Management prescriptions for twite in Ireland

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Cover photo: Twite during winter season © Liam McDevitt

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EXECUTIVE SUMMARY

The twite *Carduelis flavirostris* is one of only three passerine species on the Red List of Birds of Conservation Concern in Ireland. The national population is estimated at between 54 and 110 breeding pairs with an estimated minimum of 650 – 1100 birds in winter. Therefore, breeding twite can be categorised as being 'Endangered' using the IUCN criteria for the categorisation of Red List species and are thus considered to be facing a 'very high risk of extinction in the wild' in Ireland.

Due to the precarious situation regarding the twite breeding population in Ireland, it is vital that land management prescriptions and species policy now focus on their conservation.

The implementation of successful conservation plans for bird species can often be complicated due to the large areas the species may cover between the winter and summer seasons. In the case of twite however, due to the sedentary nature of our population, conservation action plans focused in the areas they occur have the potential to be highly successful in targeting both breeding and wintering populations.

The primary aim of this document is to outline the ecological requirements of twite in Ireland and to give guidance on the enhancement of twite habitat through suitable land management. It will be useful to those providing advice to landowners in areas where twite occur and will inform future conservation policies in these areas. As this is the first such document on twite in Ireland, many of the suggested interventions have not previously been tested here and should be closely monitored to ensure their long-term success.

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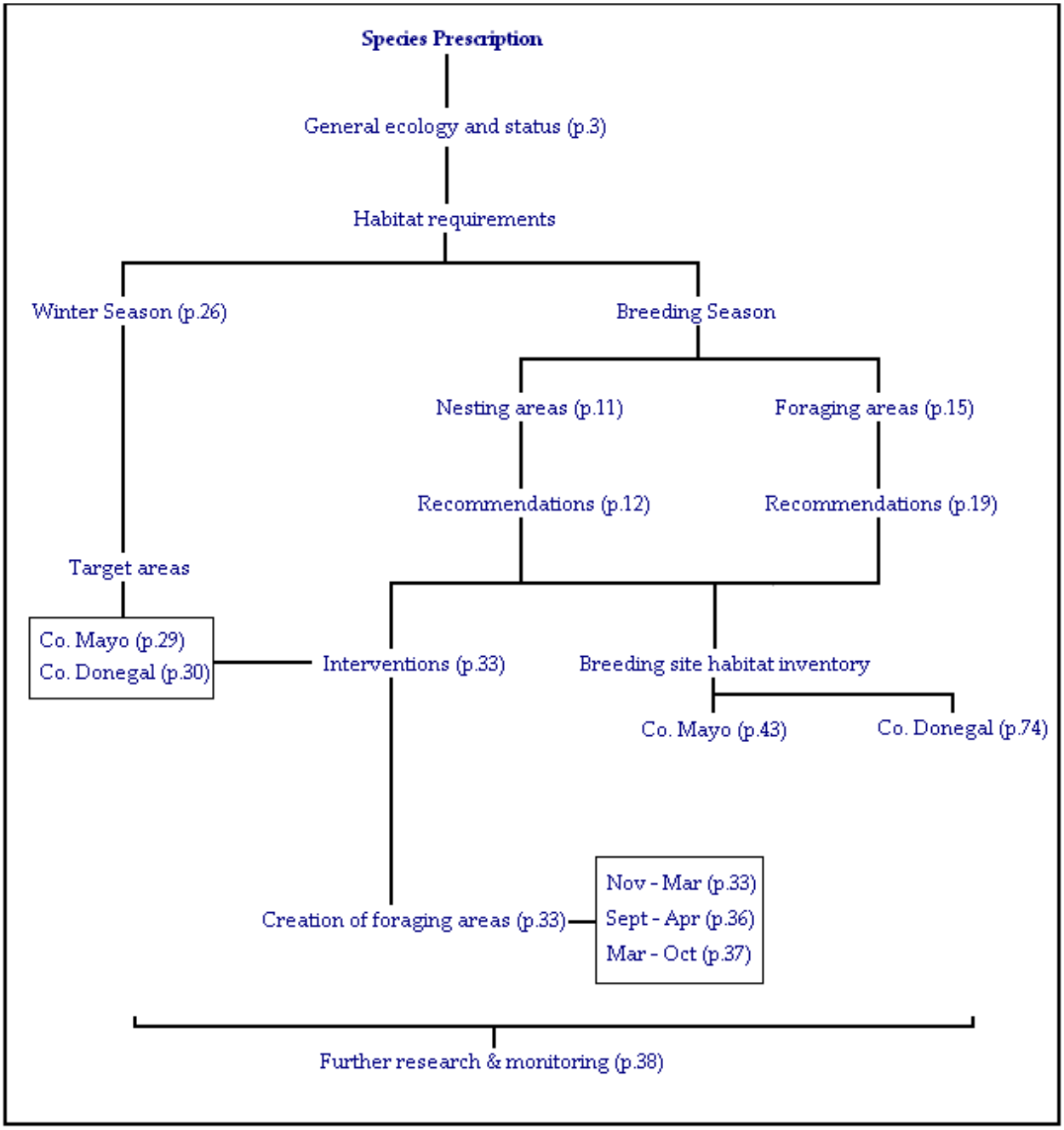
DOCUMENT MAP

Schematic of the layout key sections of this document.



1.0 INTRODUCTION

1.1 Background

The twite *Carduelis flavirostris* is a member of the finch family that breeds and winters in Ireland. It has a disjunct world population, being found on the coastline and mountains of northwest Europe, and over 2,700km away, in the uplands of Central Asia, from eastern Turkey to Tibet and western China. Twite of the subspecies *C.f. pipilans* is thought by some to be endemic to Ireland and Britain (Brown *et al.* 1995).

1.2 Current status

Twite are listed as a Red Data species, along with being red listed in the Birds of Conservation Concern, in Ireland (Whilde 1993, Lynas *et al.* 2007) and in Britain (Eaton *et al.* 2009). Their population in Ireland is estimated at between 54 and 110 breeding pairs, which are mainly found along the coasts of west Co. Donegal and north Co. Mayo. Small breeding populations also occur in west Co. Kerry, northwest Galway, north Donegal and along the north Co. Antrim coast (Figure 1). The minimum winter population is estimated at between 650 and 1,100 birds. These birds generally occur in coastal areas in the northern half of the country from Achill Island in the northwest to Strangford Lough in the northeast (Figure 1; McLoughlin & Cotton 2008). Many of these wintering birds are thought to be migrants originating in Scotland (McLoughlin *et al.* 2010). Due to the potentially large distance twite have been known to move (Raine *et al.* 2006), small winter flocks (comprising <10 individuals) may occur on any coastal area in Ireland.

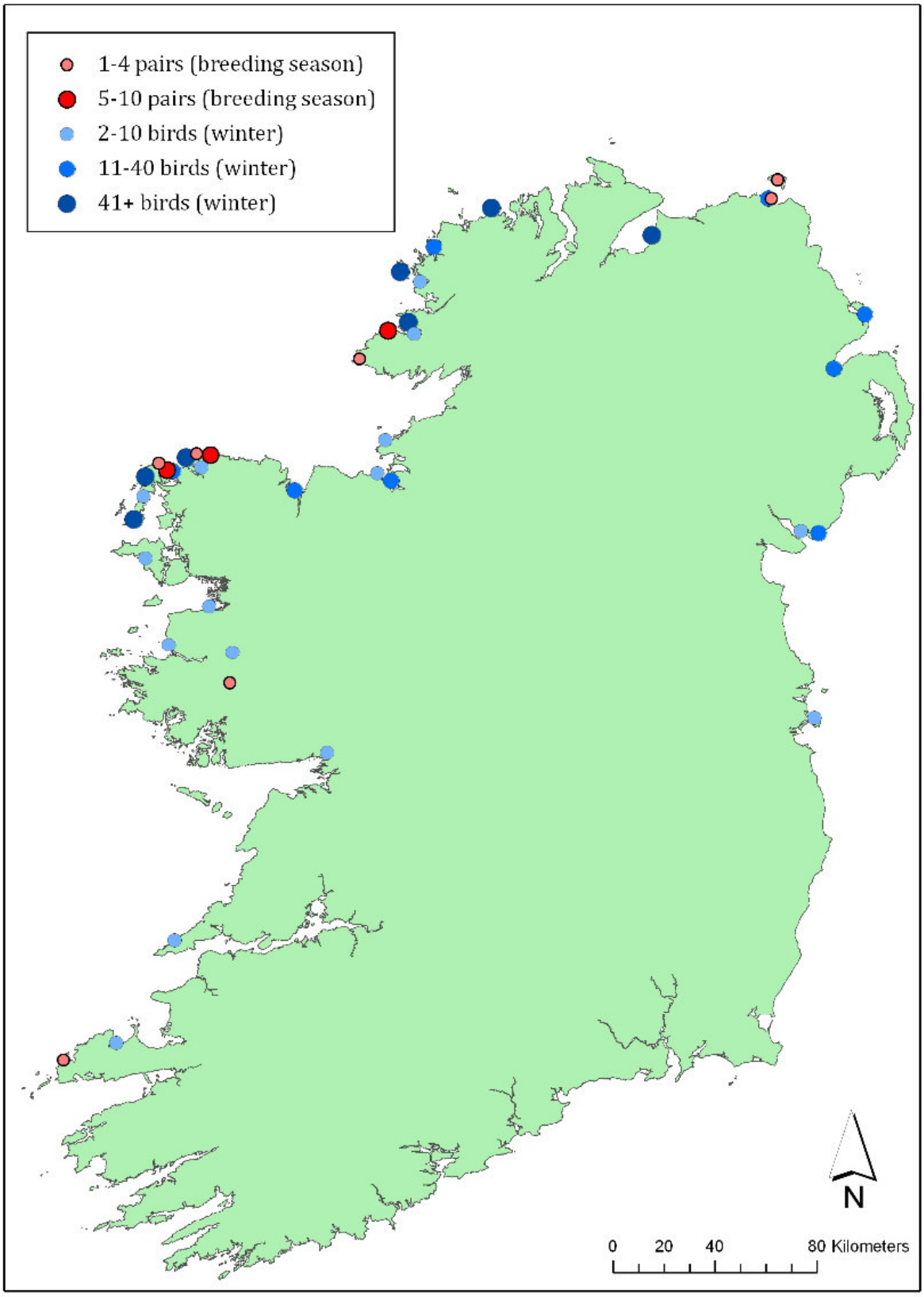


Figure 1. Twite breeding and winter distribution 2005 – 2008 from McLoughlin & Cotton (2008).

1.3 Aspects of the twite's ecology

1.3.1 Nesting biology

Twite nests are generally found in bracken *Pteridium aquilinum* and ling heather *Calluna vulgaris*, usually less than 50cm above the ground (McGhie *et al.,* 1994). Nests have also been recorded in a wide variety of other habitats including rushes *Juncus* spp., stonewalls, thistles *Cirisium* spp. (Brown *et al.,* 1995), coniferous plantations (Wilkinson & Wilson, 2010) and cliff ledges with or without vegetation (Cramp, 1998). The nests are generally built using grasses and plant stems and are almost invariably lined with wool, hair or feathers (Plate 1; Harrison & Castell, 1998). As with the linnet *Carduelis cannabina* and redpoll *Carduelis flammea*, it is the female that chooses the nesting location, constructs the nest, and incubates the eggs and young. The male generally 'stands guard' within approximately 20 metres of the nest, singing from a prominent perching point, e.g. a clump of heather or bracken, a rock, or cliff top position.

Photo © Derek McLoughlin

Plate 1: Twite nest with six eggs in heather on the Mullet Peninsula, Co. Mayo.

Twite (and most other Cardueline finches) tend not to defend large territories, in or out of the breeding season but instead nest in loose colonies and forage throughout the year in flocks (Newton 1972).

The twite's mating system is apparently mainly monogamous with some examples of polygamy as noted by Marler & Mundinger (1975). Pair formation is said to occur in the late winter & spring flock

(Cramp, 1998, D. McLoughlin pers. obs.). In Britain and Ireland, egg laying begins in mid- to late April and continues until August. However, laying in northern Scotland is a little later with the first eggs in mid-May and the last in mid-August. Some of the Norwegian birds lay from early April to mid-August.

Twite tend to have two broods during the course of the breeding season with the average clutch sizes of 5 or 6 eggs. The female generally lays an egg a day and probably commences incubation after the third or fourth egg. Incubation takes approximately 12 or 13 days and hatching may occur over a two or three day period. Both parents feed the young although there are records of males taking no part in the provisioning of the chicks. The young are fed by regurgitation usually by seeds alone but occasionally by a mixture of both seeds and insects.

Photo © Derek McLoughlin

Plate 2: Typical twite nest site in Ireland with long heather occurring in areas generally not accessible to sheep grazing.

1.3.2 Feeding ecology

Small seeds form the sole diet for twite throughout the year. Cramp (1998) surmises that the few birds in whose diet invertebrates have been found may have inadvertently picked them up in the course of foraging for seed.

Twite feeding behaviour is relatively versatile. Depending on the particular sward height and composition, if a suitable seed is present, twite will pick seed from the ground, bend stalks to access seed head (e.g. dandelion), or perch on the plant (e.g. sorrel). Certain targeted seed plants require very short grazing to become available to twite (e.g. pearlwort). However dense long grass swards limit their ability to feed on the ground.

1.3.3 Winter / non-breeding season ecology (September - April)

Wintering twite are strongly associated with saltmarshes, particularly in England and the Low Countries, where they target glasswort spp. (Atkinson, 1998, Dierschke & Bairlein, 2004). In Ireland winter flocks also target saltmarsh habitat along with areas of disturbed ground, and drift lines, where they also feed on the seeds of plants including sea arrowgrass, orache spp., and sea mayweed.

1.3.4 Movement patterns

Irish breeding twite generally appear to be sedentary and over-winter within 30km of their breeding areas (McLoughlin *et al.,* 2010). During the winter season Irish populations are augmented by migrants from the Western Isles of Scotland. Other Western Isles breeding twite have been found to winter on the Lancashire and Cumbrian coasts of England. Raine *et al.* (2006) demonstrated the highly mobile nature of twite when he recorded movements of greater than 400km between breeding and wintering sites in England.

1.4 Relevant legislation

Twite are not listed in Annex I to the EU Birds Directive, however, they are afforded some protection under Article 4.2 to the EU Birds Directive and Appendix III to the Berne Convention. Through the United Nations Convention on Biological Diversity (CBD), which Ireland became a signatory to in 1996, a national Biological Diversity Plan (BDP) was put in place. The BDP is the route taken to put in place Species Action Plans (SAP), which are species specific plans designed to propose and implement measures to conserve species of conservation concern (Anon, 2005).

1.5 Threats to the twite

The primary threat to twite in Britain, and main reason for its decline, is considered to be a reduction in the food supply through the loss of hay meadows used during the breeding season and a loss of salt marsh used during the winter (Atkinson, 1998; Newton, 2004). Agricultural intensification resulting in reseeding of fields with perennial rye grass *Lolium perenne*, earlier cutting dates, and more intensive grazing, is widely considered to be the main cause of the loss of suitable foraging habitat in the breeding season (Newton, 2004; Raine, 2006). The threat of climate change to twite populations is unclear and difficult to ascertain (Norris *et al.,* 2004).

Large-scale agricultural intensification has also taken place over the past four decades in Ireland, largely as a consequence of the European Union's Common Agricultural Policy (CAP). CAP has been linked to a decrease in bird populations throughout the European Union for the same period (Donald *et al*. 2002). One of the manifestations of this agricultural intensification in Ireland was the increase in sheep populations on the uplands from 3.3 million in 1980 to 8.9 million in 1992 (The Heritage Council, 1999; Walsh *et al.,* 2001). This gave rise in many western areas to serious overgrazing of upland areas and a subsequent decrease in upland biodiversity (Geerling *et al.,* 2002). Large-scale plantations of coniferous forestry possibly represent a threat to twite nesting habitat in upland areas in Ireland. In addition, genetic drift due to population fragmentation and isolation may also pose a further threat to populations.

As one potential approach to combat the impacts of climate change is the expansion of renewable energy technologies, developments including wind farms, (and possibly other new technologies such as pump-storage hydro-electric schemes) will inevitably become more common in the Irish landscape. Wind farms generally require exposed upland sites, and where they are placed in or near twite breeding areas, they may result in a loss of twite nesting habitat.

The populations of many other species of farmland bird in Western Europe that share some aspects of the twites' habitat requirements have also suffered as a result of agricultural changes. The list of species to have undergone severe population decline includes grey partridge *Perdix perdix*, stock dove *Columba oenas*, yellowhammer *Emberiza citrinella*, and corn bunting *Miliaria calandra*, which is now thought to be extinct as a breeding species in Ireland (Taylor & O'Halloran, 2002).

1.6 Agri-environment schemes relevant to twite

Ireland's agri-environment scheme REPS (Rural Environmental Protection Scheme) was revised in June 2004 and re-launched as REPS 3. REPS 3 included enhanced biodiversity measures in relation to grassland management (including options for Traditional Hay Meadows and Species-Rich Grassland), retaining wildlife habitats (including options for creation of a New Habitat and Nature Corridors), tillage crop production (Management of Straw and Stubble and Establishment of an Uncultivated Margin with options including Green Cover Establishment, Environmental Management of Set-aside and Increased Arable Margins) and a Supplementary Measure, LINNET (Land Invested in Nature, Natural Eco-Tillage) habitats. REPS 4, which develops the options available in REPS 3, was launched in 2007 and will run until 2013, at which point the REPS will cease. Although the REPS had measures that may benefit twite none were specifically aimed at twite.

In 2009, the Agri-Environment Options Scheme (AEOS) was launched as a replacement for REPS 4. The measures in this scheme which may benefit twite are the 'Species Rich grassland' and 'Wild Bird Cover' options. As with the REPS, no measure in the AEOS specifically targets twite, however, the 'Wild Bird Cover' option suggests triticale, rape and mustard, all of which may be used by twite (Anon, 2010). Twite would benefit from this measure if landowners in their wintering areas participate in this option.

The chough *Pyrrhocorax pyrrhocorax* occurs throughout much of the west and south coasts of Ireland, including many twite breeding areas. As the Chough is listed as an Annex I species under the EU Birds Directive, Special Protection Areas have been designated to protect chough and their preferred habitat. Management activities in their preferred foraging habitat include heavy grazing regimes to give tight

sward grassland (Anon 2006). This raises a potential conflict in conservation interests as twite require long heather for nesting and traditional hay meadows for foraging.

1.7 Previous work on twite in Ireland

Although some data on twite populations and distribution in Ireland was presented in the previous breeding Atlases (Sharrock 1976, Gibbons *et al.* 1993), much of the previous information on twite in Ireland was largely anecdotal giving rise to informed opinion. A PhD study on the general ecology of twite in Ireland by McLoughlin (2009) investigated the current status of twite in Ireland (McLoughlin & Cotton 2008), the movement patterns in the breeding strongholds (McLoughlin *et al.*, 2010), and their breeding habitat requirements. This information has been augmented with data from similar studies in Britain to compile this conservation plan for twite in Ireland.

1.8 Twite management prescription

The purpose of a species prescription is to document the necessary actions required to manage a given species.

The format of this prescription comprises five sections on the following: Nesting areas (Section 2.0), Foraging areas (Section 3.0), Summary of breeding season conservation measures (Section 4.0), and Winter season (Section 5.0). Each section gives a brief general discussion on the ecological requirement in an Irish context and shows similar examples from twite studies in Scotland and England. Suggested conservation actions are detailed in tables towards the end of each section.

Sections 6.0 and 8.0 present proposed conservation efforts for twite in Ireland, which will focus initially on the 30km radius around known breeding colonies. Within this area, maps are given for all known breeding colonies, outlines of approximate breeding home range, important foraging areas for the breeding season, inventory of all habitats within 2km of known nest sites, and target areas for winter conservation measures (Section 8.0). Additional sites with the potential to sustain breeding twite are also outlined as target areas which would form areas of expansion. These recommendations should be available to all interested parties including NPWS regional staff, agri-environment scheme planners and policy makers, and ultimately should be incorporated as a measure under such schemes including the NPWS Farm Plan Scheme (FPS) along with any similar measure for other species, e.g. corncrake *Crex crex*.

1.9 Gaps in knowledge of twite in Ireland

As the first study on twite in Ireland was only recently completed (2008/2009), there are still many gaps in our knowledge that should be addressed. The two primary gaps are their nesting biology, and winter ecology.

1.10 Future monitoring of twite in Ireland

For a relatively short-lived species whose breeding population is vulnerable to extinction in Ireland, numbers of breeding twite should be surveyed regularly to monitor any further decline. In addition, a crucial element of a species prescription is the monitoring of any management actions taken for the

conservation of the species in order to assess the effectiveness of those actions. Monitoring recommendations are presented in Section 6.0.

2.0 NESTING AREAS AND BREEDING SEASON ROOST SITES

2.1 Nest site requirements

Of a total of 72 Irish nests sites observed between 2005 and 2008, 68 have been in long heather (height >0.3 metres) with four in bracken. The nests located in heather were generally associated with steep slopes, often with the heather over-hanging rock. They invariably faced between northeast and east in direction. Raine (2006) noted that most of the 212 twite nests found in the South Pennines during his study of twite were in bracken litter or long heather. He observed a higher breeding success rate during the nestling stage amongst birds that nested in heather. These nests were generally on east facing slopes and it is thought that this provides some protection from the prevailing wind. This explanation may also be applicable to the direction Irish nest colonies face. However, it is difficult to test this hypothesis in Ireland as very few south facing slopes in the Irish twite strongholds have adequate heather height. This is often due to relatively intense grazing pressure. Raine (2006) also mentions several unusual examples of birds nesting on such places as a cliff wall and half way up the fronds of bracken at the edge of a canal. On South Uist in the Western Isles of Scotland, Wilkinson & Wilson (2010) found that twite nested in young shelterbelt coniferous trees.

Photo © Colin Stafford-Johnson

Plate 3: Twite provisioning chicks in August with Marsh or Spear thistle seed at nest in heather near Maghera, Co. Donegal.

It is clear that long heather is vital as a nesting habitat for twite in Ireland. Overgrazing and burning, which result in such grasses as purple moorgrass *Molinia caerulea* and mat-grass *Nardus stricta* dominating, and undergrazing which results in shrub encroachment, are both detrimental to nesting

habitat. Further threats to nesting habitat include afforestation and peat harvesting of blanket bogs. However, more detailed studies of their breeding biology are required to assess breeding success in an Irish context.

2.2 Breeding season roost sites

Between late April and September birds in counties Mayo and Donegal generally roost in long heather, and occasionally bracken. In an area where long heather is lost, twite lose both nesting and roosting areas. After the breeding season when flocks move away from their natal areas, in the absence of heather, birds have been observed roosting in bracken. As discussed by Raine (2006) this raises an interesting conservation conflict where bracken is removed from such important habitats as machair, which is listed as a priority habitat under Annex I of the EU Habitats Directive. An example of this conflict in the prescription area is at Sheskinmore National Nature Reserve, west County Donegal. Extensive beds of bracken occur adjacent to a mixed crop cereal plot. Twite regularly feed on quinoa *Chenopodium quinoa* seed in this cereal plot throughout the autumn. Flocks of up to 60 birds roost in the adjacent bracken beds and bracken litter. Linnet also used these beds as roost sites. Bracken beds should be maintained for roosting (and nesting) twite when they occur within twite breeding areas. This may involve the fencing of areas to take account of potential different management regimes of an area or the zoning of priority areas, which should be maintained and not sprayed.

2.3 Conservation actions in the nesting areas

In terms of conservation actions for twite nesting areas, suitable habitat should be identified within the current known breeding range of twite, i.e. areas with a sloped gradient on blanket bog with existing heather coverage. As the loss of areas of long heather will result in the loss of twite nesting habitat it is vital that such areas be maintained and enhanced through adequate management. This management should entail grazing stocking limits that will allow the growth of large heather patches of a variety of age and height. Initially, this could be achieved through summer grazing by sheep, as they target grassy areas rather than heather during the summer (Thompson *et al.,* 1998). Thompson *et al.* (1998), recommend a grazing density of less than two ewes per hectare for a good heather condition. These large patches of heather of varying age and height would also benefit other upland species such as red grouse *Lagopus lagopus* (Cummins *et al.,* 2010), which is also on the red list of Birds of Conservation Concern in Ireland (Lynas *et al*., 2007). In County Mayo, where long heather accounted for less than 2% of the twite breeding areas, this heather enhancement and maintenance would greatly increase the proportion of available nesting sites. The rehabilitation of suitable nesting areas could be achieved through fencing potentially suitable areas and allowing only restricted access to sheep/cattle grazers. These suitable areas are detailed in the accompanying prescription maps (Section 8.0).

However, any such measures have to be cognisant of potential impacts on the chough, an Annex I species under the EU Birds Directive, and indeed other species of flora and fauna. Chough require a short sward of less than 5 cm for foraging (Kerbiriou *et al.,* 2006), and are present as a breeding species in all of the known twite breeding areas in Ireland (Gray *et al*., 2003). As a consequence of its Annex I status, areas with a significant national breeding population of chough qualify for Special Protection Area (SPA) status. Although the prescription area in County Mayo is not listed as an SPA for chough, the west County Donegal area is listed. Due to its SPA status, the National Parks and Wildlife Service (NPWS)

offer an incentive to farmers to manage their farms specifically for chough under the NPWS Farm Plan Scheme (FPS). The prescriptions within the NPWS FPS chough measure does not specify stocking rates, however, it requires that a sward height of 2-3 cm be maintained over 40% of the target habitat within the chough SPA. In a scenario where heather cover decreased as a result of heavy grazing for chough, twite nesting habitat may be negatively affected. In cases where the grazing element of the chough measure conflicts with habitat protection within a Special Areas of Conservation (SAC), this Farm Plan may not be applied. The chough measure of the Farm Plan cannot be applied to commonages.

Conversely, the consequence of increased heather coverage in chough nesting areas may be reduced numbers of chough as noted on Ramsay Island by Bullock (1980).

Conservation actions for nesting areas. " * " indicates that this action is addressed in this report (Section 8.0).

1. Identify the core breeding areas, which should be steep (ideally east-facing) slopes with suitable nesting vegetation. *
2. Identify former breeding areas which do not currently hold birds and, where suitable, target for habitat restoration. *
3. Maintain, or create, a heterogeneous mix of moorland vegetation, particularly of long heather.
   - This could be achieved through fencing suitable areas, which would allow controlled grazing.
4. Prevent the development of a monoculture of grasses, particularly purple moor-grass or mat-grass
5. Reduce overgrazing by lowering stocking density to a level suitable for maintaining a mixed moorland flora.
6. Prevent burning of large areas of blanket bog, particularly within 300 m of the coast.
7. Prevent succession of moorland to scrubland and woodland by controlled grazing, cutting or burning.
8. Maintain bracken stands but prevent them from increasing in dominance or encroaching on dwarf shrubs.
9. Prevent afforestation of potential breeding areas by careful consideration of the location of proposed plantations.
10. Engage in local education on the twite

2.4 Conservation prescriptions for twite in nesting areas in England

The primary nesting area conservation recommendations relating to twite in England relate to the maintenance of heather and bracken for nesting. In the South Pennines, conservation recommendations strongly advocate the maintaining of existing bracken and encouragement of further bracken beds (generally bracken litter). The reason for the preference for preservation and encouragement of bracken as a nesting habitat is due to the relative ease of creation. In contrast, the restoration and creation of ericaceous shrub can take several years to establish as a suitable nesting area for twite despite giving rise to a greater breeding success rate at the nestling stage (Raine, 2006).

Twite conservation prescriptions for nesting areas in the South Pennines, England, comprise the following:

1) Stocking densities should be manipulated at nesting areas by fencing off suitable sites. In damp sites, some spring grazing may be required to allow bracken to out-compete purple moor-grass.
2) Firebreaks should be cut in zones (particularly in purple moor-grass) around nesting colonies or on the top of cloughs (gorge or narrow ravine) to prevent fire reaching the breeding colonies.
3) Consultations and management should be agreed with landowners to ensure that burning, grazing, afforestation and other management regimes are done in line with the 'Twite Recovery Project' (Available from www.rspb.org.uk/ourwork/projects/details/222974-england-twite-recovery-project).
4) Where possible, encourage mature heather in order to create habitat diversity in the long term.

3.0 BREEDING SEASON FORAGING AREAS

3.1 Habitat and food requirements

Twite in Ireland mainly forage in species-rich meadows, short grassland, and roads and tracks. Following Fossitt (2000), these habitats equate to dry-humid acid grassland, lower saltmarsh, buildings and artificial surfaces, and disturbed ground and spoil. These do however vary throughout the breeding season (Figure 2). Raine (2006) found a similar preference for species-rich meadows that were rich in seeding wildflowers and an avoidance of reseeded pasture, freshly cut fields, and areas of shrub or woodland.

Between April and September, twite primarily target the seeds of dandelion, sorrel, annual meadow grass, common chickweed, sea thrift, sea plantain, thistle, pineappleweed, pearlwort and autumn hawkbit (see Table 2 for scientific names). These plants tended to be targeted when they had reached peak seeding condition. Sward structure does not appear to influence the use of feeding areas provided the targeted food plant occurs there.

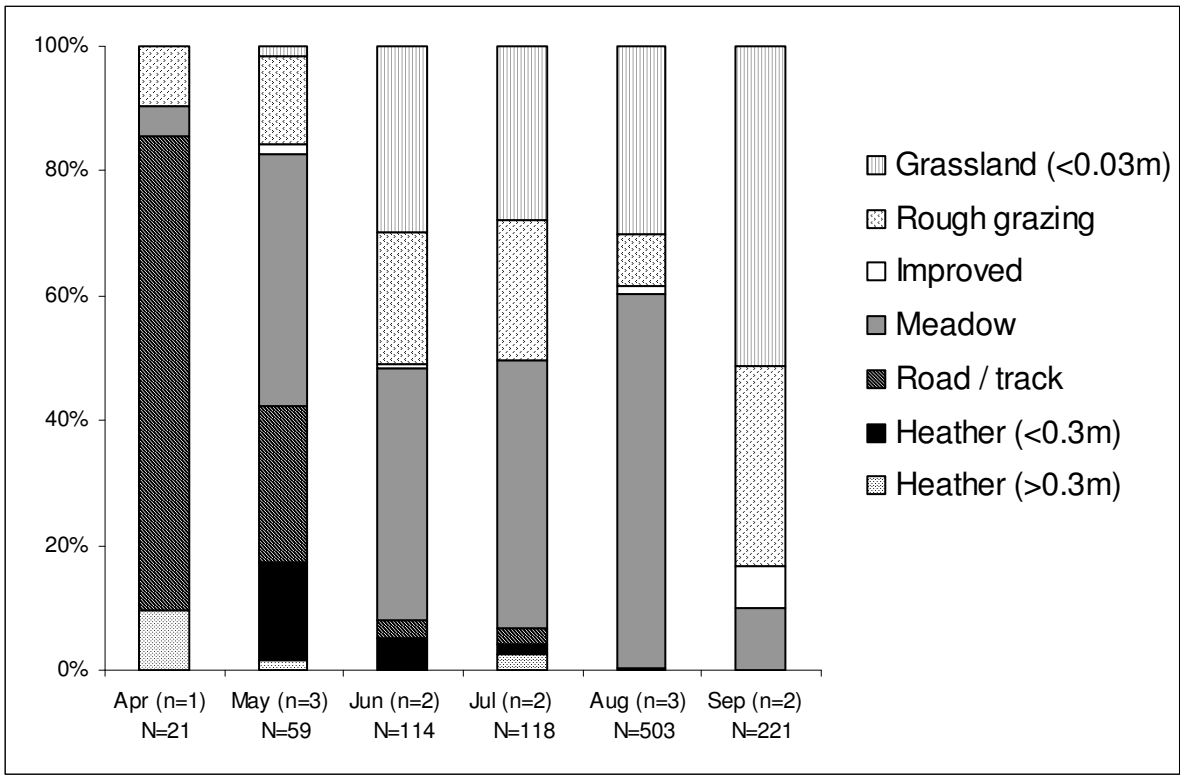


Figure 2. Monthly foraging habitat/vegetation use patterns based on transect data recorded April – September 2007 in counties Mayo and Donegal. N = total number of birds observed. n = the number of combined transects in that month (i.e. number of visits to each study area). An explanation of these categories is given in Table 1 below.

Table 1. Description of twite habitat categories used by McLoughlin (2009) in the study area and the equivalent habitats using the Fossitt (2000) classification system.

Habitat/vegetation category	**Description**	**Fossitt classification**
Heather < 0.3 m	Heather height is < 0.3 m	Peat bog, Wet/Dry heath
Heather > 0.3 m	Heather height is > 0.3 m (nesting/roosting vegetation)	Peat bog, Wet/Dry heath
Garden	Garden property adjacent to house, with or without trees	Built land, Disturbed ground
Grassland < 0.03 m	Coastal grassland that have been subjected to intense grazing with a sward < 0.03 m. Usually dominated by *P. maritima* and/or *A. maritima*	Semi-natural grassland, Salt marsh
Improved	Pastures or re-seeded land	Improved grassland
Meadow	Flower-rich, semi-natural grassland	Semi-natural grassland
Road / track	Tarred or gravel vehicular road or track	Built land, Disturbed ground
Rough grazing	Fields, generally with a long sward often grazed by cattle. Often containing, Purple Moor-grass, Rushes, Thistles, and / or Sorrel.	Peat bog, semi-natural grassland

The habitat targeted by twite throughout the breeding season varies depending on the availability of particular seeds. Figure 2 shows the observed change in use of various habitat types in their home range. A description of these habitat types is presented in Table 1. Roads/tracks, which includes roadside verges, are the most used habitat in April where dandelion and annual meadow grass are the primary targeted food plants. From May to September meadow (generally semi-improved dry-humid acid grassland) was the most used habitat. Dandelion, common sorrel and annual meadow grass were the most used plant species in April, May and early June. Many of the lands classified as 'meadows' had large densities of common chickweed in damp drains, on which the twite feed.

Despite grassland (<0.03 m; see Plate 4) occurring in less than 2% of the area available to twite in Mayo and Donegal, between 14 to 27% use was recorded from June to September. The most important plants in this period appear to be common chickweed, sea thrift, autumn hawkbit and sea plantain.

Table 2. Targeted food plants of twite in Ireland. Primary food plants represent those that twite were observed feeding on most frequently. 'B' represents breeding season. 'W' represents winter season.

Common name	Scientific name	Season
Primary food plants		
Annual meadow grass	*Poa annua*	B, W
Dandelion	*Taraxacum* agg.	B
Common sorrel	*Rumex acetosa*	B
Common chickweed	*Stellaria media*	B
Mouse-ear chickweed	*Cerastium fontanum*	B
Pearlwort	*Sagina nodosa*	B
Sea plantain	*Plantago maritima*	B
Sea thrift	*Armeria maritima*	B
Creeping thistle	*Cirsium arvense*	B
Marsh thistle	*Cirsium palustre*	B
Spear thistle	*Cirisium vulgare*	B
Self-heal	*Prunella vulgaris*	B
Pineappleweed	*Matricaria matricarioides*	B
Autumn hawkbit	*Leontodon autumnalis*	B
Cat's ear	*Hypochaeris radicata*	B
Orache spp.	*Atriplex* spp.	W
Sea mayweed	*Tripleurospermum maritimum*	W
Sea arrowgrass	*Triglochin maritima*	W
Secondary food plants		
Sheep sorrel	*Rumex acetosella*	B
Purple moor grass	*Molinia caerulea*	B
Cotton grass	*Eriophorum* spp.	B
Ling heather	*Calluna vulgaris*	B
Soft rush	*Juncus effusus*	B
Broad-leaved dock	*Rumex obtusifolius*	B
Ribwort plantain	*Plantago lanceolata*	B
Red clover	*Trifolium pratense*	B
White clover	*Trifolium repens*	B
Lesser burdock	*Arctium minus*	W

Photo © Derek McLoughlin

Plate 4: Typical twite foraging habitat (coastal grassland referred to as 'Grassland <0.03 m' in Table 1) during late July through September comprising large densities of sea plantain and autumn hawkbit.

3.2 Home range size

Radio tracking studies on the Mullet Peninsula show that for breeding birds the minimum distance travelled from nest to foraging area was 1.06km with a maximum distance of 1.49km. This reflected the availability of suitable foraging habitat. It is suspected that birds from some Irish breeding colonies will travel over 3km to suitable foraging areas. In a South Pennines radio tracking study, Raine (2006) determined the minimum distance travelled from nest to foraging area to be 1.31km with a maximum of 3.54km. He suggests the ideal foraging distance should not exceed 2.5km.

The breeding home range size of the Irish radio tracked birds using the Minimum Convex Polygon (MCP), ranged from 25.4 to 70.5 ha. Using the concave polygon range size estimator, which removes unused areas from the MCP, gives a range size of between 3.6 and 31.3 ha. This shows the confined area in which twite nest and forage throughout the breeding season. Birds tended to forage in the same small number of areas throughout the summer. Once juvenile birds became independent of their parents in July, August and September, they too showed a strong selection for these feeding areas. The MCP of four juvenile birds tracked in August ranged from 3.8 – 31.7 ha. As juvenile twite spend much of their time foraging, their strong selection for this area reflects the abundance of favoured seed plants. In both

counties Mayo and Donegal birds often use the same four or five fields, or the same strip of saltmarsh from late June to September.

With this intensive use of a small number of feeding areas by twite from April to September, maintaining this food supply should form an intrinsic part of a conservation plan for twite in the breeding season. Changes in current grazing regimes should be discouraged in the favoured twite feeding areas. The targeted seed plants on roadside verges, gravel tracks and parking areas should be maintained and should never be sprayed or cut between April and September. Although in Ireland, twite are only occasionally observed feeding on cottongrass *Eriophorum* spp. (McLoughlin pers. obs.), Raine (2006) notes the importance of patches of cottongrass to juvenile birds who feed on wind-blown seeds at peat hags and gullies. He also observed birds in April feeding on purple moor-grass.

Twite habitat selection analysis in Ireland shows the importance of upland streams for bathing and drinking. Within this habitat, twite were generally observed at relatively shallow riffle and pool stretches of narrow streams. Birds also appeared to gather grit at these points.

As all of the primary feeding areas occurred in small villages (rural settlements with between approximately 8 and 40 dwelling houses), within 2km of breeding colonies, these need to be a focus of the twite breeding season conservation plan.

3.3 Conservation actions in the breeding season foraging areas

All suitable foraging areas during the breeding season have been identified and classified in order of their suitability for twite (see Section 8.0). These foraging areas occur within a minimum of 2km of the suitable nesting habitat. As twite appear to use a relatively small number of areas within their home range, it is crucial that these areas be maintained and protected from the threats outlined in the detailed field inventory in Section 8.0. For the areas that do not appear to sustain targeted seed plants, suggested options ('Boxes 1-3') are also presented in Section 6.0. The first option for enhancing twite foraging areas ('Box 1') is a sacrificial/fodder cereal crop comprising one or more of the following: radish, mustard, turnip, quinoa, kale and triticale. Although this mix is primarily aimed at, and would be most beneficial for wintering birds, seeds of several of these crops can persist into late March/April when some birds return to their breeding areas. The second option ('Box 3') is specifically targeted at breeding season foraging areas. This option generally targets improved fields that are not currently used by twite. This plot would be re-seeded with dandelion, common sorrel and autumn hawkbit. This combination of plants has been chosen on account of their attractiveness to twite and their prolific nature. Both dandelion and common sorrel will provide a valuable food source in the early part of the breeding season (April to July), with autumn hawkbit providing seed in August and September.

Photo © Derek McLoughlin

Plate 5: Loughros Point from twite nest-site near Maghera, Co. Donegal. The sand dunes at Sheskinmore National Nature Reserve are visible in the background.

Conservation actions for breeding season foraging areas. " * " indicates that this action is addressed in this report (Sections 6.0 & 8.0).

1. Ensure an unbroken chain of natural food sources, within a 2.5km radius, throughout the breeding season.
2. Identify important foraging areas and maintain current management regime. *
3. Avoid agricultural 'improvement' of enclosed fields within a 3km radius.
4. Restoration of improved, flower-poor fields to traditionally managed hay meadows.
5. Maintain meadows with seeding wildflowers throughout the breeding season.
6. Ensure adequate grazing in areas with high densities of sea plantain due to previous heavy grazing.
7. Undertake hay harvesting as late in the season as possible and reduce the incidence of multiple cuts.
8. Where fields are harvested, leave an uncut strip at the meadow edge.
9. Liaise with local authorities to stagger roadsides cuts every two years to maintain alternative feeding areas.
10. Avoid the chemical spraying of wildflowers.
11. Liaise with agri-environment scheme planners to ensure that recommended measures do not conflict with twite foraging requirements.
12. Avoid topping of thistles and sorrel in potential feeding areas.
13. Encourage and maintain patches of cotton-grass spp. in moorland areas.
14. Create feeding stations, using nyjer seed, where appropriate. Use before and after the breeding season (*i.e.* not May to July), see 'Box 2' in Section 6.0.
15. Local education on the twite.

3.4 Potential impacts of twite conservation actions on other species

The potential conservation conflict between chough and twite has already been discussed (Section 1.6), however, the chough is only one of many species of flora and fauna that may be affected by measures designed to conserve and enhance twite populations in Ireland. It is essential that any measures introduced to benefit twite populations are mindful of the greater biodiversity of the area in which they occur. As already discussed, the diet of twite is composed solely of the seeds of weed species, which are closely related with traditional extensive agriculture practices. Several other rare or declining bird species depend on similar farming practices to that required by foraging twite include corncrake and yellowhammer. The corn bunting was also associated with traditional extensive agriculture in Ireland but is now thought extinct as a breeding species here. Corncrake populations have severely suffered in the past 40 years due an increase in intensive silage cutting (Whilde, 1993; Newton, 2004), whilst only very few yellowhammer still breed in the west of Ireland. Conservation measures for twite including the maintenance of traditionally managed meadows, late cutting of meadows and the provision of cereal

plots, would benefit these other rare and declining bird species. In many ways, the twite can be used as a key species for the wider conservation of many other vulnerable bird species. Twite conservation actions will also benefit species such as sky lark *Alauda arvensis*, tree sparrow *Passer montanus* and linnet, all of whose populations have declined in recent years (Newton, 2004).

The maintenance of traditional meadows in a twite conservation plan will also be beneficial for invertebrate diversity, including bumblebees for which there has been much concern over recent declines. These declines in bumblebees (e.g. *Bombus distinguendus*) also relate to agricultural improvement of traditional meadows (Fitzpatrick *et al.*, 2007).

3.5 Conservation actions in the breeding season foraging areas in England

Twite conservation prescriptions composed by RSPB and Natural England (Gowthorpe, 2009) aim to enhance seed availability through creating a staggered seed supply between April and October. These prescriptions require close cooperation with farmers, with the objective of a colony-specific calendar of grassland management that targets three broad areas, each containing a number of prescriptions comprising the following:

1) Maintenance and enhancement of existing hay meadows.
    a. Rotate the cutting of hay/silage within 2.5km of breeding colonies between an early cut (late May) and a late cut (after the beginning of August).
    b. Some areas of the meadows should be left uncut.
    c. Traditional regimes of spring grazing with sheep until early May and autumn grazing with cattle from later September should be maintained.
    d. Cease application of inorganic fertilisers but well-rotted farmyard manure may be applied, under consultation, up to 12.5 t per ha per year. Lime may be applied up to 3 t per ha every three to five years under consultation.

2) Maintenance and enhancement of existing species-rich pasture.
    a. Species-rich pasture should be maintained to produce a late flush of seeds.
    b. Grazing should preferably be by cattle at a density of 0.4 LU per ha.
    c. Suitable pastures, with the exception of pastures holding dandelion densities >25% flower cover, should receive early spring grazing and then cease grazing from June to August.
    d. The same regime as listed for the hay meadow, regarding the spreading of fertiliser and lime should apply.

3) Creation of new foraging habitat
    a. Receiver sites for re-creation of species-rich grassland should preferably have low fertility, comparable to local or BAP priority grasslands. Sites with higher fertility should be considered for high interventionist treatments or the introduction of nitrogen tolerant food-plants.
    b. Competition with grasses should be minimised either through the introduction of yellow rattle *Rhinathus minor* agg. and harrowing prior to seeding, or just harrowing.
    c. Seed of local provenance must be introduced to the site. This can be introduced as green hay, hay concentrate, seed, or as dried hay, depending on the circumstances.

4.0 SUMMARY OF BREEDING SEASON CONSERVATION MEASURES

4.1 Overview

During the breeding season twite require long heather for nesting and suitable foraging habitat within 2-3km. Twite in County Mayo predominantly select species-rich meadows or dry-humid acid grassland as their preferred foraging habitat. In County Donegal, lower saltmarsh and dry-humid acid grassland habitats were the most selected. It is important to note that this is a combination of all data from April to September and that 'roads and tracks' provided an important food source in April and early May.

One of the main threats to twite populations in Ireland and elsewhere is a change in land management practices within the ranges of breeding twite colonies. The removal of heather through sheep overgrazing has been a major problem in the breeding colonies in County Mayo resulting in a dramatic decline in the number of suitable nesting sites. Breeding colonies only occur in long heather on steep cliff sides in areas largely inaccessible to sheep. This type of heather occurs in less than 2% of their breeding range in County Mayo. In County Donegal, although overgrazing of blanket bog is not a threat in the Maghera/Slievetooey study area, other blanket bog areas in the west of the county have been seriously affected by overgrazing (McLoughlin & Cotton, 2008). Conversely, recent (and current) agricultural policy (e.g. Commonage Framework Planning) is encouraging wide-scale destocking of sheep from many hillsides along the west and northwest of Ireland (Warner 1999). If this greatly reduced grazing pressure relates to all western seaboard blanket bog, where the heather has not been completely degraded, this would result in larger areas of long heather and suitable twite nesting habitat (Thompson *et al.*, 1998).

One of the effects of destocking sheep in the west of Ireland is that farming in some areas may be discontinued. This could give rise to land abandonment, which is of increasing concern across Europe. Land abandonment has a damaging effect on many habitats (Bignal & McCracken, 1996) and would impact twite through the subsequent loss of some of the targeted food plants, particularly on dry-humid acid grassland and meadows. The reseeding of traditionally species-rich fields with Perennial Rye Grass represents a loss of foraging habitat for twite. Although in Ireland twite were occasionally observed feeding in these improved agricultural grasslands, they invariably targeted damp or disturbed areas with large concentrations of common chickweed or pineappleweed within the improved grassland areas.

4.2 Expansion of the breeding range of twite in Ireland

Twite populations in Ireland appear to be in decline, however, it is hoped that this situation will stabilise and that populations will eventually increase as a result of our greater understanding of their ecology and with the implementation of specific conservation measures. An important component in the scenario that populations in Ireland start to expand is the identification of new areas with the potential to sustain breeding twite. Figures 3 and 4 outline the current breeding range in counties Mayo and Donegal, which comprises up to 85% of the national population, and 'Target' areas that could potentially sustain twite populations. The 'Target' areas have been selected using one of the following criteria: They have either historically sustained breeding twite, e.g. Achill Island, and/or they have habitat and vegetation that is it either partly or wholly suitable for twite.

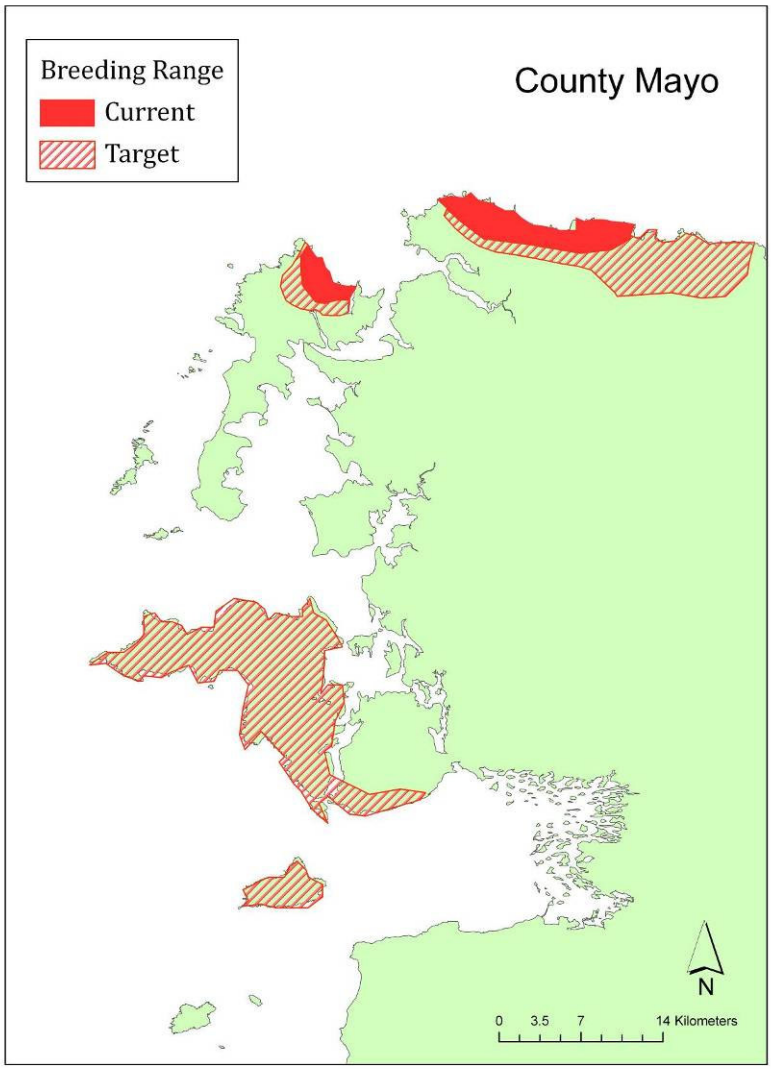


Figure 3. Current breeding range for twite in Co. Mayo with 'Target' areas for potential range expansion also shown. The target range includes the hills to the southeast of Belderg along the north Mayo coast, Achill Island, and Clare Island.

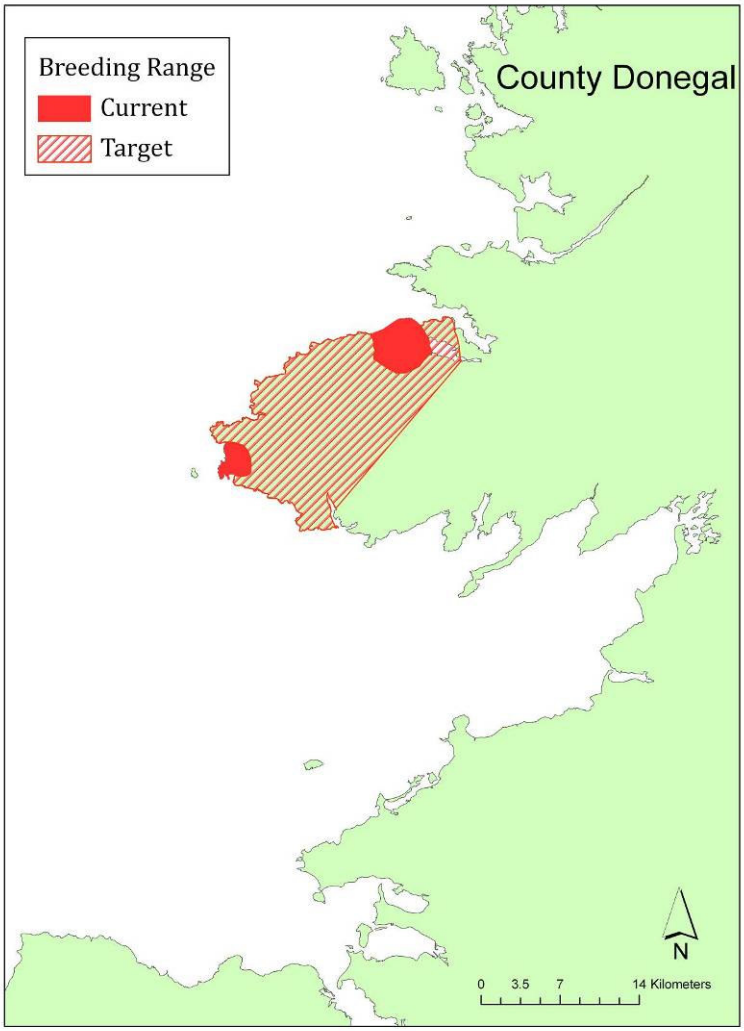


Figure 4. Current breeding range for twite in west Co. Donegal with 'Target' areas for potential range expansion also shown. The target range includes all areas between the Glencolumbkille and Maghera breeding areas and stretches as far south as Teelin Bay.

4.2.1 Breeding areas outside of Mayo/Donegal breeding strongholds

Although the prescriptions outlined in this report only focus on the strongholds of north Mayo and west Donegal it is important to note the occurrence of small breeding populations of twite in counties Kerry and Galway. Indeed due to the 'small brown job' nature of the twite they can be easily overlooked and may breed in small numbers in areas as yet unknown. Where breeding populations occur outside of the Mayo/Donegal area, similar attention should be given to the targeted vegetation types in those areas, e.g. long heather, species rich meadows.

5.0 WINTER SEASON

Although no quantitative research has been done on the twite's winter ecology in Ireland, some data has been gathered through fieldwork activities including ringing, monitoring locations and activity of winter (October – March) flocks, and radio tracking of birds in March.

5.1 Winter season habitat requirements

Wintering twite are strongly associated with saltmarshes, particularly in England and the Low Countries, where they target glasswort spp. (Atkinson, 1998; Dierschke & Bairlein, 2004). In Ireland winter flocks also target saltmarsh habitat along with areas of disturbed ground, and drift lines, where they also feed on the seeds of plants including, sea arrowgrass, orache spp. and sea mayweed.

On the Mullet Peninsula, Co. Mayo, twite display a strong selection for machair habitat, an Annex I priority habitat under the EU Habitats Directive. However, the target of foraging twite here are ring feeders, which are used for supplementary feed for cattle being over-wintered on the machair. Twite specifically focused on feeding sites in which haylage (cut forage grass, stored in an airtight plastic wrap) was used as the supplementary feed. This haylage contains relatively high densities of wildflower seeds including dandelion. Wintering twite elsewhere on the Mullet Peninsula also show a strong association with cattle ring feeders.

Wintering twite in west Donegal show a similar concentration in a small number of feeding areas provided adequate food resources remained. In Sheskinmore National Nature Reserve (NNR) (also largely composed of dune and machair habitat), twite focused on a one-hectare cereal plot containing a linseed *Linum usitatissimum* / quinoa *Chenopodium quinoa* mixture. Flocks of up to 80 birds were observed consistently from late October to February, at which point seed resources were exhausted.

During the winter twite in Scotland are associated with stubbles from crops such as rape *Brassica napus* and turnip *Brassica rapa* and initiatives, e.g. 'Neaps for Linties' have been introduced there to encourage farmers in the north to grow turnip specifically for over-wintering twite (Anon, 2007a; RSPB, 2007). In Ireland the LINNET scheme encourages a similar initiative to farmers as part of Rural Environment Protection Scheme (REPS) 3 & 4 (Anon, 2005, 2007). To date however, in the twite strongholds in Ireland the uptake of this option is very low with the Sheskinmore Cereal Plot being the only scheme with suitable cereal crops in either of the prescription areas. Also, in many cases the recommended seed types, with the exception of quinoa, are too large for twite and therefore not available to them. As quinoa is native to Bolivia, some have questioned its widespread use, particularly on priority habitats under the EU Habitats Directive.

Photo © Micheál Casey

Plate 6: Flock of 32 wintering twite at Termoncarragh, Co. Mayo.

5.2 Winter range sizes

Although twite can move over 400km between breeding and wintering sites (Brown & Atkinson 2002, Raine *et al.* 2006) it appears that Irish twite generally remain within 30km of their breeding areas if an adequate food supply is present. At the Termoncarragh wintering site on the Mullet Peninsula, 8.5% (n=274) of the birds ringed were retrapped during subsequent winters (McLoughlin *et al.*, 2010). This shows relatively strong winter site fidelity for a short-lived bird.

Two birds radio tracked at Termoncarragh, Co. Mayo over a 12-day period had Minimum Convex Polygons (home ranges) of 74.2 ha and 112.2 ha. Using the concave polygon range size estimator, which eliminates unused areas in their range, gives a range size of 29.8 and 81.4 ha respectively. This relatively small range size reflected the distribution of feeding sites in the area. Flock sizes of between 80 – 100 twite use these sites throughout the winter-season. These flocks comprise primarily of birds that have hatched in the breeding colonies in County Mayo, however, twite of Scottish origin appear to account of some of the birds (McLoughlin *et al.*, 2010).

5.3 Conservation issues

Ring feeders are recognised as a source of damage to machair habitat through intense trampling from cattle, which causes degradation. Machair on the Mullet Peninsula, once noted as one of the finest examples of machair habitat in Ireland, has suffered heavily from intensive agricultural management and its conservation value has subsequently been radically reduced (NPWS, 2008). As the presence of ring

feeders on the Mullet Peninsula benefits twite during the winter, this raises an interesting conflict of conservation interests between the conservation of machair habitat and the provision of a winter food source for twite. A comparable conservation conflict occurs with petalwort *Petalophyllum ralfsii*, which also occurs on machair habitat. Petalwort requires a short sward through a relatively intense grazing regime (Anon, 2007b). In the absence of petalwort, this grazing regime may be seen as detrimental to the machair habitat as a whole and reduces biodiversity. However, as it is listed under Annex II of the EU Habitats Directive, conservation measures such as short cropping have been introduced through the NPWS Farm Plan Scheme.

5.4 Suggested conservation measures

5.4.1 Suggested conservation measures

One solution to the current damage to machair caused by ring feeders, particularly on the Mullet Peninsula, could be to have carefully selected areas on the machair that farmers are permitted to place their ring-feeders to where damage would be limited. This would not be in contravention of any existing agri-environment scheme measures (Anon, 2000; 2005; 2007), but may contravene Good Farming Practice (GFP) if severe poaching of the ground resulting in a pollution risk, were to occur. Alternatively, the use of strategically positioned cereal plots would create more sustainable food source in terms of protection of the machair habitat (see 5.4.2).

The inclusion of any twite-specific measure into future agri-environment schemes may, however, pose some issues as twite are not listed as an Annex I species on the EU Birds Directive. The NPWS FPS only covers habitats and species listed on the EU Habitats Directive and EU Birds Directive, and commonages under the Commonage Framework Plan (CFP). REPS and AEOS, however, are not confined to designated areas, e.g. Special Areas of Conservation (SAC), Natural Heritage Areas (NHA) or Special Protection Areas (SPA).

5.4.2 Supplementary feeding plots

Conservation measures for wintering twite in the study areas should include the provision of trial cereal plots in the areas outlined in Figures 5 & 6 and Table 3. Suggestions on sacrificial plots are given in detail in Section 6.0 ('Box 1' & '3').

The provision of an artificial feeding station as used by Raine (2006) and McLoughlin (2009) could also be part of winter season conservation measures, particularly between January and April. This feeding station would comprise the provision of nyjer *Guizotia abyssinica* or rape seed at a location not prone to excess disturbance. The areas shown in Figures 5 & 6 would form the target areas. Information on the creation of artificial feeding stations is presented in Section 6.0 ('Box 2').

Any such measures must be situated near adequate roost sites e.g. bracken litter, rushes *Juncus* spp. etc. In cases where long-term cereal plots are being established, it may be necessary to also encourage bracken specifically as roosting vegetation.

5.4.3 Location of winter season supplementary feeding plots

Figures 5 & 6 outline areas suitable for proposed supplementary feeding plots to target twite during the winter months. Twite are recorded each year in varying numbers in these areas and it is most likely that the provision of feeding plots would greatly benefit twite (and many other bird species) during the winter months. It is probable that up to 85% of the twite that breed in Ireland spend most, or all, of the winter season in these areas. Within each of these 'Winter Areas' a number of plots should be sown as per the recommendations given in 'Box 1' (Section 6.0).

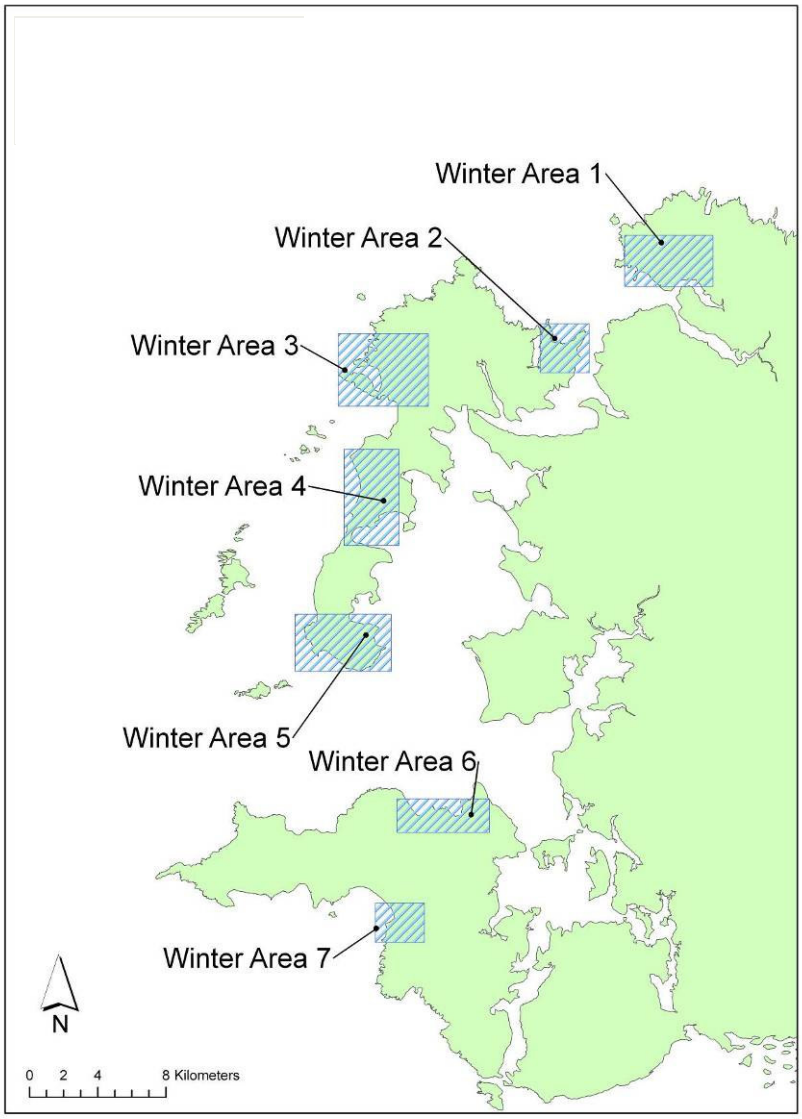


Figure 5. Proposed locations of winter season sacrificial feeding plots in Co. Mayo.

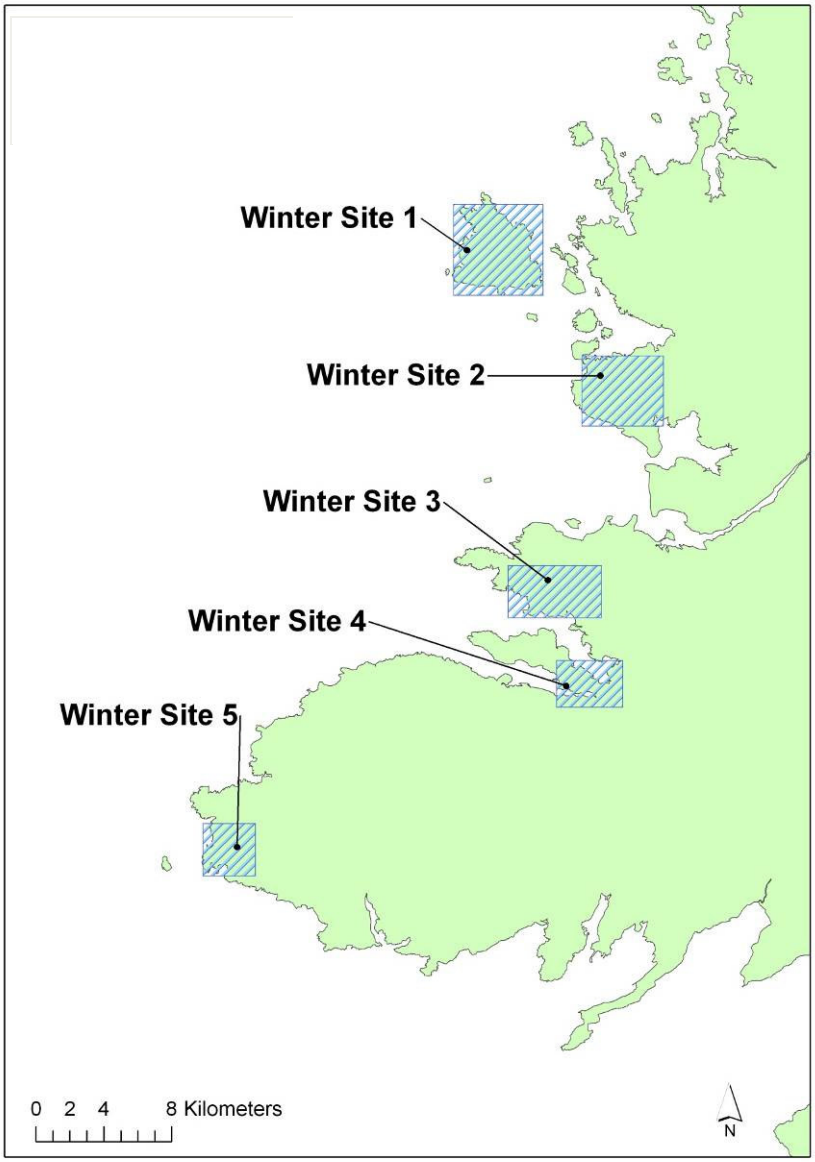


Figure 6. Proposed locations of winter season sacrificial feeding plots in Co. Donegal.

Table 3. General locations of proposed target wintering areas in Mayo and Donegal. An extra site should be considered at Glencolumbkille, Co. Donegal.

Site no.	Mayo	Donegal
1	Carrowteige/Rossport	Aran Island
2	Ballyglass	Crohy Head/Maghery
3	Termoncarragh	Sheskinmore
4	Cross Pt. / Elly Bay	Loughros Point
5	Blacksod/Surge View	Malin Beg
6	Doogort	
7	Dooega	

Outside of the Mayo/Donegal strongholds, wintering flocks are also regularly observed in counties Sligo, Galway, Kerry and Louth. Similar sacrificial plots should also be considered in strategic areas in these counties.

5.4.4 Saltmarshes

Modelling by Atkinson (1998) suggests that loss of saltmarsh in the southeast of England could go a long way to explaining the decline of twite there. Raine (2006) suggests that re-creation and conservation of saltmarsh should be an integral part of a countrywide recovery plan.

The saltmarshes adjacent to Lough Foyle, counties Donegal and Derry, sustain between 50-150 twite each winter season, and their importance for twite (most likely Scottish migrants) should not be underestimated. All areas of saltmarsh within 30km of the known breeding colonies (and extended areas including neighbouring counties) need to be studied to identify sheltered areas that would potentially provide large densities of glasswort spp. and other seeding plants targeted by twite.

Table 6. Conservation actions for the winter season. " * " indicates that this action is addressed in this report (Section 8.0).

Suggested conservation actions for wintering twite
1. Identify and protect key wintering sites. *
2. Identify and protect saltmarsh within 30km of known breeding areas.
3. Re-create new areas of saltmarsh and ensure these have a high density of glasswort spp. seed.
4. Ensure new patches have a low rate of natural seed depletion by protecting from wind and wave action.
5. Maintain areas of fresh water adjacent to glasswort spp. patches.
6. Create suitable roosting areas, such as areas of bracken, reeds, or rushes.
7. Create feeding stations, using nyjer seed, where appropriate.
8. Create a series of sacrificial/fodder cereal plots within 30km of known breeding colonies.
9. Local education on the twite.

6.0 TWITE HABITAT INTERVENTION

6.1 Suggested steps towards implementation of plan

1. Formulation of plan
2. Identification of suitable candidate sites for intervention and formulation of suitable seed mix.
3. Co-ordination of twite conservation plan with other conservation plans, e.g. corncrake plan.
4. Discussion with possible landowners interested in taking part in a trial scheme.
5. Land-use agreements (leases etc.) with landowners where appropriate and commence seeding of relevant cereal crops.
6. Monitoring of intervention sites.
7. Assessment of success of interventions to look at importance for twite, and, or, other species, any issues relating to landowners (e.g. viability of project), and adjustments/alternatives that may improve success of interventions.

6.2 Creation of new foraging habitat

Twite feed exclusively on seeds and have a preference for seeds that are small and are produced in large numbers. The habitat and plants that twite target throughout the breeding and winter seasons vary depending on the availability of good densities of suitable seeds. It is thought that bottlenecks in the annual supply of seeds (particularly between December and late March) may be a considerable factor in twite survival rates. Twite are also particularly vulnerable to sudden changes in land management in their breeding areas and as they often only forage in a small number of areas, this vulnerability is increased. For this reason, the provision of new foraging plots aimed at twite will provide a consistent food supply. The location of these plots should be situated at locations throughout their breeding and wintering ranges and should be composed of plants that will provide seed at a given time of the twite's life cycle, e.g. plots in twite wintering areas should produce seed during the winter months.

The options presented here comprise proposed plots which, when combined, will have available seed throughout the year. With the exception of the cereal plot at Sheskinmore, NNR, Co. Donegal, no other plots have been sown in the twite strongholds in Ireland. Therefore the following options are largely desktop based using information from similar conservation plots in England and Scotland. It is important to note that these options are trial suggestions and should be closely monitored and adapted to Irish growing conditions.

6.2.1 Seed Crops targeting birds between November and March.

Sacrificial seed crop plots have been incorporated into agri-environmental schemes, e.g. LINNET, for the past number of years. However, many of the crops used in LINNET tend to bear seeds that are too large for twite, such as oats and linseed.

The NPWS sacrificial plot at Sheskinmore NNR, Co. Donegal has been successful at regularly attracting and sustaining twite throughout part of the winter season. This appears to be the only such sacrificial plot in Ireland. From 2005 to 2007, the primary target crop of twite was quinoa, triticale and possibly kale (E. Magee, D McLoughlin pers. obs.). The following mix was sown in 2005:

- 25 kg triticale
- 12.5 kg linseed
- 0.75 kg quinoa

Some kale seed was grown along the edge of the plot, along with a wildflower mix, to provide some degree of structure to the main crop.

6.2.1.1 Suggested crops

The provisional suggested targeted crops for twite (pending appropriate NPWS consents) comprise the following:

- radish
- mustard
- turnip
- quinoa
- kale
- triticale

These crops closely follow examples of similar crops used on RSPB lands on Islay and Orkney where fodder radish, has successfully been planted for several years with excellent results, producing a large crop of seeds that ripen between July and September, with both twite and the co-generic linnet regularly feeding on it. It is a reliable crop, in both areas has been grown on previously improved, fertilised soils, and is highly disease resistant. The seeds will also persist throughout the winter until February or March.

On Islay fodder radish has been mixed with a mustard seed mix, which flowers earlier. On Orkney it has also been mixed with kale and stubble turnip. This mix is used to give structure to the crop, as radish collapses in heavy rain without support.

Box 1. Fodder radish & sacrificial seed plot. Adapted from Gowthorpe (2009)

(a) Fodder radish should be sown, initially in test proportions, with mustard, kale, and stubble turnip on previously fertilised fields

Cultivation should be as follows:

1) *Fields ploughed in March or April and seeds sown (ideally with a quad-bike spreader).*
2) *After sowing the fields should be chain harrowed and rolled.*
3) *The fields can be grazed from January.*
4) *The following mixes (per ha) should initially be trialed:*
    - *6 kg radish & 9 kg mustard (Islay mix - should only be used on relatively sheltered sites).*
    - *1 kg radish, 1 kg mustard, 7.5 kg kale, 7.5 kg turnip (Orkney mix)*
    - *3 kg radish, 4 kg mustard, 8 kg kale*

(b) Seed crops should be sown, initially in test proportions, using radish, mustard, turnip, quinoa, kale and triticale

Cultivation should follow the same method and time-scale as above. No grazing should take place in this plot.

- Various mixes of the six recommended crops should be trialed. However, it is important to ensure an adequate mix of plants that will provide structure to the overall crop such as kale and turnip, particularly at exposed sites.

(C) Modifications to plot to benefit corncrake

To also benefit corncrake, the layout of the sacrificial plot should be planned to allow a wide field margin (particularly on the windward side of site) to be sown with nettles *Urtica dioica*, hogweed *Heracleum sphondylium* and kale. These plants should ideally be sown in Autumn. As well as providing 'early cover' for corncrake, they will provide perching and possible roosting opportunities for twite.

6.2.1.2 Possible benefits to corncrake

As corncrake breed less than 1km from some of the twite's wintering areas (e.g. Mullet Peninsula) plots targeted at wintering twite can also act as 'early-cover' for corncrakes returning to their breeding areas. These plots could be optimised for both species by including linseed in the seed mix with nettles and hogweed in a shelter-belt toward the south and west (windward side) of the plots.

6.2.2 Supplementary feeding stations targeting birds between September and April.

Supplementary feeding stations could be considered in the short-term where no other alternative is available and changes in the regular foraging areas have resulted in a loss of foraging areas. One possible example is the Mullet Peninsula where twite currently depend on seed from cattle ring-feeders on machair habitat. This use of ring feeder is detrimental to the machair. Although not natural, the provision of a feeding station would be the more sustainable option of the two.

Box 2. Provision of feeding stations (September to April)

Recommended seed: *nyjer or rape seed.*

Recommended site: *Must be situated in an area that twite already use, with limited disturbance and ideally away from dwelling houses with potential predators e.g. cats.*

Nyjer or rape seed is recommended for use in feeding stations. Nyjer seed has been used with good success to bait sites in Donegal and Mayo for Twite ringing. Evidence from the monitoring of colour-ringed birds showed a large turn-over of individuals at the feeding station which suggests that birds do not become dependant on it. Raine (2004, 2006) also shows that twite often abandoned these plots when natural food sources become available.

Such feeding stations tend to form part of a 'feeding circuit' where birds feed for a given length of time until disturbed, etc., and move on to other potential food sources.

The most important time for the provision of such a feeding station is between December and March.

Photo © Colin Stafford-Johnson

Plate 7: Twite at a nyjer seed feeding station at Sheskinmore, Co. Donegal in February.

6.2.3 Seed plants targeting birds between March and October.

The re-creation of meadows rich in seed can be quite complex and in the context of Irish twite populations still needs some research to assess the viability of such a project and the potential implications for local biodiversity. However, the creation of plots of three favoured food plants of twite during the breeding season (common sorrel, dandelion and autumn hawkbit) is a practical option. These plants have been successfully established after two years in England (Trueman & Millett, 2003) by strewing green hay to seed the receiving site.

It is important to note that this is an experimental treatment and should be applied subject to rigorous scientific experimental design and closely monitored thereafter. It is suggested that trials be carried out to examine the benefit of varying the cutting dates of the crop.

Box 3. Creation of breeding season foraging areas in previously fertilised lands. Adapted from Gowthorpe (2009)

Suggested plants: common sorrel, dandelion, autumn hawkbit

1) *Ideally the site should be grazed heavily and trampled by cattle following by harrowing.*
2) *Seed can be sown in early spring.*
3) *Either harrow the site, or allow grazers to integrate the seed into the soil.*
4) *The sward should not be cut until late October or until Twite have stopped feeding on the seed.*
5) *After cutting, a light harrowing may encourage re-establishment from the seed.*
6) *This site should be grazed with cattle, preferably until March.*

- *Plots should be planted with even quantities of the dandelion, sorrel, autumn hawkbit mix.*
- *This mix should be applied at a rate of 0.5 to 1kg per ha.*

- *Advice should be sought from relevant experts, e.g. suppliers of seed regarding the suitability of the soil at a particular site.*
- *Consider including yellow rattle seed to the above mix to aid in competition with grasses.*

6.2.3.1 Roadside verges

Roadside verges are amongst our least altered grassland habitats in Ireland and in many twite areas act as an important source of nutritious seed in the early part of the breeding season. Plants such as dandelion, common sorrel and grasses such as annual meadow grass are the primary targeted roadside verge plant for twite.

6.3 Monitoring and further research on twite in Ireland

Where interventions are being implemented to enhance twite populations a programme of monitoring should be used to assess the success of such interventions and to inform more efficient use of these in future. In addition, due to the vulnerability of breeding twite to extinction in Ireland, it is strongly recommended that a regular national monitoring programme of the breeding and wintering population be put in place.

6.3.1 National population monitoring

The national population of twite should be assessed at a minimum of every five years as long as twite remain on the red-list of BOCCI. To assess the breeding population all known breeding areas listed in McLoughlin & Cotton (2008) should be revisited.

A similar survey method to that used by McLoughlin & Cotton (2008) should be adopted. As the detection of breeding twite on sea-cliffs can be relatively difficult due to the logistics of locating a small bird in a relatively large area (Langston *et al.,* 2006), constant effort watches as described in McLoughlin (2009) should be used. This involves two surveyors doing 90-minute watches at vantage points in suitable habitat. Although the surveyors will be working separately, they will be in constant contact using hand-held two-way radios. When twite are observed, their flight path, height, and behaviour will be used to locate nests. These areas should all be visited on four occasions between mid- April and mid- September. Further, a number of days each year should be given to surveying potentially new breeding colonies. Surveys should not take place on days with poor visibility or with wind speed greater than Beaufort force 4.

Winter population monitoring and assessments of total wintering numbers can be problematic due to the highly mobile nature of twite during the winter season. For this reason winter monitoring should involve a largely desk-based approach similar to that used by McLoughlin & Cotton (2008).

6.3.2 Population monitoring relating to twite management actions

Where conservation actions are implemented in a breeding/wintering area a program of regular monitoring should be also undertaken. Specific monitoring programs to the various prescriptions should be put in place to assess the success of the program. As a general guide it is suggested that the following monitoring frequencies be used:

The site should be searched for twite at, or near, the site approximately once per week. If twite are then observed feeding at the plot, monitoring visits can decrease to once every 2-3 weeks. During these visits the number of birds and their targeted food source should be recorded. Where the dandelion/sorrel/autumn hawkbit intervention is undertaken the trial plot should be monitored at a minimum of twice per week for the duration of the breeding season.

The impact of any possible interventions on other bird species (particularly species of conservation concern) should also be assessed through the recording of all species present at the site.

6.3.3 Further research on twite in Ireland

Although we have developed a relatively good picture of the ecology of twite in Ireland through previous works and information from similar studies in Britain, there still remains several gaps in our knowledge that require further research. The two most important areas are breeding biology (breeding success, chick diet, etc.) and winter ecology (diet, roost sites, etc.). These could be undertaken in a cost-effective manner through student post-graduate studies. In terms of the wintering ecology, such a study could look at winter habitat use and diet of several rare or declining bird species, e.g. tree sparrow.

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8.0 APPENDICES

Appendix 1. Inventory of habitat and vegetation type in twite breeding areas in north County Mayo and west County Donegal detailing locations for potential habitat interventions

Photo © Derek McLoughlin

Plate 1A: Sea thrift which is targeted by twite in their breeding areas

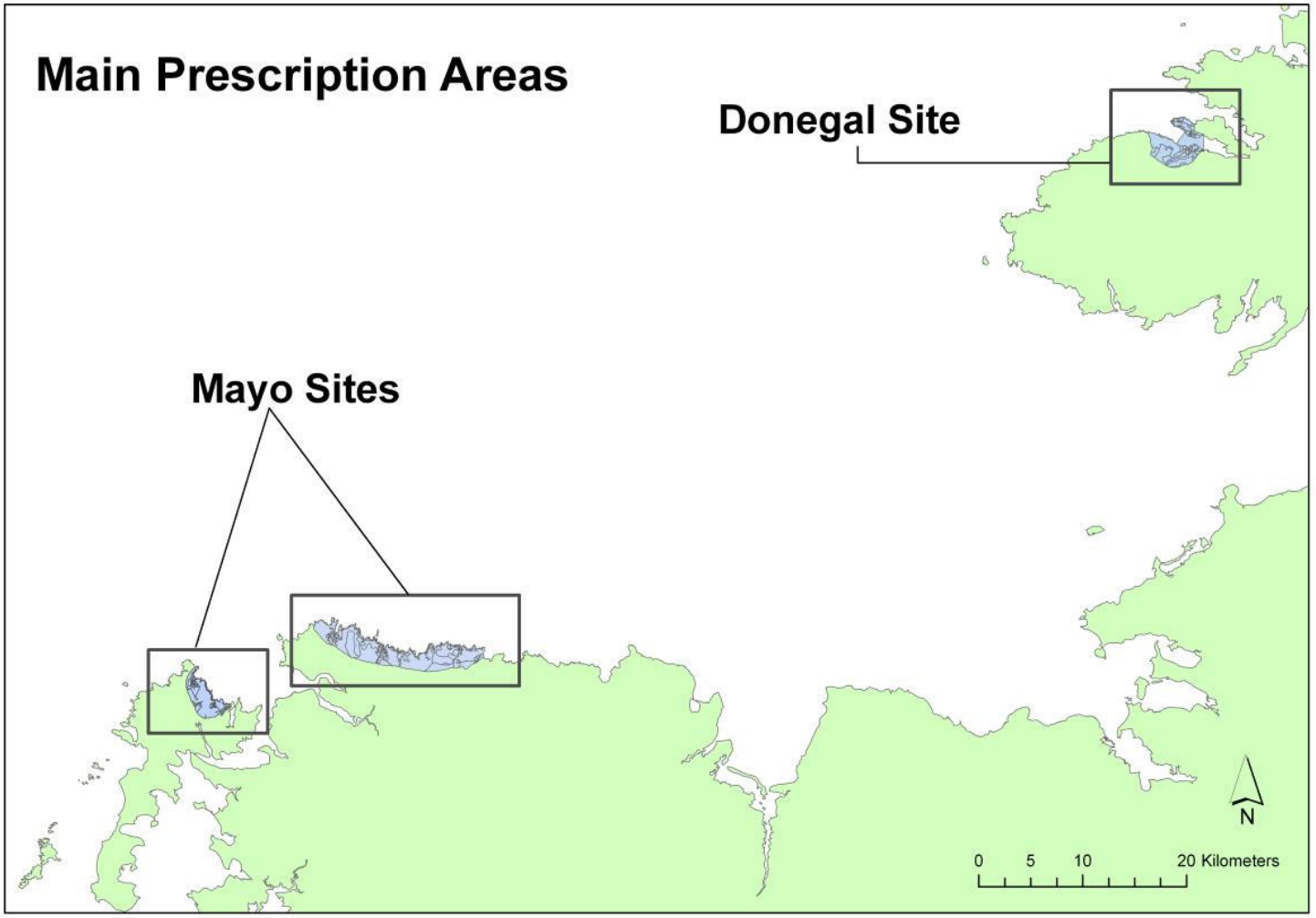

Figure 1A. Focus areas for twite prescriptions

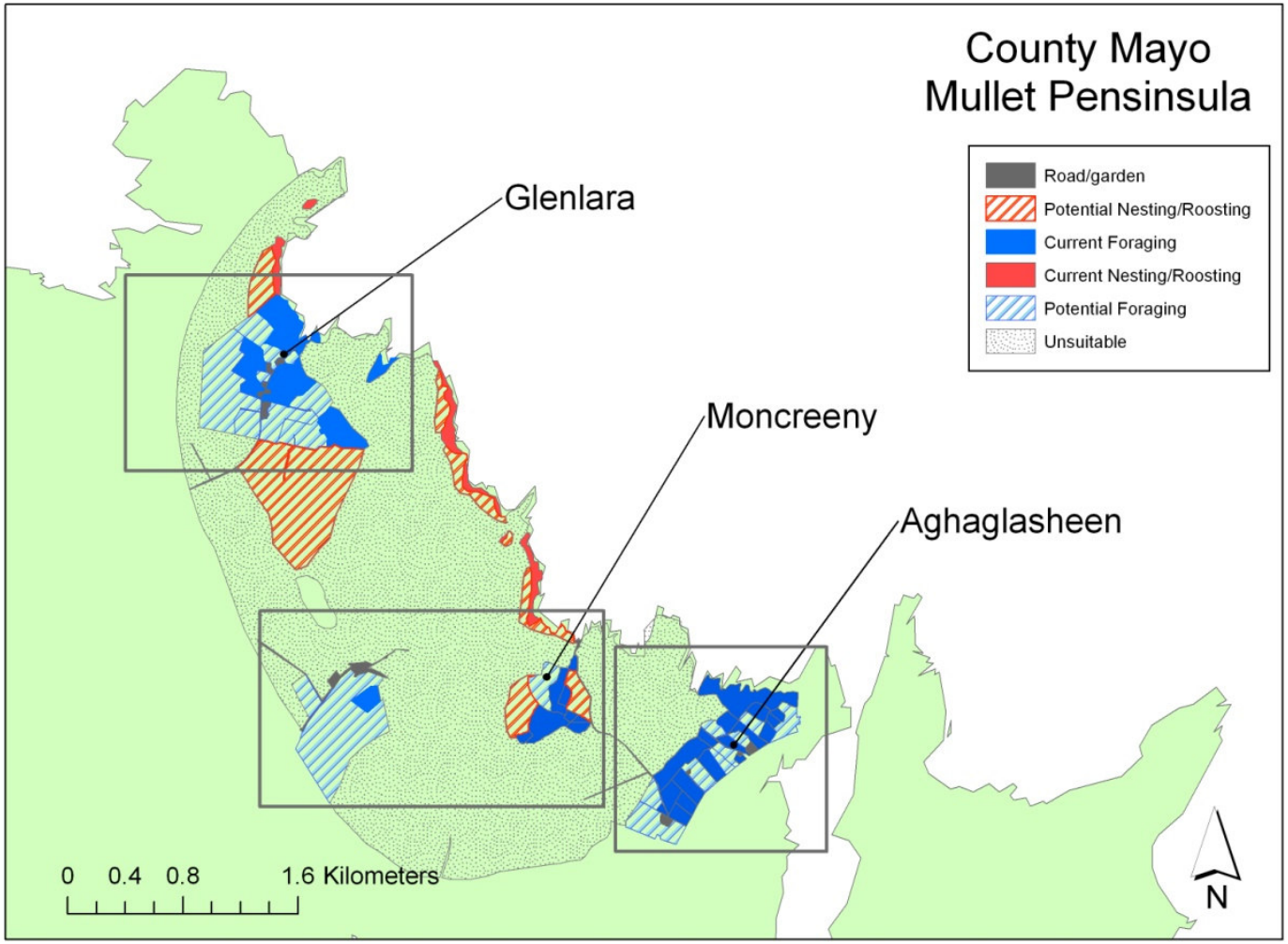

Figure 2A. Breeding area on the Mullet Peninsula showing important foraging areas. Areas within an approximately 2 km radius of nest sites are categorised according to suitability for twite.

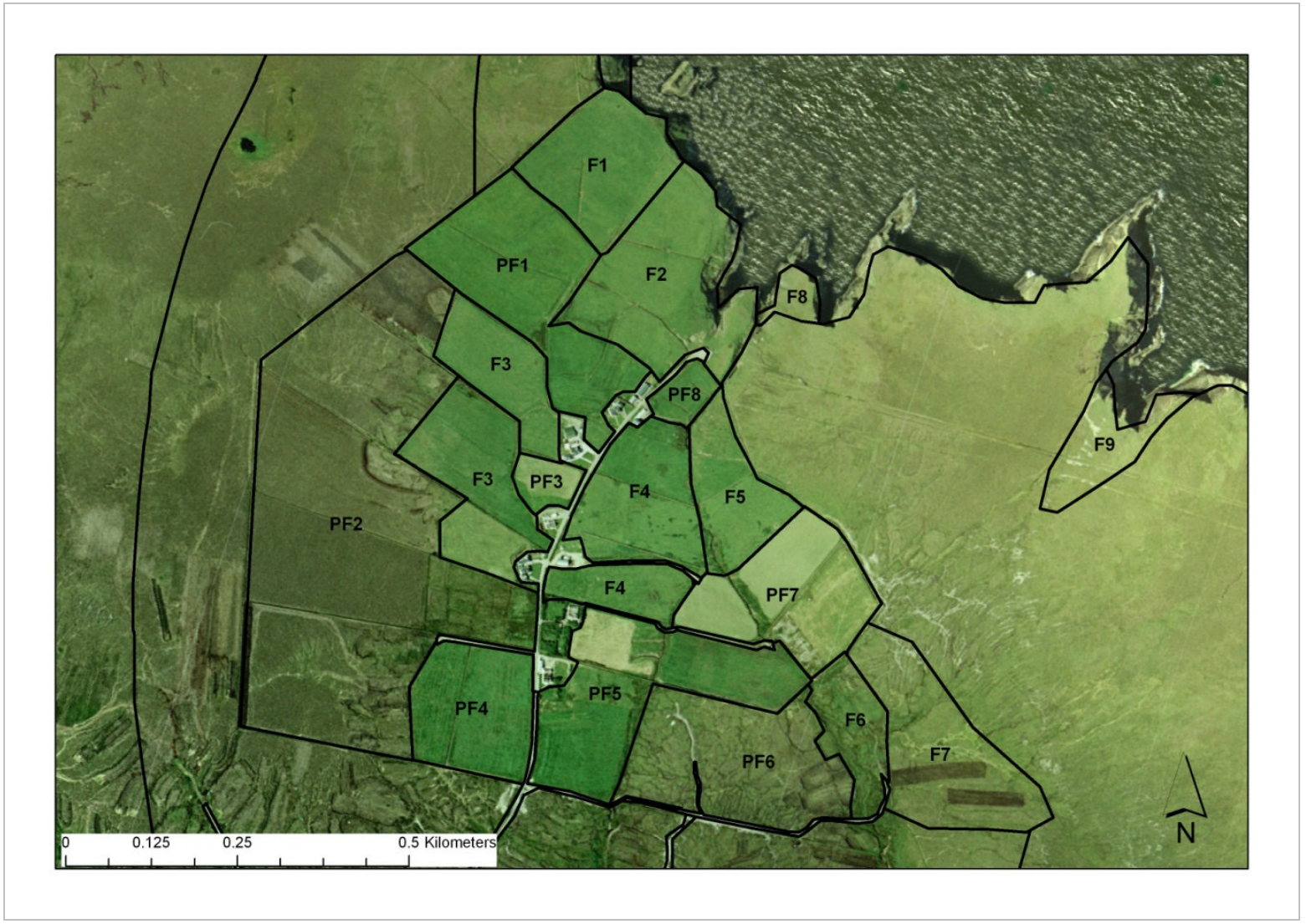

Figure 3A. Glenlara twite foraging site suitablity details.

Table 1A(a). Details of Glenlara 'Current Foraging (F)' field categories for Figure 3A (Fields F1 - F4).

Field no.	Period of use	Targeted food plants	Management description	Threats	Suggested actions	Priority
F1	May - Sept	Autumn hawkbit. Thistle spp. Common chickweed. Pineappleweed. Pearlwort. Mouse-ear chickweed.	Dry-humid acid grassland. Sward height 150-250mm. Low density cattle/sheep. Not suitable for hay/silage. Generally not artificially fertilised. Patch of disturbed ground to south with good variety of targeted food plants. Several damp drainages provide good abundance of chickweed/ Mouse-ear/pearlwort.	Agricultural improvement. Re-seeding. Application of fertiliser.	Maintain current management regime. Maintain current drainage system.	High.
F2	Apr - Sept	Autumn hawkbit Thistle spp. Mouse-ear chickweed. Common chickweed. Pineappleweed Pearlwort. Sea plantain. Sea thrift. Common sorrel. Dandelion.	Dry-humid acid grassland. Sward height <100mm. High density sheep grazing. Not suitable for hay/silage. Generally not artificially fertilised. Highest densities of targeted food plants occur within 50m of sea.	Agricultural improvement. Re-seeding. Application of fertiliser.	Maintain current management regime. Ensure continued sheep grazing of area within 50m of sea.	High.
F3	Aug - Sept	Thistle spp.	Dry-humid acid grassland. Sward height 150-250mm. Low density cattle/sheep.	Agricultural improvement. Re-seeding. Application of fertiliser.	Maintain current management regime.	Medium.
F4	Jun - Sept	Common chickweed. Thistle spp.	Dry-humid acid grassland. Sward height 150-250mm. Low density cattle/sheep.	Agricultural improvement. Re-seeding. Application of fertiliser.	Maintain existing stands of thistle spp.	Medium.

Table 1A(b). Details of Glenlara 'Current Foraging (F)' field categories for Figure 3A (Fields F5 – F9).

Field no.	Period of use	Targeted food plants	Management description	Threats	Suggested actions	Priority
F5	Apr - Sept	Autumn hawkbit. Sea plantain. Poa spp. Common sorrel. Dandelion.	Dry-humid acid grassland. Sward height 150-250mm. Sheep grazing. Silage harvested in part of F5. Many of the targeted food plants occur on earth banks. This area also includes the 4m wide naturally eroded gravel area to the northeast.	Agricultural improvement. Re-seeding. Application of fertiliser.	Maintain current management regime. Leave 5 m strip uncut during the silage harvesting.	Medium.
F6	Jun - Sept	Autumn hawkbit. Common sorrel. Common chickweed.	Mosaic of dry-humid acid grassland & blanket bog. Rough cattle grazing with gravel track providing disturbed ground.	Agricultural improvement. Intense grazing during the period Jun - Sept Re-seeding.	Refrain from grazing between Jul & Sept. Maintain current grazing regime outside these months.	High.
F7	Apr - Sept	Sea plantain. Pearlwort.	Heavily weather-eroded disturbed ground occasionally used for feeding.	No serious threat.	None.	Medium.
F8	Jun - Sept	Sea plantain. Sea thrift.	Generally not accessible to sheep. Primarily sea influenced.	No serious threat.	None.	Medium.
F9	Jun - Sept	Sea plantain. Sea thrift.	Subject to sheep grazing. Strongly influenced by local harsh weather conditions. Large density of sea plantain.	Cessation of sheep grazing.	Ensure adequate grazing by sheep in this area to retain sea plantain sward.	Medium.

Table 2A. Details of Glenlara 'Target Potential Foraging' (PF) field categories for Figure 3A (Fields PF1 – PF7).

Field no.	Management/Habitat description	Suggested actions	Priority
PF1	Improved grassland. Grazed by cattle & sheep. Artificial fertiliser applied annually. Harvested for silage.	Cease/minimise the application of artificial fertiliser. Leave an uncut margin of 5m around area cut for silage.	High.
PF2	Lowland blanket bog. Heavily grazed. Only sparse vegetation. Very low density of heather cover.	Where heather hasn't been completely removed, encourage re-colonisation.	Low.
PF3	Improved grassland. Sheep grazed.	Possible location for Twite 'Box 3' plot.	High.
PF4	Improved grassland. Cattle grazed. Artificial fertiliser applied annually. Re-seeded. Harvested for silage.	Cease/minimise the application of artificial fertiliser. Leave an uncut margin of 5m around area cut for silage. Possible location for Twite cereal plot.	High.
PF5	Improved grassland. Cattle grazed. Artificial fertiliser applied annually. Re-seeded. Harvested for silage.	Cease the application of artificial fertiliser. Leave an uncut margin of 5m around area cut for silage. Possible location for Twite 'Box 1' or '3' plot. Creation of shallow 'drainage' ditches with the aim of establishing good density of Common Chickweed.	High.
PF6	Heavily eroded cutover bog. Rough grazing for sheep.	Possible location for Twite 'Box 1' or '3' plot.	Low.
PF7	Improved grassland. Cattle grazed. Artificial fertiliser applied annually. Re-seeded. Harvested for silage.	Cease the application of artificial fertiliser. Leave an uncut margin of 5m around area cut for silage. Possible location for Twite cereal plot.	Medium.

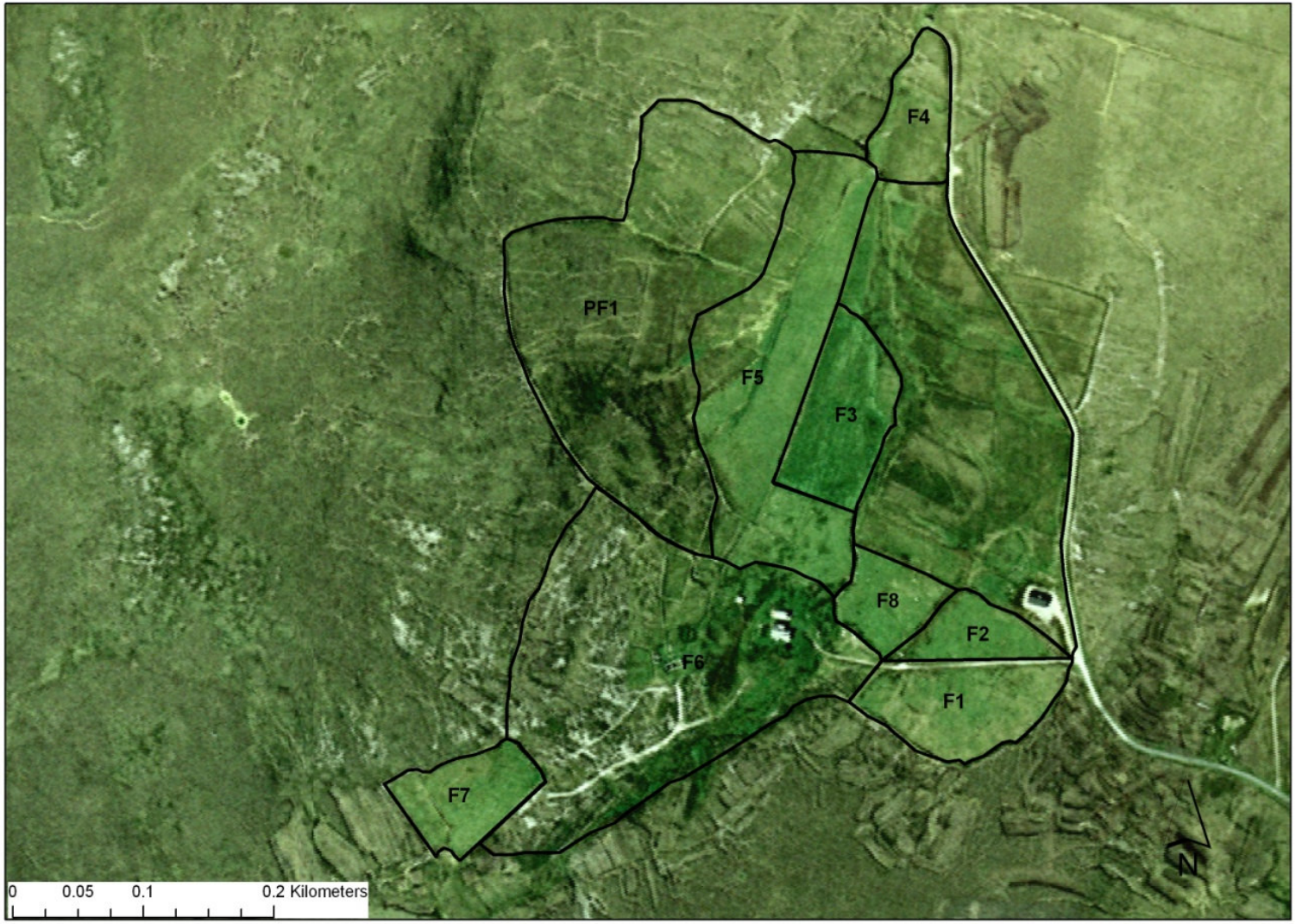

Figure 4A. Moncreeney twite foraging site suitablity details.

Table 3A(a). Details of Moncreeny 'Current Foraging (F)' field categories for Figure 4 (Fields F1 – F3).

Field no.	Period of use	Targeted food plants	Management description	Threats	Suggested actions	Priority
F1	May-Sept	Thistle. Common sorrel. Autumn hawkbit.	Dry-humid acid grassland. Ungrazed. Sward height 250-500mm. Not suitable for hay/silage. High density of targeted seed throughout this field. Not artificially fertilised.	Agricultural improvement. Agricultural re-seeding. Application of fertiliser.	Consider trial cutting/grazing regimes	High.
F2	July-Sept	Autumn hawkbit. Common chickweed. Thistle.	Dry-humid acid grassland. Sward height < 150mm. Low density sheep grazing. Not artifically fertilised. Targeted seed widespread.	Agricultural improvement. Agricultural re-seeding. Application of fertiliser.	Maintain current management regime.	Medium.
F3	April-Sept	Common chickweed. Common sorrel.	Dry-humid acid grassland. Sward height 150-300mm. Low density sheep grazing. Not artifically fertilised. Targeted seed occurs towards eastern boundary. Fresh water stream used for bathing and drinking.	Agricultural re-seeding.	Maintain current management regime.	Low.

Table 3A(b). Details of Moncreeny 'Current Foraging (F)' field categories for Figure 4 (Fields F4 – F6).

Field no.	Period of use	Targeted food plants	Management description	Threats	Suggested actions	Priority
F4	Aug-Sept	Sea plaintain. Common sorrel. Self heal.	Dry-humid acid grassland. Sward height 150-300mm. Low density sheep grazing. Not artifically fertilised. Fresh water stream used for bathing and drinking.	No significant threats.	Maintain current management regime.	Low.
F5	Apr-Sept	Common chickweed. Autumn hawkbit. Pearlwort.	Dry-humid acid grassland. Sward height 150-300mm. Low density sheep grazing. Not artifically fertilised. Wet areas near drains provide good density of seed, particularly in August.	Clearance of drains.	Possible location of "Box 3 type" plot.	Low.
F6	Apr-Sept	Autumn hawkbit. Common sorrel. Dandelion. Annual meadowgrass. Thistle. Pearlwort.	Mosaic of dry-humid acid grassland and wet & dry heath. Low density sheep grazing. Not artifically fertilised. Wide diversity of feeding areas. Birds target both disturbed areas and grassland.	Agricultural improvement. Abandonment.	Maintain current management regime.	High.

Table 3A(c). Details of Moncreeny 'Current Foraging (F)' field categories for Figure 4 (Fields F4 – F6).

Field no.	Period of use	Targeted food plants	Management description	Threats	Suggested actions	Priority
F7	May-July	Thistle. Common sorrel.	Dry-humid acid grassland. Ungrazed. Sward height 250-500mm. Not suitable for hay/silage. High density of targeted seed throughout this field. Not artificially fertilised.	Agricultural improvement. Agricultural re-seeding. Application of fertiliser.	Maintain current management regime.	High.
F8	July-Sept	Autumn hawkbit. Common chickweed. Thistle.	Dry-humid acid grassland. Sward height < 150mm. Low density sheep grazing. Not artifically fertilised.	Agricultural improvement / re-seeding. Agricultural re-seeding. Application of fertiliser.	Maintain current management regime.	Medium.

Table 4A. Details of Moncreeny 'Target Potential Foraging (PF)' field categories for Figure 4 (Field PF1).

Field no.	Management/Habitat description	Suggested actions	Priority
PF1	Dry-humid acid grassland. Wet heath. Poor densities of targeted seed plants.	Actions should only take place on grassland habitat. Possible location for "Box 3" type option.	Low.

Figure 5A. Aghaglasheen twite foraging site suitablity details.

Table 4A(a). Details of Aghaglasheen 'Current Foraging (F)' field categories for Figure 5A (Fields F1 – F4).

Field no.	Period of use	Targeted food plants	Management description	Threats	Suggested actions	Priority
F1	Apr-July	Thistle. Common sorrel.	Dry-humid acid grassland. Traditional hay meadow. Sward height 200-400mm. Not artifically fertilised. Targeted plants widespread.	Agricultural improvement. Re-seeding.	Maintain current management regime.	High.
F2	May-June	Common sorrel. Common chickweed.	Dry-humid acid grassland. Low density cattle/sheep grazing. Targeted plants occur around drainage ditches.	No serious threats.	None.	Low.
F3	May-June	Common sorrel. Common chickweed.	Dry-humid acid grassland Low density cattle /Sheep grazing. Targeted plants occur around drainage ditches.	No serious threats.	None.	Low.
F4	Jul-Sept	Pearlwort. Autumn hawkbit.	Dry-humid acid grassland. Wet/dry heath. Heavily eroded.	No serious threats.	None.	Low.

Table 4A(b). Details of Aghaglasheen 'Current Foraging (F)' field categories for Figure 5A (Fields F5 – F7).

Field no.	Period of use	Targeted food plants	Management description	Threats	Suggested actions	Priority
F5	May-Sept	Common sorrel. Common chickweed. Thistle. Annual meadow-grass.	Dry-humid acid grassland. Sward height 200-350mm. Sward usually preserved for silage harvesting. Targeted plants widespread.	No serious threats.	Maintain current management regime.	Medium.
F6	May-Sept	Common sorrel. Common chickweed. Thistle. Annual meadow-grass.	Dry-humid acid grassland. Sward height 200-350mm. Sward usually preserved. for silage harvesting. Targeted plants widespread.	No serious threats.	Maintain current management regime.	Medium.
F7	Apr-June	Common sorrel. Thistle. Red clover.	Dry-humid acid grassland. Sward height 200-350mm. Low intensity grazing.	No serious threats.	Maintain current management regime.	Low.

Table 4A(c). Details of Aghaglasheen 'Current Foraging (F)' field categories for Figure 5A (Fields F8 – F10).

Field no.	Period of use	Targeted food plants	Management description	Threats	Suggested actions	Priority
F8	May-Jul	Common sorrel. Selfheal. Pearlwort.	Dry-humid acid grassland. Wet heath. Targeted areas generally slightly disturbed. Relatively intense sheep grazing.	Agricultural improvement. Re-seeding.	None.	Low.
F9	May-Sept	Common sorrel. Common chickweed. Thistle. Annual meadow-grass.	Dry-humid acid grassland. Sward height 200-350mm. Targeted plants widespread.	No serious threats.	Maintain current management regime.	Medium.
F10	May-Sept	Common sorrel. Common chickweed. Thistle. Autumn hawkbit. Dandelion. Catsear. Mouse-ear.	Dry-humid acid grassland. Sward height 200-350mm. Targeted plants widespread.	Agricultural improvement.	Maintain current management regime.	Medium.

Table 4A(d). Details of Aghaglasheen 'Current Foraging (F)' field categories for Figure 5A (Fields F11 – F14).

Field no.	Period of use	Targeted food plants	Management description	Threats	Suggested actions	Priority
F11	Aug-Sept	Autumn hawkbit. Common chickweed. Pineappleweed.	Dry-humid acid grassland. Sward height 150-300mm. Targeted plants occur in area heavily trampled by cattle.	No serious threat.	Maintain current management regime.	Medium.
F12	Apr-Sept	Common sorrel. Poa spp.	Dry-humid acid grassland. Sward height <200mm. Cattle grazed. Targeted food plants widespread.	Abandonment.	Maintain current management regime.	Medium.
F13	Aug-Sept	Autumn hawkbit Common chickweed.	Dry-humid acid grassland. Sward height 150-300mm. Targeted plants widespread.	Re-seeding.	Maintain current management regime.	Low.
F14	Aug-Sept	Autumn hawkbit. Common chickweed.	Dry-humid acid grassland. Sward height 150-300mm. Targeted plants widespread.	Re-seeding.	Maintain current management regime.	Low.

Table 4A(e). Details of Aghaglasheen 'Current Foraging (F)' field categories for Figure 5A (Fields F15 – F17).

Field no.	Period of use	Targeted food plants	Management description	Threats	Suggested actions	Priority
F15	May-Sept	Sea plantain. Sea thrift.	Dry-humid acid grassland. Sward height <100mm. Intense Sheep grazing.	Cessation of sheep grazing.	Ensure adequate grazing by sheep to retain sea plantain sward.	High.
F16	Apr-May	Pearlwort.	Wet heath. Some acid grassland. Targeted food plants occur in heavily disturbed areas.	No serious threats.	None.	Low.
F17	May-Sept	Sea plantain. Sea thrift.	Dry-humid acid grassland. Sward height <100mm. Intense sheep grazing.	Cessation of sheep grazing.	Ensure adequate grazing by Sheep occurs to help retain Sea Plantain sward.	High.

Table 5A. Details of Aghaglasheen 'Target Potential Foraging (PF)' field categories for Figure 5A (Fields PF1-PF9).

Field no.	Management/Habitat description	Suggested actions	Priority
PF1	Improved grassland. Grazed by cattle and sheep.	Possible location for Box 1-3.	High.
PF2	Wet heath/acid grassland. Heavily disturbed.	Encourage heather growth.	Medium.
PF3	Improved grassland. Grazed by cattle and sheep. Artificially fertilised.	Possible location for Box 1-3.	High.
PF4/5	Dry-humid acid grassland. Grazed by cattle and sheep. Low density of seed plants.	Possible location for Box 1-3.	High.
PF6/7	Improved grassland. Grazed by cattle and sheep. Artificially fertilised.	Possible location for Box 1-3.	High.
PF8	Wet heath/acid grassland. Heavily disturbed	Encourage heather growth.	Low.
PF9	Dry-humid acid grassland. Wet grassland. Low density of seed plants.	Encourage common chickweed.	Low.

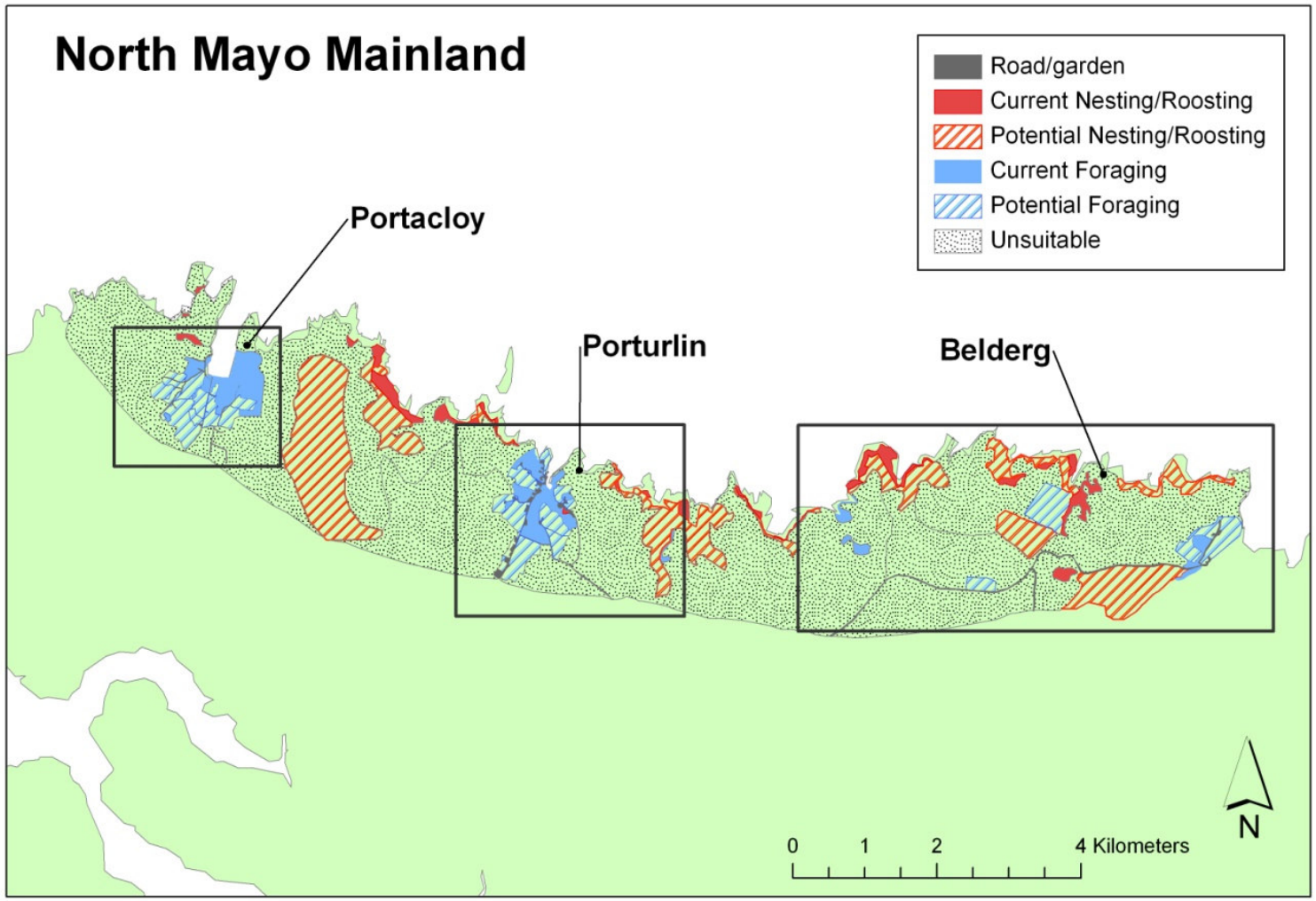

Figure 6A. Breeding area on the north Mayo mainland coastline showing important foraging areas. Areas within an approximately 2 km radius of nest sites are categorised according to suitability for twite.

Figure 7A. Portacloy twite foraging site suitablity details.

Table 6A(a). Details of Portacloy 'Current Foraging (F)' field categories for Figure 7A (Fields F1 – F4).

Field no.	Period of use	Targeted food plants	Management description	Threats	Suggested actions	Priority
F1	May-Aug	Dandelion. Annual meadow-grass. Sea plantain. Sea thrift. Common sorrel.	Dry-humid acid grassland. Sward height <50mm. Unenclosed ground adjacent to sea shore. Grazed by sheep.	None.	None.	High.
F2	Apr-Jul	Dandelion. Common sorrel.	Dry-humid acid grassland. Sward height 150-300mm. Low intensity sheep grazing. Targeted seed occurs on disturbed hillocks in field.	Re-seeding.	Maintain current management regime.	Medium.
F3	Jul-Aug	Common chickweed.	Wet grassland. Sward height 150-300mm. Grazed by cattle. Targeted seed occurs in damp drain where chickweed is abundant.	Clearance of drainage system.		Low.
F4	Apr-May	Annual meadow-grass. Pearlwort. Sheep sorrel. Common sorrel.	Rough grazing comprising mainly exposed gravel. Targeted plants generally around 'damp' flushes.	Agricultural improvement. Re-seeding.	None.	Low.

Table 6A(b). Details of Portacloy 'Current Foraging (F)' field categories for Figure 7A (Fields F5 – F8).

Field no.	Period of use	Targeted food plants	Management description	Threats	Suggested actions	Priority
F5	May-Sept	Common sorrel. Autumn hawkbit.	Dry-humid acid grassland. Sward height 150-300mm. Low intensity sheep grazing. Targeted seed plants occur towards southern boundary of site, particularly along earthen ditches.	Removal of earthen ditches.	Maintain current management regime.	Low.
F6	Apr-Sept	Dandelion. Annual meadow-grass. Selfheal. Sea plantain Autumn hawkbit. Catsear.	Sand-dune with calcareous grassland. Birds target areas adjacent to dunes but not the dunes themselves. Running water areas also important.	Any change to the habitat type.	Maintain current management regime.	High.
F7	May-Aug	Common chickweed. Common sorrel.	Birds target wet grassland area of this field adjacent to stream.	No significant threat.	Maintain current management regime.	Low.
F8	Apr-Sept	Annual meadow-grass. Common sorrel.	Running water. Banks of stream. Important for bathing & picking up grit.	No significant threat.	No suggested action.	Medium.

Table 6A(c). Details of Portacloy 'Current Foraging (F)' field categories for Figure 7A (Fields F9 – F10).

Field no.	Period of use	Targeted food plants	Management description	Threats	Suggested actions	Priority
F9	Apr-Sept	Dandelion. Annual meadow-grass. Selfheal. Autumn hawkbit. Catsear. Pineappleweed. Common chickweed. Thistle spp.	Mix of semi-improved enclosed fields. Targeted seed widespread throughout this area, particularly towards northern perimeter. Silage harvested in small proportion of this area. Pineappleweed & chickweed occur in disturbed areas were cattle ring-feeders were placed during the winter. Overwintering of cattle appears to enhance suitablity of twite during the breeding season. Low intensity sheep grazing during the breeding season.	Agricultural improvement. Re-seeding. Abandonment. Changes in farming practices.	Maintain current management regime. Monitor twite use of this area.	High.
F10	Apr-Sept	Sea plantain. Dandelion. Annual Meadow-grass. Self-heal. Autumn hawkbit. Catsear.	Predominantly dry-humid acid grassland. Moderate intensity sheep grazing. Sward <150mm. Particular occurence of targeted seed patches in semi-exposed gravel areas.	Agricultural improvement. Re-seeding. Abandonment.	Maintain current management regime. Monitor twite use of this area.	High.

Table 7A. Details of Portacloy 'Target Potential Foraging (PF)' field categories for Figure 7A (Fields PF1-PF12).

Field no.	Management/Habitat description	Suggested actions	Priority
PF1	Dry-humid acid grassland. Rough grazing. Poor density of targeted seed plants.	Possible location for 'Box 1 or 3' option.	Low.
PF2	Dry-humid acid grassland. Poor density of targeted seed plants.	Possible location for 'Box 1 or 3' option.	Low.
PF3/4	Large areas with variety of wet heath, and semi-improved and improved grassland.	Possible location for 'Box 3' option. Should only be place in areas of previous fertilised grassland	High.
PF5/6	Dry-humid acid grassland. Rough grazing. Poor density of targeted seed plants.	Possible location for 'Box 1 or 3' option.	Medium.
PF7	Dry-humid acid grassland. Poor density of targeted seed plants.	Possible location for 'Box 1 or 3' option.	Low.
PF8	Wet grassland. Poor density of targeted seed plants.	Encourage common chickweed.	Low.
PF9	Improved grassland. Rough grazing. Poor density of targeted seed plants.	Possible location for 'Box 1 or 3' option.	Medium.
PF10/11	Mix of Improved and Semi-improved grassland.	Possible location for 'Box 1 or 3' option. Should only be place in areas of previous fertilised grassland.	High.
PF12	Dry-humid acid grassland. Poor density of targeted seed plants.	Possible location for 'Box 1 or 3' option.	Low.

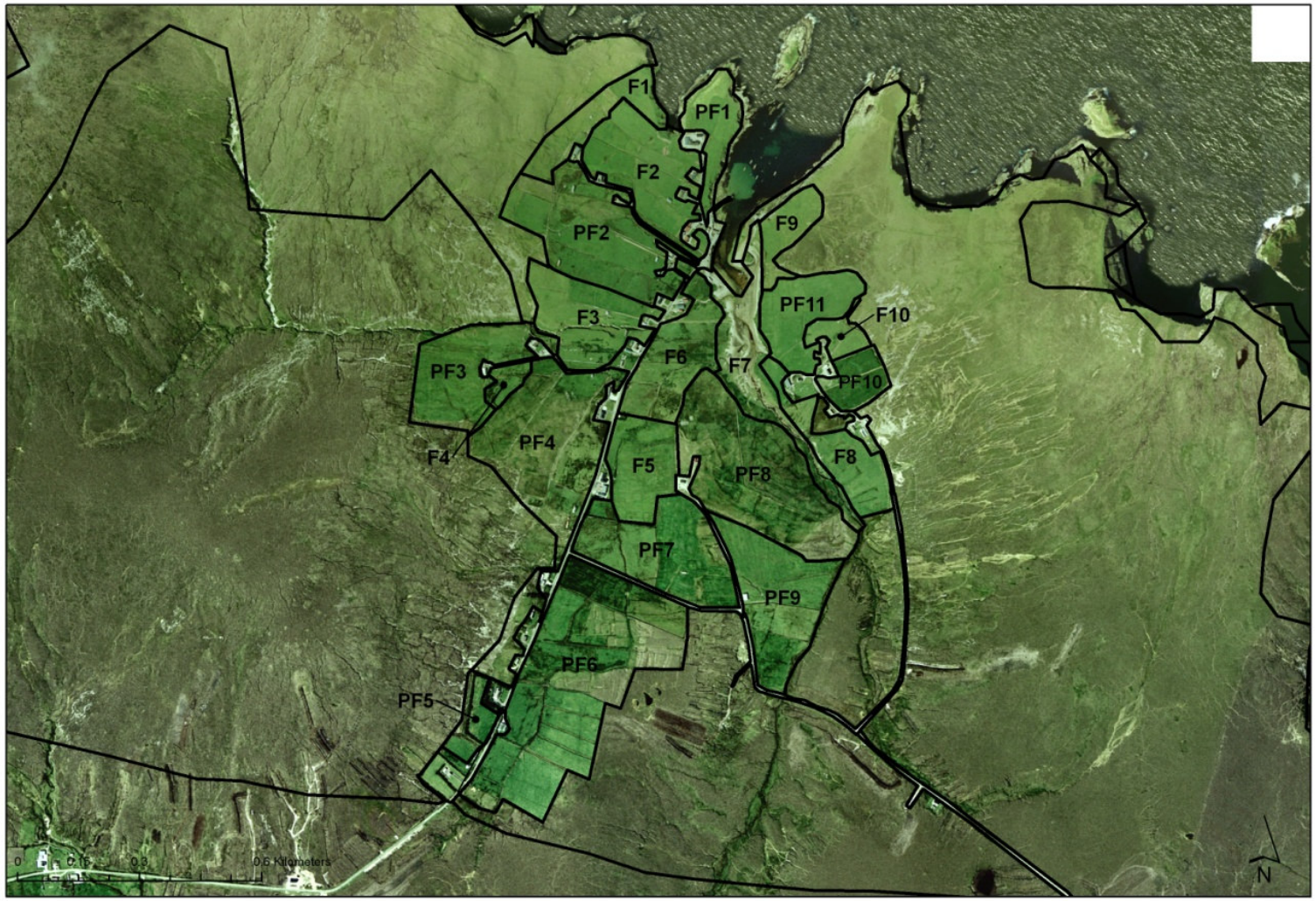

Figure 8A. Porturlin twite foraging site suitablity details.

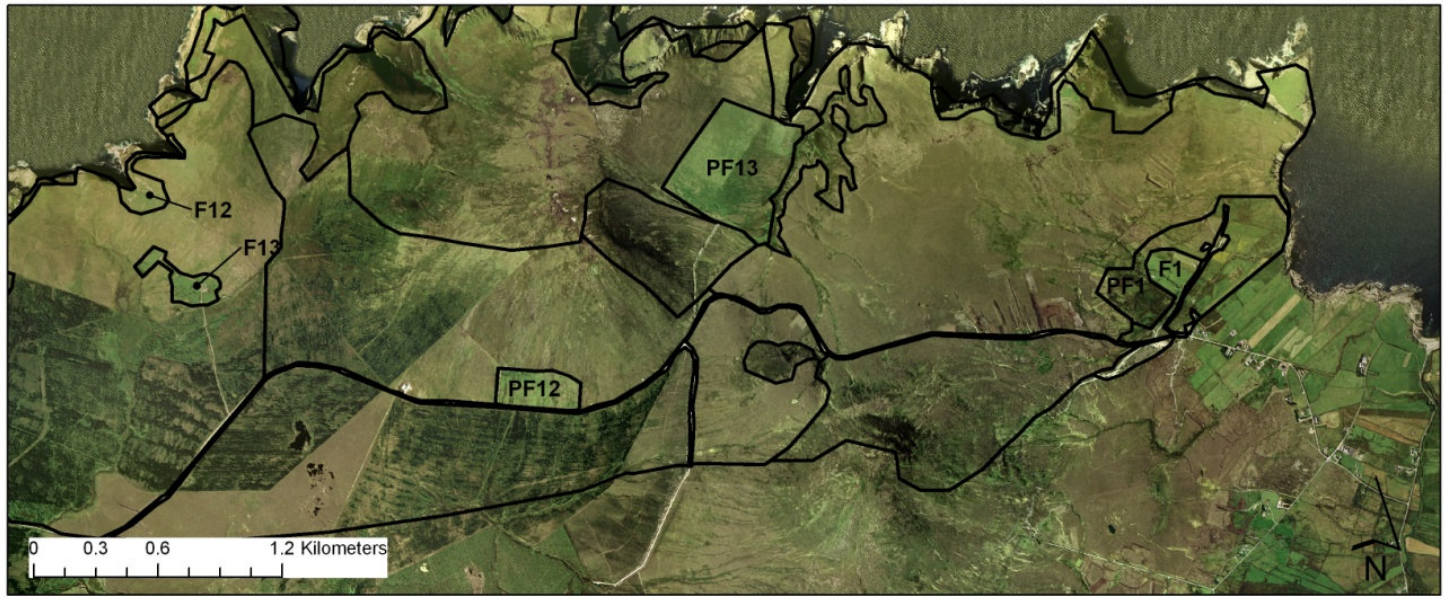

Figure 9A. Belderg twite foraging site suitablity details.

Table 8A(a). Details of Porturlin 'Current Foraging (F)' field categories for Figure 8A (Fields F1 – F6).

Field no.	Period of use	Targeted food plants	Management description	Threats	Suggested actions	Priority
F1	Apr-Sept	Common sorrel. Common chickweed. Pineappleweed. Pearlwort. Sea plantain. Sea thrift.	Dry-humid acid grassland. Sward height <100mm. High density sheep grazing. Not suitable for hay/silage. Generally not artificially fertilised. Targeted seed occurs within 50m of coast and along drainage ditches.	Re-seeding.	Ensure continued sheep grazing in this area.	High.
F2	May-Sept	Common sorrel. Common chickweed. Pineappleweed. Pearlwort. Sea plantain. Sea thrift. Autumn hawkbit.	Mix of improved and semi-improved grassland. Sward height 100-300mm. Medium density sheep grazing. Autumn hawkbit throughout field. Other targeted seed generally occurs along drainage ditches.	Re-seeding. Application of fertiliser. Clearance of drains.	Ensure continued sheep grazing of area within 50m of sea. Patches of heavy grazing from. winter ring-feeder would encourage chickweed.	Medium.
F3	Apr-Sept	Common sorrel. Thistle. Common chickweed. Mouse-ear.	Dry-humid acid grassland. Birds target boundary and draingage ditches, and stream.	Clearance of drains.	Continue current management regime.	High.
F4	Apr-Jul	Common sorrel. Thistle.	Dry-humid acid grassland. Birds target boundary and draingage ditches, and stream.	Clearance of drains.	Continue current management regime.	Medium.
F5/6	Apr-Jul	Common chickweed. Mouse-ear.	Improved and Semi-improved grassland. Birds target draingage ditches.	Clearance of drains	Continue current management regime.	Medium.

Table 8A(b). Details of Porturlin 'Current Foraging (F)' field categories for Figure 8A (Fields F7 – F11).

Field no.	Period of use	Targeted food plants	Management description	Threats	Suggested actions	Priority
F7	Apr-Sept	Common sorrel. Common chickweed. Pineappleweed. Pearlwort. Sea plantain. Sea thrift. Autumn hawkbit. Thistle. Annual meadow-grass.	Saltmarsh, shingle, freshwater river. Occasional Sheep grazing. High densities of seed plants.	Alteration to this habitat.	Preserve current habitat.	High.
F8	Apr-Aug	Common sorrel. Common chickweed. Dandelion.	Dry-humid acid grassland. Sward<200 mm. Relatively high-density sheep grazing. Birds target drainage ditches and bare hump in field.	Clearance of drains. Re-seeding.	Continue current management regime.	Medium.
F9/10	Jul-Sept	Common sorrel. Sea plantain. Sea thrift. Autumn hawkbit.	Dry-humid acid grassland. Sward height <100mm. High density sheep grazing. Generally not artificially fertilised. Targeted seed occurs within 50 m of coast and along drainage ditches.	Re-seeding. Abandonment.	Ensure continuation of sheep grazing in this area.	High.
F11	May-Aug	Annual meadow-grass. Cotton grass.	Wet heath/disturbed ground. Eroding blanket bog with high density of *Poa* and *Eriophorum* spp.	No serious threats.	None.	Low.

Table 8A(c). Details of Porturlin/Belderg 'Current Foraging (F)' field categories for Figure 9A (Fields F12 – F13).

Field no.	Period of use	Targeted food plants	Management description	Threats	Suggested actions	Priority
F12	May-Sept	Sea plantain. Sea thrift.	Coastal heath/grassland. Relative high-density sheep grazing. Sward height <50 mm.	Undergrazing.	Continue current grazing regime.	High.
F13	Apr-Aug	Annual meadow-grass. Dandelion.	Dry-humid acid grassland. Moderate density sheep grazing. Targeted seed plant widespread.	Undergrazing.	Continue current grazing regime.	Medium.

Table 8A(d). Details of Belderg 'Current Foraging (F)' field categories for Figure 9A (Field F1).

Field no.	Period of use	Targeted food plants	Management description	Threats	Suggested actions	Priority
F1	Apr-Sept	Common sorrel. Common chickweed. Pineappleweed. Pearlwort. Sea plantain. Autumn hawkbit. Thistle. Annual meadow-grass.	Dry-humid acid grassland, freshwater stream, disturbed ground. Moderate intensity sheep grazing in enclosed lands. Low intensity sheep grazing in unenclosed areas. Targeted plants throughout this area, but particularly along drainage ditches and quarry pit.	No serious threat.	None.	Medium

Table 9A. Details of Porturlin/Belderg 'Target Potential Foraging (PF)' field categories for Figures 8A & 9A (Fields PF1-PF13).

Field no.	Management/Habitat description	Suggested actions	Priority
PF1/2/3	Mix of Improved and Semi-improved grassland. Poor seed-plant density.	Possible location for "Box 1 or 3" option.	High.
PF4	Wet heath / Semi-improved grassland. Rough grazing.	Possible location for "Box 1" option.	Low.
PF5	Dry-humid acid grassland.	Possible location for "Box 3" option.	Low.
PF6/7	Mix of wet and dry-humid acid grassland.	Possible location for "Box 3" option.	Low.
PF8	Wet heath/wet grassland. Rough grazing.	None.	Low.
PF9	Improved & Semi-improved grassland.	Possible location for "Box 3" option.	Medium.
PF10	Wet grassland dominated by Hard rush. Low intensity cattle grazing.	Possible location for "Box 3" option.	High.
PF11	Dry-humid acid grassland. Poor densities of targeted seed plants. Moderate intensity sheep grazing.	Possibly suitable for enclosure with higher density of sheep grazing to encourage colonisation by targeted plant species	Medium.
PF12/13	Dry-humid acid grassland. High density sheep grazing. Poor densities of targeted seed plants.	Possible location for "Box 1 or 3" option.	High.

Table 10A. Details of Belderg 'Target Potential Foraging (PF)' field categories for Figure 9A (Field PF1).

Field no.	Management/Habitat description	Suggested actions	Priority
PF1	Mix of Improved and Semi-improved grassland and Wet heath.	Possible location for "Box 1 or 3" option (The above action is only recommended on previously fertilised land).	Medium

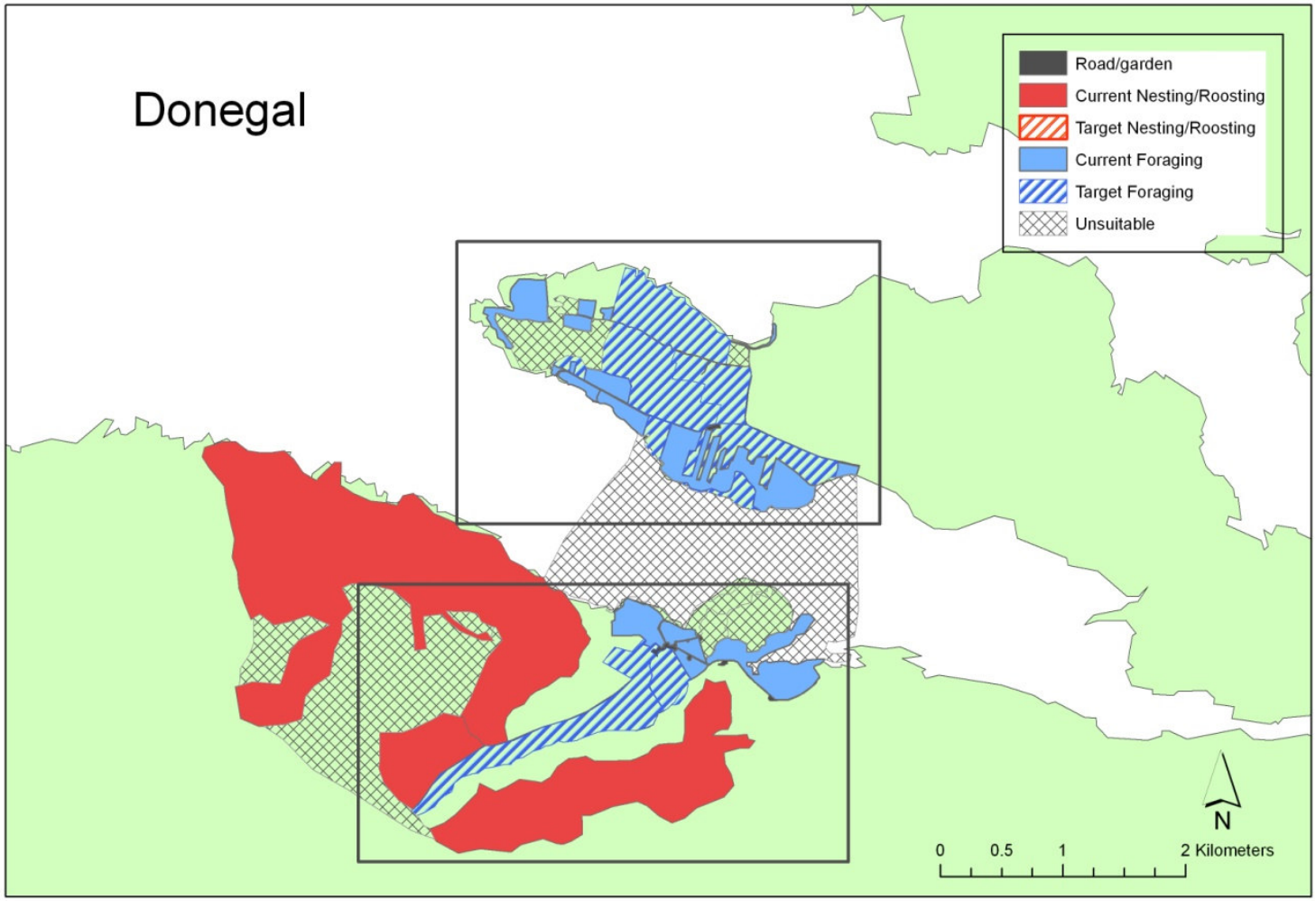

Figure 10A. Breeding area in west Donegal showing important foraging areas. Areas within an approximately 2 km radius of nest sites are categorised according to suitability for twite.

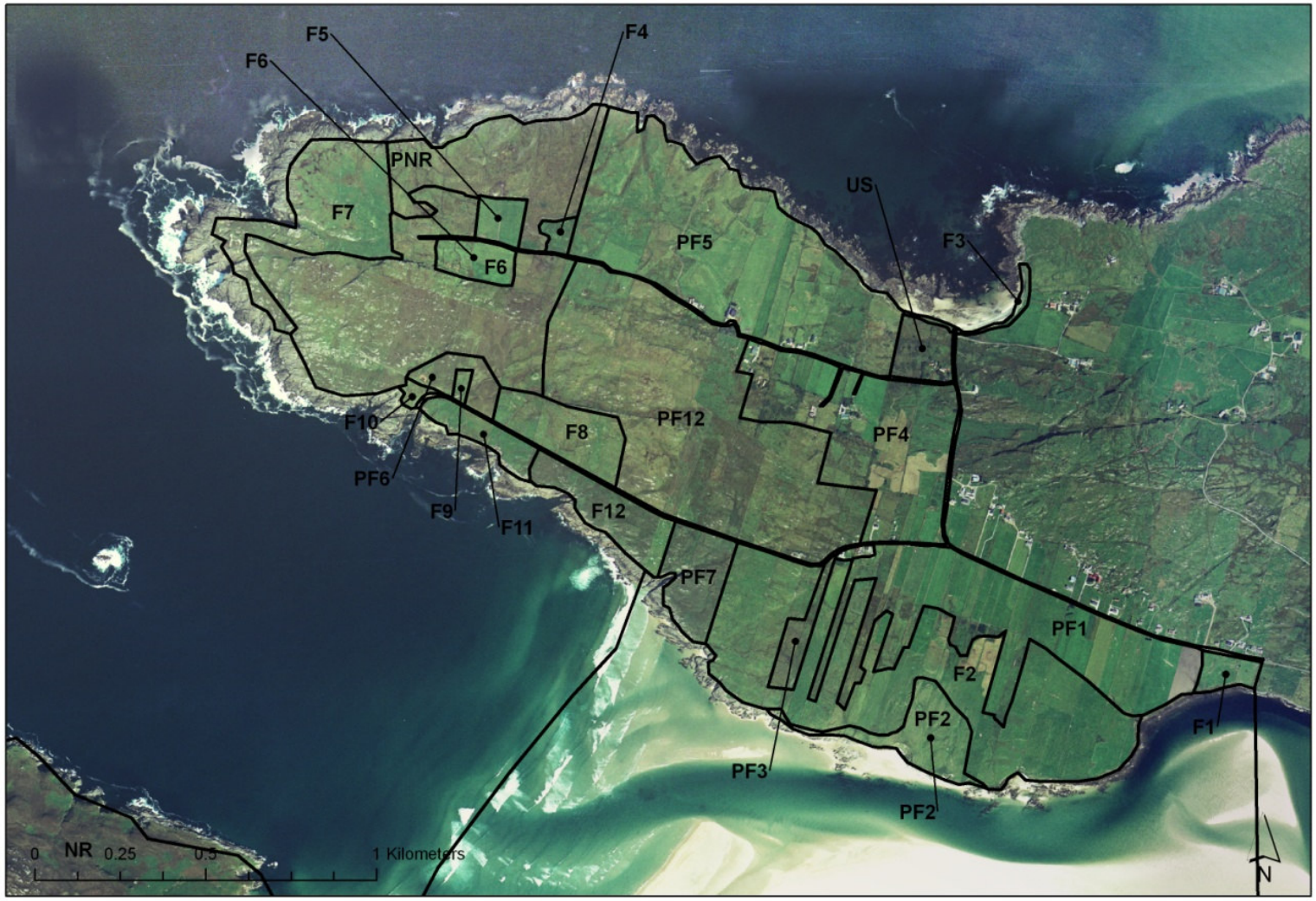

Figure 11A. Loughros Point twite foraging site suitablity details. 'NR' = Nest/roost site.

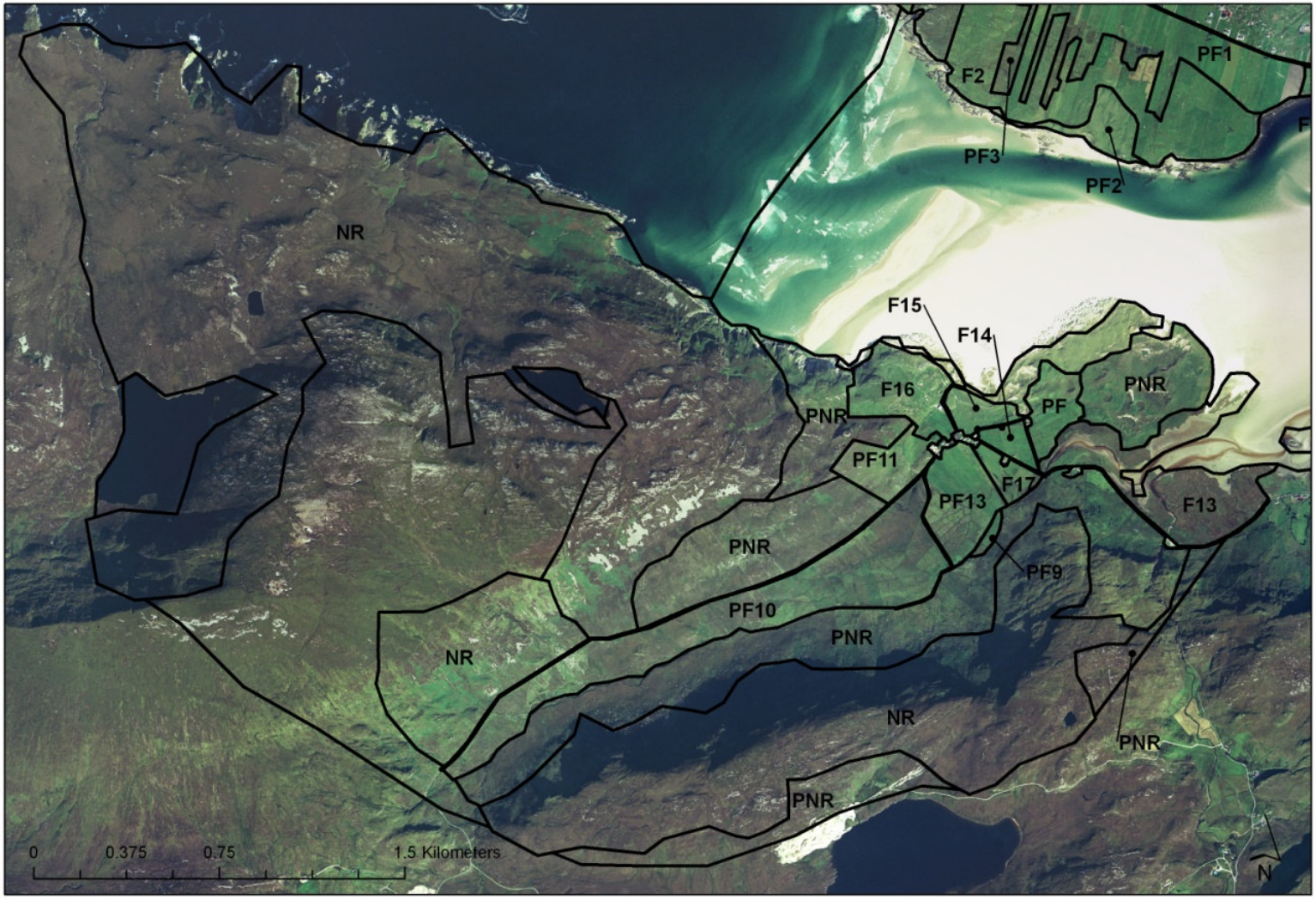

Figure 12A. Maghera twite foraging site suitablity details. 'NR' = nest/roost site. 'PNR' = potential nest/roost site.

Table 11A(a). Details of Loughros Point/Maghera 'Current Foraging (F)' field categories for Figures 11A & 12A (Fields F1 – F7).

Field no.	Period of use	Targeted food plants	Management description	Threats	Suggested actions	Priority
F1	May-Jul	Annual meadow-grass. Common sorrel.	Improved grassland. Moderate intensity sheep/cattle grazing. Birds target disturbed patch on humps and earthen banks.	No serious threats.	None.	Low.
F2	May-Aug	Annual meadow-grass. Common sorrel. Thistle. common Chickweed. Dandelion. Sea plantain.	Dry-humid acid grassland. Coastal grassland. Generally low-intensity cattle/sheep grazing. Target seed plants are quite widespread, but with a greater concentration near the shoreline.	Agricultural improvement. Re-seeding.	Maintain current management regime.	Medium.
F3	Aug-Sept	Sea plantain. Sea thrift. Sea mayweed.	Shingle / shoreline. Very little grazing.	No serious threats.	None.	Medium.
F4/5/6	Jun-Jul	Thistle. Sheep sorrel.	Dry-humid acid grassland. Low intensity sheep grazing.	Agriculture improvement. Re-seeding.	Maintain current regime.	Medium.
F7	Jul-Aug	Sea plantain. Sea thrift.	Coastal grassland/ dry-humid acid grassland. Moderate intensity sheep grazing.	No serious threats.	None.	Medium.

Table 11A(b). Details of Loughros Point/Maghera 'Current Foraging (F)' field categories for Figures 11A & 12A (Fields F8 – F13).

Field no.	Period of use	Targeted food plants	Management description	Threats	Suggested actions	Priority
F8/9	May-Jul	Dandelion. Common sorrel. Thistle.	Dry-humid acid grassland. Moderate intensity sheep grazing. Targeted seed plants occur relatively widespread in these fields.	Agriculture improvement. Re-seeding.	Maintain current regime.	Medium.
F10	Jul-Aug	Dandelion. Sea plantain. Sea thrift. Common sorrel. Thistle.	Coastal grassland/ dry-humid acid grassland. Moderate intensity Sheep grazing. Sward height <200 mm.	Agriculture improvement. Re-seeding.	Maintain current regime.	High.
F11/12	May-Aug	Dandelion. Sea plantain. Sea thrift. Common sorrel. Thistle. Selfheal. Annual meadow-grass.	Dry-humid acid grassland with some wet heath. Moderate intensity sheep grazing. Sward height 100-350 mm. Many of the targeted seed plants occur adjacent to exposed rock or disturbed ground. ground.	Agriculture improvement. Re-seeding.	Maintain current regime.	High.
F13	Jul-Sept	Sea plantain. Sea thrift.	Saltmarsh. Very little sheep grazing.	Agriculture improvement. Re-seeding.	Maintain current regime.	High.

Table 11A(c). Details of Loughros Point/Maghera 'Current Foraging (F)' field categories for Figures 11A & 12A (Fields F14-17).

Field no.	Period of use	Targeted food plants	Management description	Threats	Suggested actions	Priority
F14/15	Apr-Jul	Dandelion. Common sorrel. Common chickweed. Thistle.	Dry-humid acid grassland. Moderate intensity sheep grazing. Targeted seed plants are generally widespread.	Agriculture improvement. Re-seeding.	Maintain current regime.	Medium.
F16	May-Aug	Common sorrel. Dandelion. Thistle. Chickweed. Annual meadow-grass.	Dry-humid acid grassland. Sand dune, coastal grassland. Some moderate sheep grazing near house. Low intensity sheep grazing toward the west of this area where thistle dominates. Some bracken occurs in this area.	Re-seeding.	Maintain current regime. Maintain bracken stands to provide potential roost vegetation sites.	High.
F17	May-Jul	Common chickweed. Common sorrel.	Improved/wet grassland. Moderate intensity sheep grazing. Chickweed is confined to damp drains, Sorrel appears to be widespread.	No serious threat.	Leave 5 m margin at edge of field after cutting hay silage.	Low.

Table 12A. Details of Loughros Point/Maghera 'Target Potential Foraging (PF)' field categories for Figures 11A & 12A (Fields PF1-PF13).

Field no.	Management/Habitat description	Suggested actions	Priority
PF1	Wet heath & improved grassland. Variety of grazing densities.	Possible location for 'Box 1 or 3' option. Interventions should take place on improved grassland.	Medium
PF2	Sand dunes. Some cattle grazing.	None	Low
PF3	Wet heath/dry-humid acid grassland. Cattle grazing.	None	Low
PF4/5	Wet heath & Improved grassland. Variety of grazing densities. Bracken also present in the area which would provide roosting opportunities.	Possible location for 'Box 1 or 3' option. Interventions should take place on improved grassland.	High
PF6	Wet heath/dry-humid acid grassland. Moderate intensity sheep grazing.	None	Low
PF7	Wet heath/wet grassland.	Possible location of 'Box 1' option.	Low
PF8	Sandy shoreline.	None	Low
PF9/10	Wet heath/Wet grassland.	Possible location for 'Box 1 or 3' option. Interventions should take place on grassland habitat only.	Medium
PF11	Dry-humid acid grassland. Low intensity sheep grazing.	Possible location for 'Box 1 or 3' option. Interventions should take place on grassland habitat only.	Medium
PF12	Wet heath & Improved grassland. Variety of grazing densities. Bracken also present in the area which would provide roosting opportunities.	Possible location for 'Box 1 or 3' option. Interventions should take place on improved grassland.	High
PF13	Dry-humid grassland/wet grassland.	Possible location for 'Box 1 or 3' option.	High