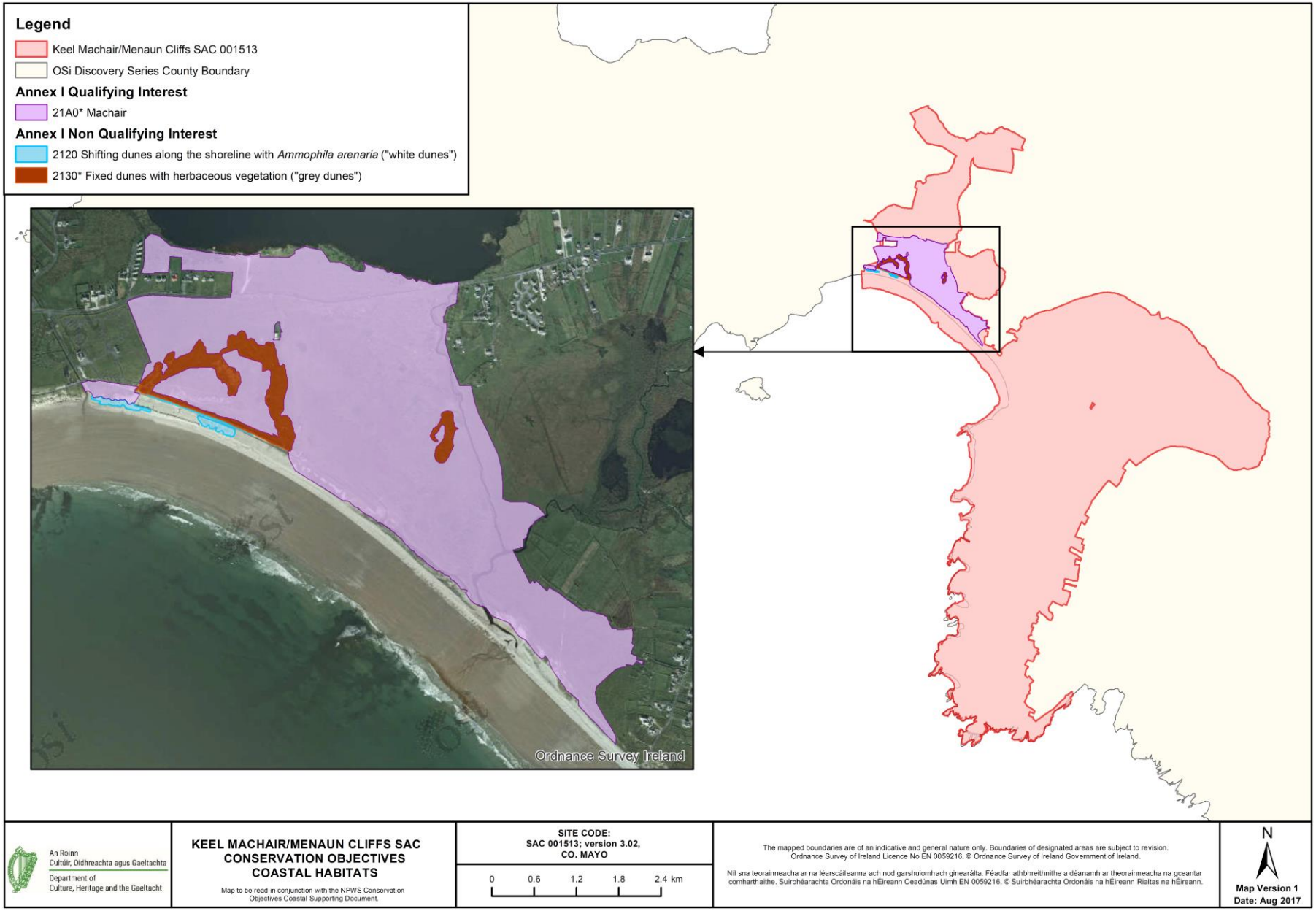
Appendix I – Distribution map of sand dune habitats within Keel Machair/Menaun Cliffs SAC



Appendix II – Site report and habitat maps for Trawmore, Keel from the Vegetated Shingle Monitoring Project (VSM)

SITE 006 TRAWMORE, KEEL

The following individual site report should be read in conjunction with the main report (Martin *et al*., 2017). Please note that NSBS refers to the National Shingle Beach Survey (NSBS) (Moore & Wilson, 1999), CMP refers to the baseline Coastal Monitoring Project (Ryle *et al*., 2009), SDM refers to the Sand Dunes Monitoring Project (Delaney *et al*., 2013) and VSM to the Vegetated Shingle Monitoring Project (Martin *et al*., 2017).

The shingle at this location is referred to as a Site 48 Trawmore, Keel by the NSBS, and the dune system and shingle at this location are referred to as Site 113 Keel Lough by the CMP.

1 SITE DESCRIPTION

Trawmore, Keel is a medium sized site located directly adjacent to the village of Keel and approximately 9.5 km north-west of Achill Sound, Co. Mayo. It is located on the southern coast of Achill Island and comprises a machair plain which runs from Trawmore beach northwards to Keel Lough. It lies within the Keel Machair/Menaun Cliffs SAC (001513) (NPWS, 2013). Two Annex I sand dune habitats (* indicates a priority habitat) were recorded during the CMP: **2120 Marram dunes (white dunes)** and ***21A0 Machairs.** The NSBS recorded the presence of **1220 Perennial vegetation of stony banks** at Trawmore, Keel and ranked it as a 'High interest' site due to its size and diversity. **1220 Perennial vegetation of stony banks** was not recorded by the CMP, and although the VSM did note extensive areas of shingle beach, no areas of the shingle were vegetated and no **1220 Perennial vegetation of stony banks** was recorded during the VSM either. It is possible that this habitat on the shingle beach at Trawmore, Keel has been temporarily lost due to natural erosion and will re-establish again in the future.

The ***21A0 Machairs** habitat and damp hollows within the dunes are noteworthy for a number of rare and scarce moss and liverwort species, including *Bryum calophyllum, B. marattii, Catoscopium nigritum, Tortella inclinata, Fossombronia fimbriata, F. pusilla* and *F. incurva*. The rare Annex II liverwort *Petalophyllum ralfsii* (petalwort) has also been found within these sand dune habitats at Trawmore, Keel (NPWS, 2013). Other noteworthy species include the Annex I bird species *Cygnus cygnus* (whooper swan) which winters at Keel Lough, and *Pyrrhocorax pyrrhocorax* (chough) which feeds on the ***21A0 Machairs**. The ***21A0 Machairs** habitat also provides a good habitat for breeding *Charadrius hiaticula* (ringed plover) (NPWS, 2013).

The site is situated in a scenic area, overlooked by the Menaun Cliffs, and is easily accessed by road. This makes the area popular for amenity use. The site is also used for agriculture, where it is grazed non-intensively by sheep.

2 CONSERVATION ASSESSMENTS

2.1 Overview

Trawmore, Keel was surveyed on the 26th and 27th July 2016 for the VSM. Of the two Annex I habitats recorded on the site during the baseline CMP survey, both were recorded in 2016. ***2130 Fixed dunes**

(grey dunes) were also recorded as present in 2016. The habitats found at Trawmore, Keel in 2016 and the results of the conservation assessments are presented in Table 1. The conservation status of **2120 Marram dunes (white dunes)**, ***2130 Fixed dunes (grey dunes)** and ***21A0 Machairs** were assessed as Unfavourable-Inadequate.

Table 1. Conservation assessment results for all Annex I dune habitats surveyed at Trawmore, Keel, Co. Mayo.

Habitat	Area	Structure & Functions	Future Prospects	Overall result
2120 Marram dunes (white dunes)	Favourable (improving)	Unfavourable-Inadequate (stable)	Unfavourable-Inadequate (stable)	Unfavourable-Inadequate (stable)
*2130 Fixed dunes (grey dunes)	Favourable	Unfavourable-Inadequate	Unfavourable-Inadequate	Unfavourable-Inadequate
*21A0 Machairs	Favourable (improving)	Unfavourable-Inadequate (stable)	Unfavourable-Inadequate (stable)	Unfavourable-Inadequate (stable)

2.1.1 Area

The areas of Annex I sand dune habitats at Trawmore, Keel are presented in Table 2. The baseline habitat areas presented here are taken from the baseline CMP maps for this site (Ryle *et al*., 2009), with some minor changes made as a result of re-interpretation of some sand dune habitats during the VSM. Comparisons are made between the baseline CMP areas and the VSM areas, as presented in Table 2, for changes in habitat area at this site.

Table 2. Areas of Annex I dune habitats mapped at Trawmore, Keel during the baseline CMP survey and the VSM.

Habitat	†Baseline CMP (ha)	VSM (ha)
2120 Marram dunes (white dunes)	1.87	1.28
*2130 Fixed dunes (grey dunes)	0.05	6.39
*21A0 Machairs	92.83	87.60
Total	94.75	95.27

†Note: Baseline CMP areas were revised based on re-interpretation of some habitats during the VSM survey.

2120 Marram dunes (white dunes) have decreased in area since the baseline survey; however, all loss in area appears to be due to natural processes, namely succession to both ***2130 Fixed dunes (grey dunes)** and ***21A0 Machairs**. New areas of **2120 Marram dunes (white dunes)** have developed since the baseline CMP survey, though not enough to offset the loss of area due to succession. ***2130 Fixed dunes (grey dunes)** have increased in area since the CMP. This increase is quite significant and is largely due to succession from **2120 Marram dunes (white dunes)** and a change from ***21A0 Machairs** to ***2130 Fixed dunes (grey dunes)**. ***21A0 Machairs** have decreased in area since the CMP, however all losses appear to be due to natural processes. These areas, which were previously mapped as ***21A0 Machairs,** are now either **2120 Marram dunes (white dunes)** or ***2130 Fixed dunes (grey dunes)**, possibly the result of erosion events or a change in the management regime of the ***21A0 Machairs**. Similar to **2120 Marram dunes (white dunes)** and ***2130 Fixed dunes (grey dunes)**, ***21A0 Machairs** have also had some development in a seaward direction since the CMP.

With regards to interpretation, both ***2130 Fixed dunes (grey dunes)** and ***21A0 Machairs** have had their CMP areas adjusted. One area of ***21A0 Machairs** in the east of the site was changed from ***21A0 Machairs** to ***2130 Fixed dunes (grey dunes)** by the VSM surveyors, while three areas of ***21A0 Machairs** which were not mapped during the CMP and one of ***2130 Fixed dunes (grey dunes)** were brought into the site during the VSM. The CMP areas of both habitats were adjusted accordingly. A further area of ***21A0 Machairs** was removed from the CMP area for this habitat as this area was clearly a car park based on the 2005 aerial photographs, rather than the Annex I habitat.

The total area of sand dune habitats has increased from 94.75 ha to 95.27 ha since the baseline CMP survey due to the seaward development and expansion of **2120 Marram dunes (white dunes), *2130 Fixed dunes (grey dunes)** and ***21A0 Machairs**. As all changes in area are due to either interpretation or natural processes, Area for all habitats was Favourable.

2.1.2 Structure and Functions

Table 3 shows the number of monitoring stops carried out in each habitat and the number of criteria assessed. The number of criteria that failed is also shown. The Structure and Functions of all three sand dune habitats at Trawmore, Keel were assessed as Unfavourable-Inadequate. **2120 Marram dunes (white dunes)** and ***21A0 Machairs** had two criteria fail, while ***2130 Fixed dunes (grey dunes)** had failure of a single criterion.

Table 3. Annex I sand dune habitats at Trawmore, Keel for which Structure and Functions were assessed, with the number of monitoring stops, assessment criteria and the number of criteria that failed.

Habitat	No. monitoring stops	Total no. assessment criteria	No. failed criteria
2120 Marram dunes (white dunes)	8	7	2
*2130 Fixed dunes (grey dunes)	8	11	1
*21A0 Machairs	12	10	2

2.1.3 Future Prospects

Impacts and activities recorded at Trawmore, Keel are presented in Table 6.4. Impact codes are assigned according to Ssymank (2011). Non-intensive sheep grazing was recorded as a positive impact on ***2130 Fixed dunes (grey dunes)** and a neutral impact on ***21A0 Machairs**. Horse-riding and walking, paved roads, car park and the golf course on ***21A0 Machairs** were recorded as neutral impacts. All other impacts recorded at Trawmore, Keel were negative impacts, with the majority associated with recreational activities. These included horse-riding and walking on both **2120 Marram dunes (white dunes)** and ***2130 Fixed dunes (grey dunes)**, the setup of a fairground on the ***21A0 Machairs**, trampling on ***2130 Fixed dunes (grey dunes)**, and off-road driving, camping, and litter on both ***2130 Fixed dunes (grey dunes)** and ***21A0 Machairs**. Other negative impacts recorded on the site included invasive non-native species within the ***2130 Fixed dunes (grey dunes)** and scrub encroachment.

Table 4. Impacts recorded in Annex I sand dune habitats at Trawmore, Keel in 2016. Source refers to whether the impact being scored originates inside or outside the Annex I habitat being assessed.

Habitat Code	Impact code	Impact description	Intensity	Effect	Percent of habitat	Source
2120	D01.03	Car park	High	Negative	10	Inside
2120	G01.02	Horse riding, walking	High	Negative	50	Inside
2120	J02.12.01	Rock armour	High	Negative	50	Inside
*2130	A04.02.02	Non-intensive sheep grazing	High	Positive	100	Inside
*2130	D01.02	Paved road	High	Negative	<1	Inside
*2130	G01.02	Horse riding, walking	Medium	Negative	10	Inside
*2130	G01.03.02	Off-road driving	Medium	Negative	5	Inside
*2130	G02.08	Camping	High	Negative	3	Inside
*2130	G05.01	Trampling	High	Negative	5	Inside
*2130	H05.01	Litter	High	Negative	1	Inside
*2130	I01	Invasive non-native species	High	Negative	<1	Inside
*21A0	A04.02.02	Non-intensive sheep grazing	High	Neutral	100	Inside
*21A0	D01.02	Paved road	High	Negative	<1	Inside
*21A0	D01.03	Car park	High	Negative	1	Inside
*21A0	G01.02	Horse riding, walking	Medium	Neutral	40	Inside
*21A0	G01.03.02	Off-road driving	Medium	Negative	5	Inside
*21A0	G02.01	Golf course	High	Neutral	5	Inside
*21A0	G02.06	Fairground setup on machair	Medium	Negative	<1	Inside
*21A0	G02.08	Camping	Low	Negative	<1	Inside
*21A0	H05.01	Litter	Low	Negative	<1	Inside
*21A0	K02.01	Gorse scrub	Low	Negative	1	Inside

2.2 Annex I habitat assessments

The conservation status of the Annex I habitats at Trawmore, Keel is discussed below. The present conservation status in 2016 is compared with the baseline status and if a habitat is not in Favourable status, the main reasons for the Unfavourable assessment are given. Areas recorded in 2016 are compared with the revised baseline areas. It should be borne in mind that natural processes such as erosion, deposition and succession are primary drivers of change on coastal habitats.

2.2.1 2120 Marram dunes (white dunes)

2120 Marram dunes (white dunes) were found on the western seaward side of the site close to Keel village. Here, they were the most seaward habitat mapped. It is worth noting that during the CMP the **2120 Marram dunes (white dunes)** were not considered to be naturally functioning at that time due to the fact that they were mostly man-made with an imported rock core.

Area

The area of **2120 Marram dunes (white dunes)** decreased from 1.87 ha to 1.28 ha since the baseline survey. This decrease is due to succession to both ***2130 Fixed dunes (grey dunes)** and ***21A0 Machairs**. Area of **2120 Marram dunes (white dunes)** was assessed as Unfavourable-Inadequate during the CMP due to the lack of natural development of this habitat and artificial stabilisation. **2120 Marram dunes (white dunes)** have expanded in a seaward direction since the CMP however, suggesting that there is a fresh supply of sand entering the site and that the **2120 Marram dunes**

(white dunes) are now functioning naturally. Area was assessed as Favourable (improving) during the VSM.

Structure and Functions

Eight monitoring stops were recorded in **2120 Marram dunes (white dunes)**, with Structure and Functions failing on one criteria. The disturbance criterion failed at Trawmore, Keel, with walking and horse-riding recorded as impacting negatively on 50% of this habitat. The Structure and Functions were assessed as Unfavourable-Inadequate in the baseline CMP survey due to the stabilised nature of the habitat. Structure and Functions of **2120 Marram dunes (white dunes)** were assessed as Unfavourable-Inadequate (stable) during the VSM.

Future Prospects

One high intensity negative impact, walking and horse riding (affected 50% of the habitat) was recorded for **2120 Marram dunes (white dunes)** in 2016. Rock armour affected 50% of the habitat, while the presence of a car park affected 10% of the habitat. However their impacts were considered neutral following the approach undertaken by the SDM in which most permanent built infrastructure, such as coastal defences and coastal roads, that were in place on the 1995 aerial photographs and had not undergone significant modifications or improvements since 1995 were scored as neutral. Future Prospects were assessed as Unfavourable-Inadequate in the baseline CMP survey due to the stabilised character of the **2120 Marram dunes (white dunes)**. Walking was also recorded as a negative impact for this habitat during the CMP. Future Prospects were assessed as Unfavourable-Inadequate (stable) during the VSM.

Conservation assessment

2120 Marram dunes (white dunes) were assessed as Unfavourable-Inadequate during the CMP and as Unfavourable-Inadequate (stable) in 2016.

*2.2.2 *2130 Fixed dunes (grey dunes)*

***2130 Fixed dunes (grey dunes)** are largely restricted to the west of the site, close to Keel village, where they are fronted by **2120 Marram dunes (white dunes)**. They have an unusual formation in one area close to the caravan park, where they have developed into a ring, with ***21A0 Machairs** habitat both inside and outside of the ring. Part of this ring of ***2130 Fixed dunes (grey dunes)** has succeeded from **2120 Marram dunes (white dunes)** which was noted by Ryle *et al.* (2009) as being artificially developed by the owner of the caravan park to provide shelter and protection for the caravans. ***2130 Fixed dunes (grey dunes)** were not mapped or assessed during the CMP, although a small area close to Sruhillbeg Lough in the east, was believed to be present at the time. For this reason, no comment on whether the condition of this habitat has improved, deteriorated or remained the same can be made.

Area

The area of ***2130 Fixed dunes (grey dunes)** increased from 0.05 ha to 6.39 ha between the baseline CMP survey and 2016, with much of the gain attributed to either succession from **2120 Marram dunes**

(white dunes) or due to a change from ***21A0 Machairs** to ***2130 Fixed dunes (grey dunes)**. Area of ***2130 Fixed dunes (grey dunes)** was assessed as Favourable during the VSM.

Structure and Functions

Eight monitoring stops were recorded in ***2130 Fixed dunes (grey dunes)**, with Structure and Functions failing on one criterion. Disturbance on this habitat exceeded the 20% upper threshold limit, with walking and horse-riding, trampling, camping, litter and off-road driving all contributing to this. Structure and Functions were assessed as Unfavourable-Inadequate during the VSM.

Future Prospects

Non-intensive sheep grazing was the only positive impact recorded for ***2130 Fixed dunes (grey dunes)** at Trawmore, Keel, the road was assessed as neutral as it was present on the 1995 aerial photograph and had not been significantly altered since. The remaining impacts were negative and either of medium intensity (horse-riding and walking, off-road driving) or high intensity (camping, trampling, litter, invasive non-native species). Due to the negative impacts Future Prospects were assessed as Unfavourable-Inadequate during the VSM.

Conservation assessment

***2130 Fixed dunes (grey dunes)** were assessed as Unfavourable-Inadequate during the VSM. This is due to the presence of negative impacts, particularly those related to recreation, on the habitat.

2.2.3 Machairs

***21A0 Machairs** is the most extensive sand dune habitat mapped at Trawmore, Keel. It extends from Keel village in the west to just short of the foothills of the Menaun cliffs in the south-east along the coast, and landwards to the shores of Keel Lough. In the eastern part of the site, it is the most seaward habitat mapped.

Area

The area of ***21A0 Machairs** decreased from 92.83 ha to 87.60 ha since the baseline survey. This decrease is due to a change in the ***21A0 Machairs** habitat to both **2120 Marram dunes (white dunes)** and ***2130 Fixed dunes (grey dunes),** and also from natural erosion along the seaward edge of the site. Where the ***21A0 Machairs** habitat has changed to **2120 Marram dunes (white dunes)**, this has occurred along the seaward edge of the site where erosion of the ***21A0 Machairs** habitat has occurred since the CMP, with the area recolonising as **2120 Marram dunes (white dunes)**. There are also two large areas of ***21A0 Machairs** which have developed into ***2130 Fixed dunes (grey dunes)** since the CMP. The largest of these areas (4.1 ha) is located close the caravan park where **2120 Marram dunes (white dunes)** were artificially developed and planted with *Ammophila arenaria* (marram) by the caravan park owner (Ryle *et al.*, 2009). By examining 2005 aerial photos, it is obvious that the area of ***21A0 Machairs** adjacent to this was very disturbed with a lot of bare sand visible. It is likely that the *Ammophila arenaria* colonised these areas of bare sand and succeeded to firstly **2120 Marram dunes (white dunes)** and then to ***2130 Fixed dunes (grey dunes)**, fundamentally changing the nature of the ***21A0 Machairs** habitat to that of ***2130 Fixed dunes (grey dunes)**. There was also a small natural increase of ***21A0 Machairs** area since the CMP, though not enough to offset the loss.

Area was assessed as Unfavourable-Inadequate during the CMP as a result of a loss of area from the development of a golf course on the habitat, and also due to the presence of a dump where no machair vegetation was present. As the loss of ***21A0 Machairs** habitat since the CMP cannot be attributed directly to anthropogenic influences, Area was assessed as Favourable (improving).

Structure and Functions

Twelve monitoring stops were recorded in ***21A0 Machairs**, with two criteria failing the Structure and Functions assessment. Bryophyte cover was too low in one stop close to Sruhillbeg Lough, while the mean height of the vegetation at 2.2 cm also too low. The low vegetation height indicates that grazing levels at the site are too high. Structure and Functions were assessed as Unfavourable-Inadequate during the baseline CMP survey due to overgrazing leading to a very low vegetation height. Structure and Functions of ***21A0 Machairs** were assessed as Unfavourable-Inadequate (stable) during the VSM.

Future Prospects

Non-intensive sheep grazing was recorded as a high intensity neutral impact affecting 100% of the ***21A0 Machairs** habitat. The reason for scoring the impact as neutral rather than positive was due to the slightly high stocking density at the site, leading to higher grazing levels and nutrient inputs than are ideal. Horse-riding and walking, paved roads and a car park, as well as the presence of the golf course were also assessed as neutral impacts on the habitat. There were two medium intensity negative impacts recorded as impacting on the ***21A0 Machairs** habitat (off-road driving and the set-up of a fairground on the habitat), and three low intensity negative impacts (camping, litter and scrub encroachment). Of the negative impacts, only off-road driving affected more than 1% of the habitat. Future Prospects were assessed as Unfavourable-Inadequate during the CMP due to overgrazing and the presence of the golf course. VSM surveyors felt that the presence of the golf course was a neutral impact while overgrazing remains an issue for the ***21A0 Machairs** habitat in 2016. Future Prospects were assessed as Unfavourable-Inadequate (stable) during the VSM.

Conservation Assessment

***21A0 Machairs** were assessed as Unfavourable-Inadequate during the baseline CMP due to overgrazing and the presence of the golf course resulting in unfavourable Area, Structure and Functions and Future Prospects. ***21A0 Machairs** was assessed as Unfavourable-Inadequate (stable) during the VSM.

3 DISCUSSION

3.1 Agriculture

During the CMP it was recommended that the grazing on the ***21A0 Machairs** habitat should be reduced so as not to compromise the ecological stability of the habitat, and the CMP referred to the MPSU Management Plan (1999-2004) which recommended a stocking rate of 2.5 sheep/ha or 0.5 cattle/ha. Although stocking rates were not measured during the VSM, the grazing levels within the ***21A0 Machairs** were assessed to still be too high with a mean vegetation height of only 2.2 cm recorded. However, even in the ***21A0 Machairs** the impact of sheep grazing was assessed to be

neutral due to its' essential role in the management of the habitat. Of all the negative impacts recorded at Trawmore, Keel in 2016, none were associated with agriculture.

3.2 Recreation

Trawmore, Keel is located within an area popular with tourists. It is adjacent to Keel village and is easily accessed by a paved road which runs through the ***21A0 Machairs** habitat. The site offers scenic views of the Menaun cliffs, Slievemore and surrounding areas and has a large sandy beach which is attractive to walkers, horse-riders and sunbathers. Water sports, both at the adjacent Keel Lough and at the beach, are very popular too. The main impacts associated with recreation recorded in 2016 include the car park, trampling, litter, the golf course, camping, off-road driving, the set-up of a fairground on site, and walking and horse-riding. Many of these impacts are high-intensity negative impacts and present the largest threat to the viability of the sand dune habitats present at Trawmore, Keel. As such, amenity use of the site should be monitored closely to ensure no long-term or permanent loss of habitats occurs.

3.3 Habitat stabilisation

Some sand dune habitats at Trawmore, Keel have been modified by humans in an attempt to prevent further erosion and to stabilise the area. Most of the **2120 Marram dunes (white dunes)** mapped by the CMP were artificially made and comprised an imported rock core (Ryle *et al.,* 2009). Marram planting was also used to help stabilise this habitat. Typically, any attempts to alter the natural erosion and deposition cycles on our coasts are viewed negatively, as these attempts can impair the functioning of the whole system through over-stabilisation. The use of "sympathetic" management techniques, such as marram planting, and their impact on sand dune systems can be difficult to assess and a decision on their use should be made on a site by site basis. It appears that the original assessment of **2120 Marram dunes (white dunes)** as being over-stabilised and not functioning naturally, has changed since the CMP. This habitat has succeeded to both ***2130 Fixed dunes (grey dunes)** and ***21A0 Machairs**, and more importantly, has naturally accreted in other areas even though rock armour is present. There have also been some losses due to natural erosion. To all intents and purposes, the **2120 Marram dunes (white dunes)** appear to be functioning naturally and dynamically at this site at present, and the Marram planting has allowed the habitat to become self-sustaining.

***21A0 Machairs** has changed to ***2130 Fixed dunes (grey dunes)** in some parts of the site. It is hypothesised that marram colonised bare areas of sand within the ***21A0 Machairs** habitat, from nearby planted areas, and eventually succeeded to ***2130 Fixed dunes (grey dunes)**. The most likely cause of the bare sand is due to trampling and overgrazing which were both recorded as negative impacts during the CMP. One could argue that since the ***21A0 Machairs** did not recover, and instead, developed into a different habitat, that the loss should be assessed as Unfavourable as the cause was anthropogenic in nature. However, assessment of individual Annex I habitats should be considered in the context of the wider landscape, taking interactions with other habitats into account. Sand dune habitats often have a very diffuse boundary between each other and succeed from one to the other, with re-mobilisation of sediment also occurring so more stabilised dune habitats form fore-dunes again. Since the ***21A0 Machairs** habitat changed to another Annex I sand dune habitat, this loss of habitat, *in this case,* was not deemed to be Unfavourable. The dune system as a whole has not

lost any area due to anthropogenic influences, rather the proportions of each habitat within the system has changed.

3.4 Climate change

Due to the extensive erosion of coastal systems within Ireland during the winter storms of 2013/14 and evidence that an increase in Atlantic storms over the last few decades could be due to climate change (Masselink *et al.*, 2016), the impact of climate change on all sand dune habitats, particularly the foredune habitats, should be assessed. Based on comparisons between the VSM mapping recorded in 2016 and the CMP mapping recorded in 2006, there has been some loss of sand dune habitats, particularly of **2120 Marram dunes (white dunes)**, but no major losses due to natural erosion. Although there have been losses, the impact of climate change has not been assessed for this site however as it would be more appropriate if an assessment of this impact was made at the national level.

A site-specific management plan addressing the issues discussed in sections 3.1 to 3.3 would help improve the Future Prospects of **2120 Marram dunes (white dunes), *2130 Fixed dunes (grey dunes),** and ***21A0 Machairs**, and this would ultimately improve their overall conservation assessments.

4 REFERENCES

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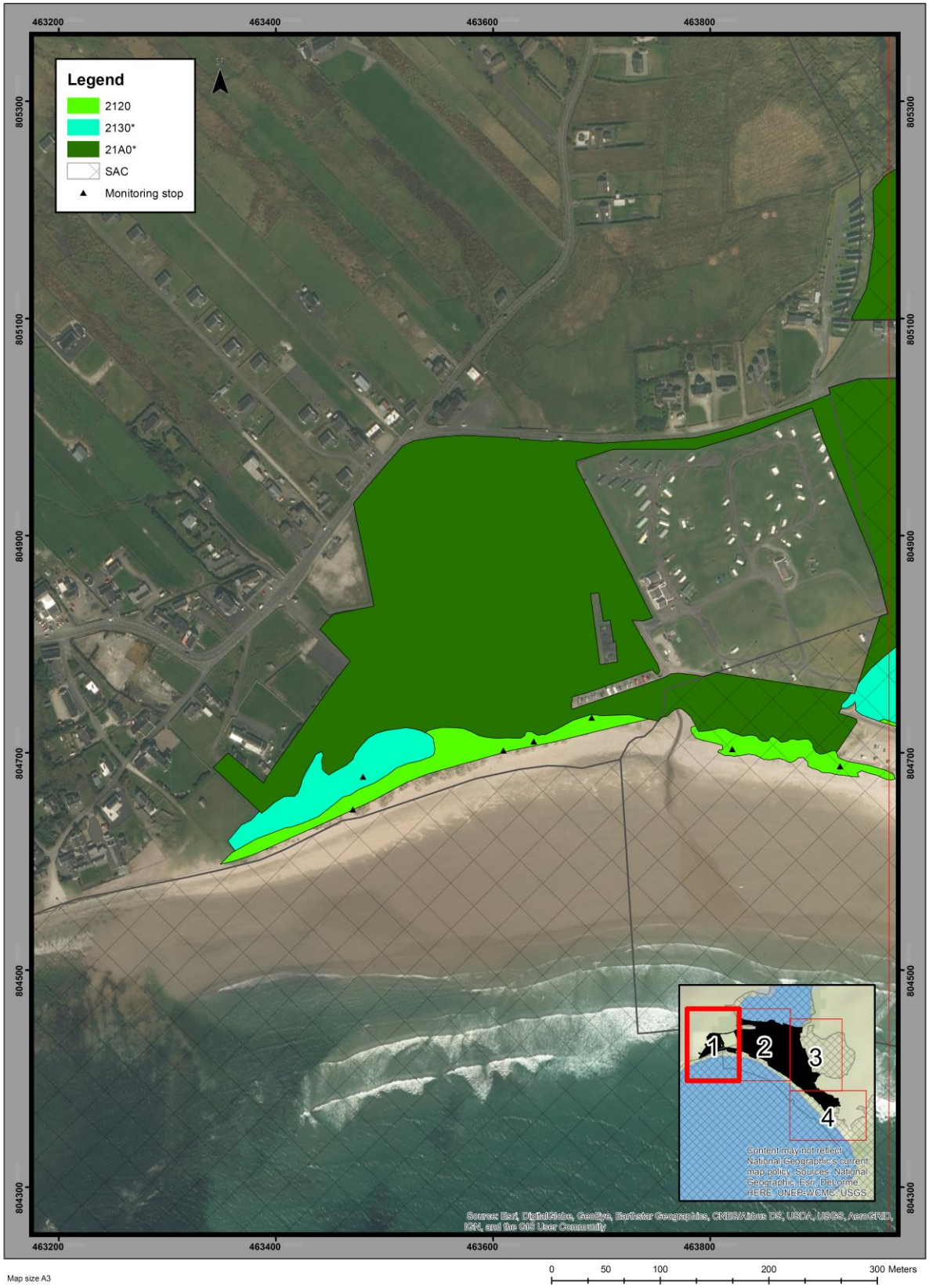
MAP 1 Site 006 Trawmore, Keel, Co. Mayo



MAP 2 Site 006 Trawmore, Keel, Co. Mayo

MAP 3 Site 006 Trawmore, Keel, Co. Mayo

MAP 4 Site 006 Trawmore, Keel, Co. Mayo