Appendix J

Galway City Outer Bypass
Marsh Fritillary Survey Report
(Barron et al., 2013)

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Galway City Outer Bypass Marsh Fritillary Survey Report

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Table of Contents

1 Background 1
1.1 Marsh fritillary ecology 1
1.1.1 Lifecycle 1
1.1.2 Population ecology 2
1.1.3 Habitat 2
1.1.4 Legal & conservation status 3
2 Methodology 3
2.1 Desktop study 3
2.2 Field survey 4
3 Results 4
3.1 Desktop study 4
3.1.1 Distribution maps 4
3.1.2 Local historical records 8
3.1.3 Previous marsh fritillary surveys 8
3.2 Field survey 8
3.2.1 Suitable habitat 8
3.2.1 Larval web surveys 8
4 Discussion 11
5 References 13
Appendix I – Galway City Outer Bypass marsh fritillary survey area and survey sites 15
Appendix II - Areas of suitable marsh fritillary habitat identified during the Galway City Outer Bypass marsh fritillary survey 17
Appendix III – Recommended additional survey sites 19
Appendix IV - Photographs 21

1 Background

BEC Consultants Ltd was appointed by Arup and Scott Cawley to carry out marsh fritillary (*Euphydryas aurina*) surveys for the Galway City Outer Bypass. The survey area for this survey is shown in Appendix I.

The aims of the survey were to:

i) identify and map areas of habitat suitable for marsh fritillary butterflies.
ii) locate any larval webs occurring within the study area and assess the condition of the habitat at these locations.

1.1 Marsh fritillary ecology

The marsh fritillary (*Euphydras aurinia*) is a resident species of Ireland and is found across a range of habitats. The presence of Devil's-bit Scabious (*Succisa pratensis*), which is the main food plant for the caterpillars, is a critical factor in the species distribution. However, given the widespread occurrence of *S. pratensis* in Ireland, more specific habitat requirements are likely to be at work in restricting the distribution of marsh fritillary.

1.1.1 Lifecycle

Adult marsh fritillary are on the wing from about mid-May to the end of June. Once mated, the morphometrically larger females lay egg batches on the back of leaves of a single plant species; *Succisa pratensis*. The eggs of marsh fritillary, laid in early June, hatch after five weeks at 20°C (Porter, 1983). The females can lay up to 600 eggs in up to three batches. It is more common to see first batches of 250-300 eggs and smaller subsequent batches of 20-40 eggs. The eggs, when laid, are white. As they mature, they change colour from yellow, through to purple, deep purple and then grey.

Hatching of the eggs in a batch usually takes one sunny day. Most eggs in a batch hatch, though some slightly later than others, but sometimes up to 5% per batch will fail to hatch (pers. obs Seale, 2010). The newly emerged larvae (1st instar) are approximately 2 mm in length. They then spin a delicate web on the back of the *S. pratensis* leaf they hatched on. In Ireland, *S. pratensis* is overwhelmingly the most important food plant for the species at the larval stages. *Succisa pratensis* abundance is integral to marsh fritillary populations; they cannot exist/breed without their food plant. The beige-coloured larvae continue to work communally and spin a succession of webs. The first moult takes place when the larvae are 20-30 days old (Porter, 1983). When the larvae are in the 2nd instar they are approximately 0.6 to 1.2 cm long, and they are beige in colour with a brown head. They can be seen actively spinning extensions to their web structures and feeding within this protected area adjacent to the web. The fuzzy brown and striped 3rd instar larvae are approximately 2 cm in length and are quite mobile and feed extensively within enlarged webs. By the 4th instar stage (the first black stage, which one sees in late September) the larvae are ready to hibernate in over-wintering hibernacula/webs. These winter hibernacula are very difficult to find, as they are built low down under vegetation.

Succisa pratensis is not the sole host plant for the over-wintering larvae. Marsh fritillary spin their hibernacula on heather and grasses, as well as nearby plants that provide shelter. In early February and March, the larvae emerge from hibernation to bask in the sun. Basking or thermoregulation in the 4th and 5th instars (pre- and post-hibernation) is important to this species of butterfly and aids food digestion (Porter, 1982). They continue to remain dependant on *S. pratensis* as a food source and it must be locally abundant. As time progresses, the larval clusters decrease in size until feeding and basking occur individually after the moult from 4th to 5th instars. Larvae feed singly in the 5th and 6th

instars and roam to find food plants; they pupate in May and metamorphose to fly as adults in May/June.

1.1.2 Population ecology

The marsh fritillary is considered to persist in the form of metapopulations. A metapopulation consists of a group of spatially separated populations of the same species that interact at some level. A metapopulation is usually considered to consist of several distinct populations within areas of suitable habitat, which have varying levels of occupation by the species. Metapopulation theory now broadly applies to species in naturally or artificially fragmented habitats. Many studies have now shown that butterflies, including marsh fritillary, demonstrate a dynamic metapopulation structure (Bulman, 2001, Walhberg *et al*., 2002, Wang *et al*., 2004). In a metapopulation, demography is important, as demographic cycles in each subpopulation work in relative independence of the other subpopulations. A subpopulation will eventually go extinct as a consequence of fluctuations in population size due to random demographic events. In metapopulation theory, individual subpopulations have finite life-spans, but the metapopulation as a whole is often stable because immigrants from one subpopulation (which may, for example, be experiencing a population boom) are likely to re-colonize habitat that has been left open by the extinction of another population. They may also immigrate into another small subpopulation and so rescue it from extinction (the "rescue effect") (Hanski & Gaggiotti, 2004). Where habitat is destroyed and conditions are unfavourable, small subpopulations will go extinct and, if isolated, will not be recolonized. It is important to emphasise the importance of connectivity between apparently isolated subpopulations. Although no one subpopulation may be able to guarantee the long-term survival of a given species, the combined effect of many populations may be able to do so. The smaller the subpopulation, the more prone it is to extinction given habitat patch size and isolation (Hanski & Gaggiotti, 2004). The former is one of the main reasons we map the areas of abundant *S. pratensis* in the landscapes, as we can understand the extent of the butterfly's local habitat, which is largely unknown in Ireland and is potentially in decline. The long-term persistence of metapopulations hinges on a stochastic balance between local extinctions and recolonizations (Levins, 1969, Hanski, 1991, Orsini *et al.*, 2008) linked to habitat availability and quality.

Dispersal in adult marsh fritillary may be dependent on demography (*Baguette & Schtickzelle*, 2006). Local populations of fritillaries may have independent demographic dynamics, which may be spatially correlated as a result of larger-scale regional or more widespread environmental effects (Ovaskainen & Hanski, 2004, Hanski & Meyke, 2005, Orsini *et al*., 2008). In marsh fritillary, increases in migration may be due to changes in individual quality during the course of a flight season. This may be affected by better performance of adults with faster larval development or decreasing availability of adult food resources. Male adult marsh fritillary of higher quality (for example with larger energy supplies) may persist longer in a site and thus be more likely to locate a mate thereby affecting metapopulation dynamics. Declining adult quality may mean that the butterfly cannot disperse to a nearby habitat or end up flying about in unsuitable habitat and fail to find a mate or lay eggs. Quality of habitat is as important as habitat linkage is within the landscape.

1.1.3 Habitat

As the food-plant of the marsh fritillary caterpillar is *Succisa pratensis*, and eggs are laid on the underside of its leaves, the presence of sufficient *S. pratensis* is the most basic requirement for an area to be capable of supporting marsh fritillary.

At a landscape level, the marsh fritillary requires areas of suitable habitat sufficiently close to other populations to allow interaction/colonisation. It is thought the maximum migration distance for the species is 10 km, but a distance of 2 km between habitat patches is more appropriate when defining the functional landscape (Fowles, 2003). Females are considerably less mobile than males, which restricts the distance across which colonies can spread (Fowles, 2003).

At a habitat level, marsh fritillary occurs on a range of different habitats in Ireland. These habitats include wet grassland, cutover bog, dry calcareous grassland, dry calcareous heath, poor fen and flush, and dry meadows and grassy verges, amongst others (NPWS, 2013). Parameters used in identifying areas of suitable habitat include: abundance of *S. pratensis*, vegetation height, vegetation structure, aspect and cover of scrub. Owing to the species' reliance on the heat of the sun to become active, generally south-facing sites are most suitable. The optimal conditions needed to sustain a population are sward heights of 10-25cm, with lots of sunny perch areas, adjacent or in a mosaic of flower-rich grassland mixed with low-level scrub species, such as heather and bog myrtle or sphagnum mosses. Low-level scrub allows the caterpillars to escape from flooding, and provides the basking positions necessary for the butterflies and caterpillars

Within areas of suitable habitat, marsh fritillary breeding activity focuses on microhabitat factors. Sufficient *S. pratensis*, vegetation structure, including grass tussocks, and hummocks in the landscape all contribute to the distribution of the species' larval webs within an area of suitable habitat. Grazing has an important role to play in maintaining an area as suitable habitat, though this varies depending on the intensity of the grazing and the species, e.g. sheep tend to graze the sward too closely and preferentially eat *S. pratensis* plants (Ash *et al*., no date).

1.1.4 Legal & conservation status

The marsh fritillary is the only Irish butterfly listed under Annex II of the European Union's Habitats Directive (92/43/EEC) and, as such, its protection requires the designation of special areas of conservation (SACs). The marsh fritillary is currently listed as a qualifying interest in 14 SACs in Ireland, but its conservation status is Inadequate-Declining (Table 1). Only three of the SACs for which the species is listed as a qualifying interest has extant populations.

Table 1. Conservation Status summary for marsh fritillary in Ireland (NPWS, 2013).

	Assessment	**Qualifier**
Range	Favourable	N/A
Population	Inadequate	Declining
Habitat	Favourable	N/A
Future Prospects	Inadequate	Declining
Overall Assessment	Inadequate	
Overall Trend	Declining	

The marsh fritillary is listed as Vulnerable (A2c) on the Irish Red List for Butterflies due to a decline in population of ≥30% (Regan *et al*., 2010).

2 Methodology

2.1 Desktop study

As part of this project, a desktop study was conducted to determine the distribution of marsh fritillary in Galway, with particular focus on the marsh fritillary survey area as defined by this study. This was achieved by reviewing species distribution maps, local historical records and reviewing previous marsh fritillary surveys. This desktop study reviewed data from the following sources:

- Butterfly Ireland
- National Biodiversity Data Centre (NBDC)
- NPWS Article 17 range and distribution maps
- Seale (2010)
- Gittings (2000)

- McCrory (2012)

2.2 Field survey

Due to the large size of the study area, the field work was conducted in two stages. An initial drive-round survey was carried out with reference to recent aerial photographs provided by Arup and a number of areas with suitable habitat were recorded. Areas which appeared on the photographs to have a similar appearance to these locations were then selected as survey sites. A total of 57 survey locations were identified. The locations of these sites are presented in Appendix I.

Field maps were prepared for each of the survey locations identified. At each of the sites the occurrence of sufficient amounts of the food plant of the marsh fritillary, *Succisa pratensis*, were mapped by annotating the field maps and taking a series of waypoints on handheld GPS units or ruggedized handheld computers (Trimble Nomads), which could be displayed on a GIS on return to the office. At sites with suitable habitat notes were made on:

- Habitat type
- Management (grazing intensity and stock type)
- Sward height
- Cover of *S. pratensis*
- Cover of scrub

Where suitable habitat was recorded, a search for larval webs of the marsh fritillary was then conducted. This comprised a meandering walk covering as much of the suitable habitat as possible, targeting areas most likely to support webs e.g. south-facing slopes, dense patches of *S. pratensis*, structured vegetation patches and sheltered locations. When larval webs were encountered assessments were carried out according to the marsh fritillary Larval Web Survey / Monitoring sheet prepared by the NBDC and NPWS (http://butterflies.biodiversityireland.ie/rare-species/marsh-fritillary/larval-web-form/). These data were recorded on the Trimble Nomads.

All field work was completed by the 28th September 2013, within the recommended survey period for marsh fritillary larval webs (NRA, 2009).

3 Results

3.1 Desktop study

3.1.1 Distribution maps

It is important to note that knowledge of the distribution of marsh fritillary is incomplete (NPWS, 2013). All distribution maps should therefore be viewed with the forewarning that the marsh fritillary is an under-recorded species in Ireland.

The majority of the marsh fritillary survey area for the current project occurs in the hectads (10 x 10 km grid squares), M22 and M32. A smaller proportion of the survey area extends into the adjacent hectads M12, M23 and M33.

- *Butterfly Ireland*

Since 1998, Butterfly Conservation (UK) and The Dublin Naturalists' Field Club (DNFC) have collected butterfly records from Irish recorders, backdated to 1995. Distribution maps are available on the Butterfly Ireland website (http://www.butterflyireland.com). Butterfly Conservation (UK) and DNFC

report that marsh fritillary were recorded in 225 hectads from 1995–2012, with the species found in 124 of these hectads during the 2010-2012 recording period.

With reference to the survey area for the current project, Figure 1 shows a 1995-2009 marsh fritillary record present within hectad M22, but no record of the species within hectad M32. Records exist for the surrounding adjacent hectads including 2-9 sighting of the species in M12 and one sighting of the species in M23 during the 2010-2012 recording period. Marsh fritillary was also recorded from M13 and M33 during the 1995-2009 recording period.

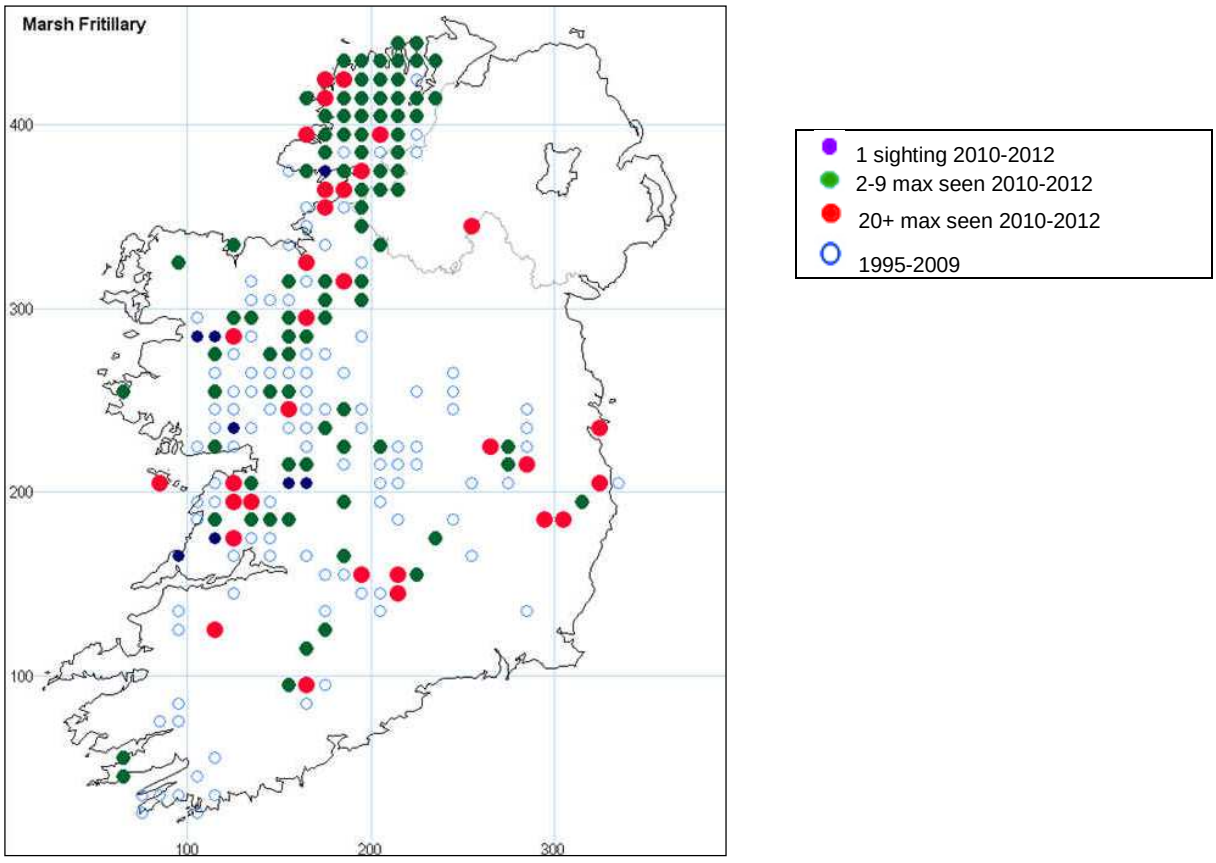

Figure 1. Distribution of marsh fritillary in Ireland between 1995 and 2012. Dots on the map represent records of the species at hectad level. This map has been sourced from the Butterfly Ireland website (http://www.butterflyireland.com/MarshFritillaryMap.htm accessed October 2013).

- *National Biodiversity Data Centre (NBDC)*

In 2007 the National Biodiversity Data Centre (NBDC) established a volunteer based Irish butterfly recording scheme, with the aim of tracking changes in Irish butterfly populations. The NBDC also collate species data recorded on an *ad hoc* basis from recorders. Species distribution maps are available online from the NBDC website (http://maps.biodiversityireland.ie). As of October 2013, the NBDC have 952 records of marsh fritillary across Ireland occurring in 161 hectads (Figure 2). The NBDC marsh fritillary distribution maps were investigated more closely with a focus on the survey area as defined by this study. The NBDC have no records within hectads M22 and M32, while species records occur within the surrounding adjacent hectads M12, M13 and M23 (Figure 3).

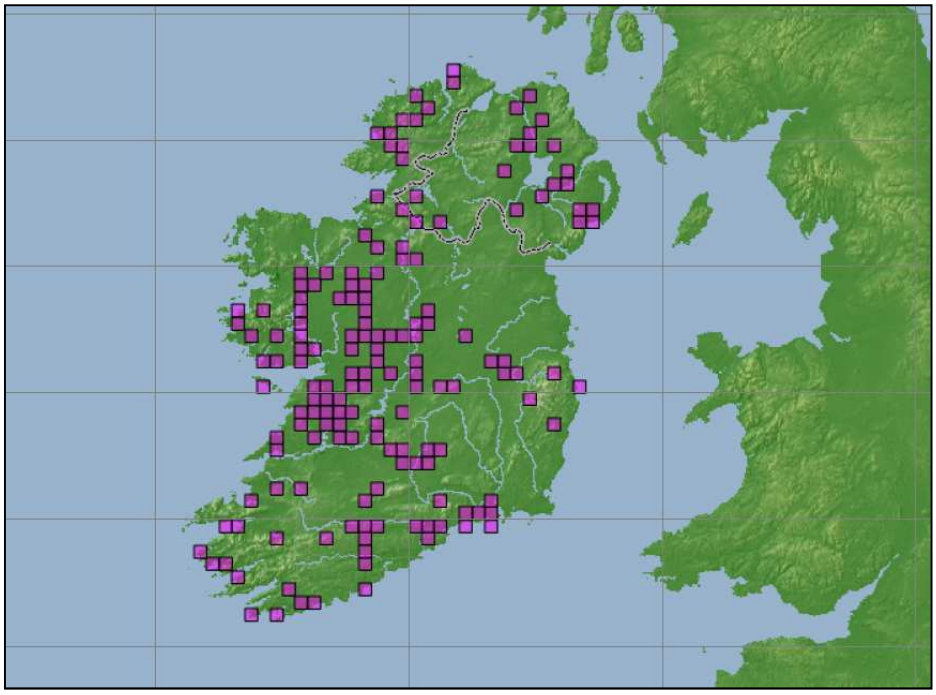

Figure 2. National Biodiversity Data Centre (NBDC) records of marsh fritillary in Ireland. Coloured squares represent records of the species at hectad level. This map is a user generated static output from the NBDC website. © Ordnance Survey Ireland. Licence number EN 0059208.

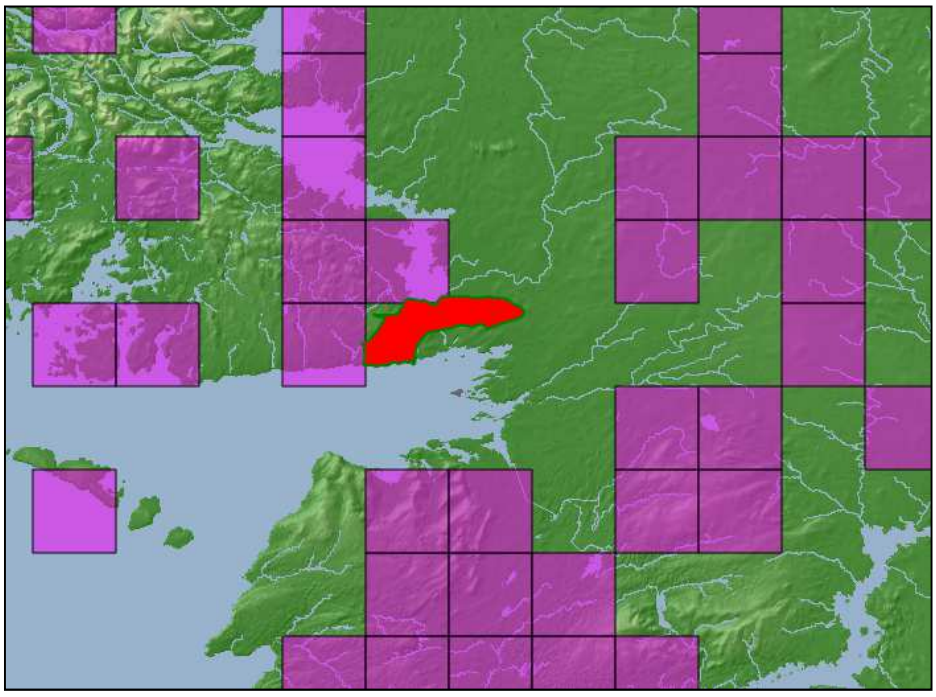

Figure 3. NBDC records of marsh fritillary with a focus on the survey area for the current project which is displayed in red. Coloured squares represent records of the species at hectad level. This map is a user generated static output from the NBDC website. © Ordnance Survey Ireland. Licence number EN 0059208.

- NPWS Article 17 range and distribution maps

The most comprehensive national distribution map of marsh fritillary currently available is the 2013 range and distribution map (Figure 4) prepared by the NPWS for reporting to the EU under Article 17

of the EU Habitats Directive. For this map, species distribution was compiled from recent records, including those published in Nash *et al.* (2012), NPWS-commissioned marsh fritillary surveys from 2011 and 2012 (NPWS, 2013), together with records from NBDC and Butterfly Ireland.

This distribution map reports that marsh fritillary has been recorded nationally from 239 hectads. The species has been recorded from five of the hectads that the study area for the current project occurs in (hectads M12, M13, M22, M23 and M33) while the remaining hectad M32 is included in the marsh fritillary current and favourable reference range.

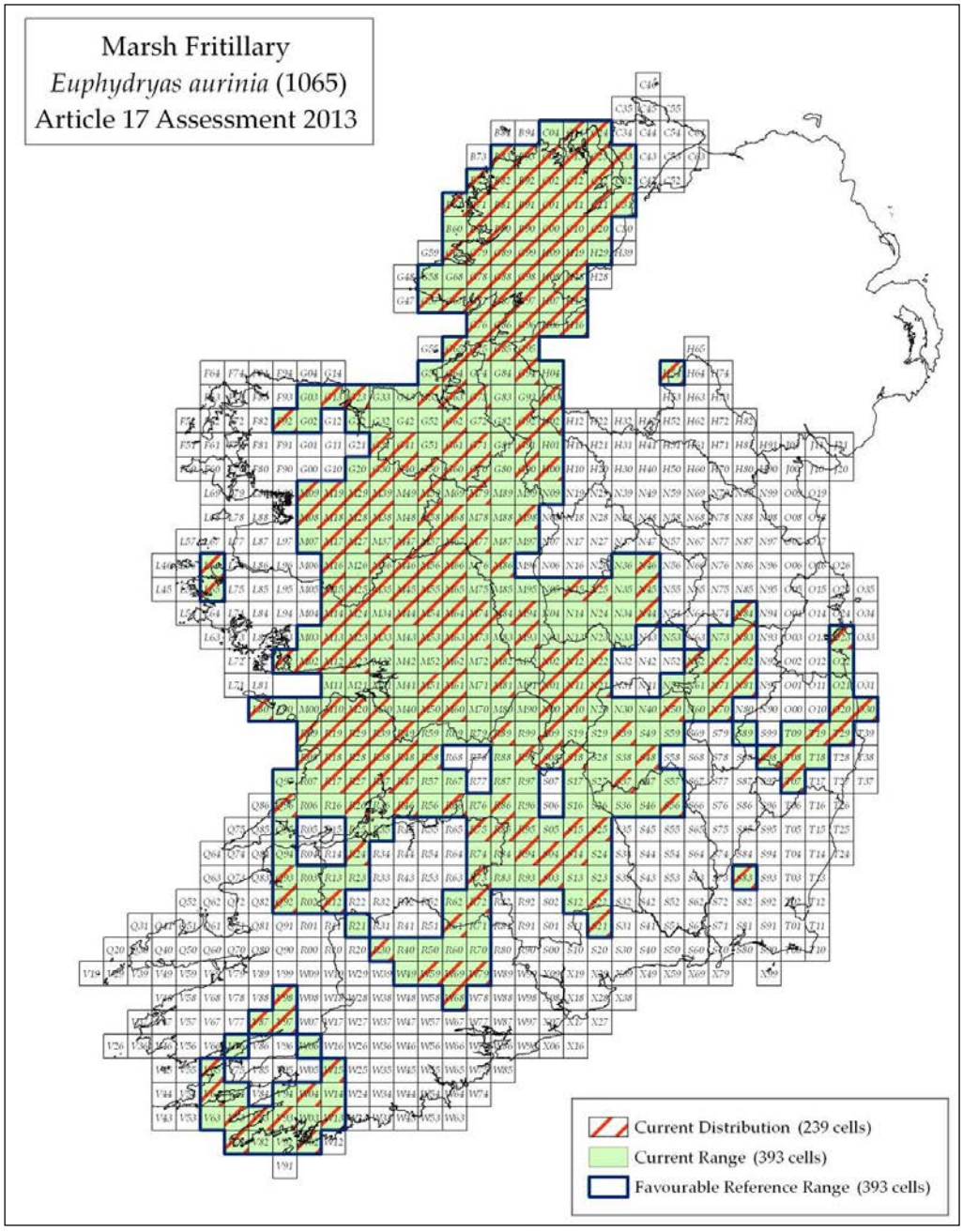

Figure 4. Distribution and range of the marsh fritillary. This map was produced for reporting purposes under Article 17 of the EU Habitats Directive. This map was produced by the Biodiversity Monitoring Unit, NPWS. © Ordnance Survey Ireland. Licence number EN 0059212.

3.1.2 Local historical records

In addition to examining distribution maps at the hectad level, local historical records were investigated using both Seale (2010) and the NBDC website. Table 2 summarises the findings.

Table 2. Results of local historical record research

Hectad	Year(s)	Location	Proximity to marsh fritillary survey area	Source
M12	1998	Spideal	< 5 km	Seale (2010)
M12	2010	Shannawoneen	< 7.5 km	NBDC
M13	2010/2011	Pollagh	< 9.5 km	NBDC
M22	1998	Barna	Within boundary	Seale (2010)
M23	2003/2004/2005/2010	Ower	< 8 km	Seale (2010)/NBDC
M23	2005	Killannin	< 8 km	NBDC
M32	-	-	-	-
M33	1998	Claregalway	< 2 km	Seale (2010)
M33	2003	Corrandulla	< 9 km	Seale (2010)

3.1.3 Previous marsh fritillary surveys

Three recent studies of marsh fritillary had been carried out within the survey area for the current project.

Gittings (2000) completed larval web surveys at four locations at Kentfield, Coolagh/Menlough, Carrowbrowne East and Carrowbrowne West in August/September 2000. Marsh fritillary were not detected at this time.

Anon (2006) surveyed the route of the Galway City Outer Bypass for adult marsh fritillary in 2006 but did not record the species.

McCrory (2012) surveyed the sites occurring within or adjacent to the proposed Galway City Outer Bypass between the R336 and the N59 for larval webs in October 2012, but the species was not detected.

3.2 Field survey

Fieldwork for the current was conducted from 23rd-27th September 2013. All 57 sites were visited. Suitable habitat for marsh fritillary were recorded at 29 sites, 17 sites contained no suitable habitat and a further 11 sites remain unsurveyed due to access issues.

3.2.1 Suitable habitat

A total of 491.8 ha were surveyed. Suitable habitat was found throughout the survey area, accounting for 61.2 ha representing 12.4 % of the total of the survey sites. Area summaries for the survey sites are presented in Table 3. Concise site summaries, including descriptions of suitable habitat, are presented in Table 4. The location of suitable habitat is presented in Appendix II.

Table 3. Survey area summaries for the marsh fritillary survey for the Galway City Outer Bypass

	Area (ha)	% of total survey area
Suitable habitat	61.2	12.4
Unsuitable habitat	430.6	87.6
Total area surveyed	**491.8**	**100**

3.2.1 Larval web surveys

Larval webs were detected at one site during the survey. A small population was recorded at Site 37, which is located approximately 2 km northwest of Barna. Two small larval webs (winter hibernacula) were recorded here on south-facing knolls supporting calcareous grassland (GS1). These knolls are

located within a matrix of wet grassland, which supports frequent to abundant *S. pratensis* (Appendix IV, Plate 1).

Habitat condition assessments were conducted in larval web locations. The first hibernaculum (Appendix IV, Plate 2) was recorded from a knoll with structured vegetation and abundant *S. pratensis.* Within the immediate vicinity (i.e. within the same 1 x 1 m plot) sward height averaged 30 cm and there was > 10% cover of bracken. Two small caterpillars were observed on the web's exterior (Appendix IV, Plate 3) and there was evidence of feeding on the *S. pratensis* leaves (Appendix IV, Plate 4).

The second hibernaculum (Appendix IV, Plate 5) was recorded in calcareous grassland (GS1) with elements of dry calcareous heath (HH2). Structured vegetation was present here along with abundant *S. pratensis*. Within the immediate vicinity sward height averaged 25 cm and there was no low invading scrub. Older inactive webs were evident in the surrounding vegetation. At the time of survey no grazers were evident at the site.

Other nearby fields also held suitable habitat in good and overgrazed condition (Appendix IV, Plate 6). There was evidence of cattle and pony grazing in the nearby sites suggesting the site is of importance within a network of habitat patches and could be used on an intermittent basis by breeding butterflies. There is the possibility that the population based in this western part of the surveyed area is potentially connected to other known historic population records from 1998 to the north and west of the site (Seale, 2010).

Extra search effort was directed towards the adjacent sites 53 and 54, which also contain suitable habitat. No webs were detected at these sites.

Table 4. Summary of sites surveyed during the marsh fritillary survey for the Galway City Outer Bypass

Site	Notes
1	A large site with a mosaic of habitats (GS4, FS1, PF1 and PB3). There are occasional patches of large-leaved *S. pratensis*, but it is generally scarce. Site generally lacks grazing. Two small areas of suitable habitat were recorded near to the bog road. These had occasional *S. pratensis*, scrub cover at <2% and a sward height of 12-20 cm. No larval webs were detected.
2	This large complex along the River Corrib contains a variety of habitats including wet grassland (GS4), calcareous and neutral grassland (GS1), rich fen and flush (PF1) and lowland blanket bog (PB3). Suitable habitat for marsh fritillary occurred within wet grassland (GS4) and rich fen and flush (PF1). *Sucissa pratensis* was generally frequent throughout the sward. Habitat condition ranged from good condition to slightly rank within areas of wet grassland (GS4). Overgrazing was observed within rich fen and flush (PF1) with an average sward height of 5 cml. A herd of cattle grazed the southern section of the site. Scrub cover within suitable habitat < 0.5%. No larval webs were detected.
3-12	Permission to access these small sites occurring within and the grounds of a hotel could not be obtained during the week of survey.
13	This complex comprised of wet grassland (GS4), calcareous and neutral grassland (GS1), scrub (WS1) and reed swamp (FS1). Two small blocks of suitable habitat occur within wet grassland (GS4) with *S. pratensis* occurring occasionally in the sward. Small patches of abundant *S. pratensis* were recorded in calcareous grassland (GS1). Horses grazed the site. Scrub cover within suitable habitat <0.5%. No larval webs were detected.
14	This site comprises of reed swamp (FS1) and scrub (WS1). No areas of suitable habitat were recorded.
15	This site largely comprises of reed swamp (FS1) and scrub (WS1). No areas of suitable habitat were recorded.
16	Permission to the access this site via a track to the south was not obtained during the week of survey. It was viewed from a vantage point and largely comprises of reed swamp (FS1) and scrub (WS1). Further survey effort was deemed unnecessary.
17	This wet grassland site (GS4) contained no suitable habitat.
18	This site comprises of reed swamp (FS1) and wet grassland (GS4). No areas of suitable habitat were recorded.
19-21	This complex of sites comprises species-rich GS1 grassland adjacent to areas of wooded and exposed limestone pavement. Habitat suitable for marsh fritillary occurred at a number of blocks. The *S. pratensis* in Site 19 was particularly abundant and these small, sheltered, cattle grazed fields were highly suitable for marsh fritillary. Variation in local topography and vegetation structure. Vegetation generally 12-25 cm tall; scrub encroachment would be a concern with >15% cover within the fields. A 120 minute search was conducted; conditions were dry and bright with light winds. No larval webs were detected.
22	No suitable habitat recorded from this horse-grazed field. Sward height 10-25 cm.
23	This site was viewed from the nearby road network. It comprises gorse scrub (WS1), improved grassland (GA1) and small areas of wet grassland (GS4). Despite there being evidence of recent disturbance in the vicinity there was no *S. pratensis*, suggesting it is not frequent in the seed-bank.
24	There had been recent disturbance at this site with some scrub removal being in evidence. Where this had

	taken place there was abundant *S. pratensis* on calcareous grassland (GS1). The area is cattle-grazed with sheltered suitable habitat among areas of bramble and gorse scrub (WS1). 80 minute search, conditions were overcast with light drizzle. No larval webs were detected.
25	*Succisa pratensis* occurred in small numbers at this wooded limestone pavement site, but in insufficient numbers to be considered suitable habitat.
26	Suitable habitat occurs within flushed wet grassland (GS4) and wet heath (HH3). *Succisa pratensis* is abundant throughout. Sward height 15–30 cm. Good structural variation occurs due to an extensive understory of bryophytes including *Sphagnum. Myrica gale* is present at the site with approximately 5 - 7 % cover. A small covering of gorse scrub (WS1) also occurs. There were signs of cattle grazing. No larval webs were detected.
27	This site comprises wet grassland (GS4), improved grassland (GA1) and a wet heath/lowland blanket bog mosaic (HH3/PB3). Suitable habitat was noted within a small block of wet grassland (GS4) with frequent *S. pratensis*. Sward height 15–30 cm. Good structural variation was present due to the occurrence of *Sphagnum*. No scrub was noted in this area. No larval webs were detected.
28	This site comprises of wet heath (HH3) and lowland blanket bog (PB3). No suitable habitat was present.
29	This site surrounds a lake. Habitats present include improved grassland (GA1), wet grassland (GS4), wet heath (HH3), reed swamp (FS1) and gorse scrub (WS1). A small block of suitable habitat occurs on the eastern side of the lake in an area of low growing *Myrica gale* with frequent *S. pratensis.* Cattle graze the site. No larval webs were detected.
30	Suitable habitat occurs within calcareous grassland (GS1) and wet grassland (GS4). The fields are cattle grazed, with vegetation generally 10-25 cm in height with a good structural variation. Gorse scrub occurs but comprises <1% of the suitable habitat. 40 minute search conducted; conditions were dry and bright with light winds. No larval webs were detected.
31	No suitable habitat recorded from this site. In general, the sward height was too high being 30-50 cm tall. A bull was noted in the central fields, so these were not entered.
32	The eastern portion of this site was too rank and the central fields too improved. Suitable habitat occurred through the western portion where ponies grazed dry heathy grassland. *Sucissa pratensis* occurred throughout the area, but was abundant on small outcrops and ridges. Sward height was 10-25 cm in general though shorter (0-10 cm) in places. Gorse and bramble scrub appeared to be under management and covered <10% of the suitable habitat. 30 minutes were spent searching for larval webs in dry and sunny conditions with light winds. No larval webs were detected.
33	*Sucissa pratensis* occurred in small numbers among wet grassland on this pony-grazed site, but in insufficient numbers to be considered suitable habitat.
34	This large complex along the coast comprises wet grassland (GS4), calcareous grassland (GS1), scrub (WS1), reed swamp (FS1) and saltmarsh (CM). Small blocks of suitable habitat occur within wet grassland (GS4) and calcareous grassland (GS1). *Sucissa pratensis* was frequent to abundant within these blocks. Sward height varied but generally ranged from 10–40 cm. Scrub cover within areas of suitable habitat was 5%. Cattle grazed the eastern section of the site. No larval webs were detected.
35	This site comprises wet grassland (GS4), wet heath (HH3) and scrub (WS1). Suitable habitat was present within both wet grassland (GS4) and wet heath (HH3). The blocks of suitable habitat to the south contained frequent *S. pratensis* but these areas were largely rank and require grazing management. Good condition habitat suitable for marsh fritillary with frequent *S. pratensis* and sward height averaging 20 cm were noted in the northern section. There was evidence of donkey grazing, scrub clearance and dumping on-site. Scrub cover within suitable habitat was approx. 5-7%. No larval webs were detected.
36	This site comprises wet grassland (GS4), wet heath (HH3), lowland blanket bog (PB3) and scrub (WS1). Several blocks of suitable habitat occur within wet grassland (GS4) and wet heath (HH3). *S. pratensis* was frequent to abundant within these areas. Management varied throughout the site with both rank and good condition habitat recorded. Good condition habitat occurs in the southern section of the site and most of the search effort was concentrated here. Scrub cover in suitable habitat < 3 %. No larval webs were detected.
37	Habitats present include wet grassland (GS4), calcareous grassland (GS1), scrub (WS1) and a wet heath/lowland blanket bog (HH3/PB3) mosaic. Suitable habitat with frequent to abundant *S. pratensis* occurs in wet grassland (GS4) and calcareous grassland (GS1). Scrub cover within suitable habitat < 3%. No grazers were observed on-site. Two larval webs were recorded on south facing knolls supporting calcareous grassland (GS1). Habitat condition assessments were conducted in these locations. The first hibernaculum occurred in an area with structured vegetation and abundant *S. pratensis.* Within the immediate vicinity (i.e. within the same 1 x 1 m plot) sward height averaged 30 cm and there was > 10% cover of bracken. The second hibernaculum was recorded in calcareous grassland (GS1) with elements of dry calcareous heath (HH2). Structured vegetation was present along with abundant *S. pratensis*. Within the immediate vicinity sward height averaged 25 cm and there was no low invading scrub. Older inactive webs were evident in the surrounding vegetation.
38	This complex comprises calcareous and neutral grassland (GS1), wet grassland (GS4) and scrub (WS1). Two small blocks of suitable habitat were recorded within calcareous grassland (GS1). One of these blocks contained elements of dry calcareous heath (HH2). *S. pratensis* was abundant in the sward. Sward height 10-25 cm. No grazers were recorded on-site. No larval webs were detected.
39	This site comprised improved grassland (GA1), wet grassland (GS4) and scrub (WS1). A small block of marginally suitable habitat with occasional *S. pratensis* and a sward height of 15-30 cm were recorded. There was evidence of cattle grazing. No larval webs were detected.
40	This small site was viewed from the road. No suitable habitat is present.
41	This site consisted of wet grassland (GS4), calcareous grassland (GS1), dense bracken (HD1) and scrub (WS1). No suitable habitat was present.
42	This turlough site (Kiltullagh Turlough pNHA 287) was not surveyed in detail due to the presence of cattle and ponies in this large field; the northern section was accessed. *Sucissa pratensis* was occasional through the surveyed section, though was possibly a little too sparse. No scrub encroachment was recorded. 30 minutes were spent searching the northern section for larval webs, but none were detected. The southern section would warrant additional consideration depending on the alignment of the selected route.

43	Habitats present consist of rank wet grassland (GS4), reed swamp (FS1) and species-rich calcareous grassland (GS1). A small patch of suitable habitat with abundant *S. pratensis* (10 x 10 m) was recorded within calcareous grassland (GS1). Sward height ranged from 5-15 cm. No scrub was present in this area and no grazers were observed. No larval webs were detected.
44	No suitable habitat recorded from this site, much of which has been agriculturally improved.
45	No suitable habitat recorded from this largely wooded limestone pavement site.
46	Searches for suitable habitat were conducted along the bog road at Pollnaclogha. One area of suitable habitat was found near the road. A 15 minute search was conducted here, but no marsh fritillary were detected. Other areas of suitable habitat could occur in this region, particularly to the north of the road which is cattle grazed.
47	Some *S. pratensis* occurred along the ditches near the roadside here, but not in sufficient numbers to be considered as suitable habitat.
48	Suitable habitat occurs on rocky outcrops and ridges among the heath, wet grassland and flushes. The site is pony-grazed with occasional-frequent *S. pratensis* plants occurring. The vegetation is 15-25 cm in height but is generally shorter on the ridges. Some disturbance in the recent past with a drainage ditch having been dug. 40 minutes was spent searching for larval webs, but none were detected.
49	Suitable habitat occurs on rocky outcrops and ridges among the heath, wet grassland and flushes. The site is pony grazed with occasional-frequent *S. pratensis* plants occurring. The vegetation is 15-25 cm in height but is generally shorter on the ridges. 30 minutes was spent searching for larval webs, but none were detected.
50	There appears to have been recent management of the gorse in this area of heath and subsequently *S. pratensis* was frequent. Site has good shelter, suitable grazing levels and variation in the topography and vegetation structure. Sward was 12-25 cm in height with < 5% gorse occurring. 30 minutes were spent searching for larval webs, but none were detected. Weather was dry and sunny with light winds.
51	*Sucissa pratensis* occurred along this road verge where disturbance caused by construction of a drain had resulted in the development of frequent *S. pratensis*. 15 minutes were spent searching for larval webs, but none were detected.
52	No suitable habitat recorded from this largely limestone pavement site though *S. pratensis* did occur.
53	This complex contains wet grassland (GS4), wet heath (HH3), lowland blanket bog (PB3), scrub (WS1) and reed swamp (FS1). Suitable habitat occurred in areas of wet grassland (GS4) and wet heath (GS4). *S. pratensis* cover generally ranged from frequent to abundant. Sward height 10–30 cm. Structural variation was noted in some areas. Horses grazed the site. Scrub cover within suitable habitat <5%. No larval webs were detected.
54	This complex contains calcareous grassland (GS1), wet grassland (GS4), improved grassland (GA1), wet heath (HH3), lowland blanket bog (PB3) and scrub (WS1). Suitable habitat with abundant *S. pratensis* occurs along grassy rocky outcrops that are a characteristic feature of this site. These outcrops create good structural variation. Sward height 3-15 cm. The site is grazed by horses with over-grazing noted in some areas. The southernmost field adjacent to the road was noted to be particularly suitable marsh fritillary habitat. Considering the proximity of this site to the larval webs in Site 37, it is highly likely that marsh fritillary use/have used this patch of habitat but no larval webs were detected at this site.
55	This site comprises of suitable habitat in wet heath (HH3) dominated by an open sward of *Myrica gale, Molinia caerulea* and abundant *S. pratensis.* Sward height 15–20 cm. No grazers were recorded from the site. Alder scrub accounts for approx. 5% of the suitable habitat. No larval webs were detected.
56	This site contains suitable habitat within wet grassland (GS4) and a wet heath/lowland blanket bog mosaic (HH3/PB3). *S. pratensis* is particularly abundant along roadside verges. The area to the south of the road has been burnt in the recent years. These areas have frequent to occasional *S. pratensis.* Sward height was 15-20 cm in these areas. Some cattle were observed during the survey. Scrub cover within suitable habitat <5%. No larval webs were detected.
57	This site largely comprises of rank wet grassland (GS4) with scrub (WS1). No suitable habitat was recorded.

4 Discussion

Marsh fritillary has previously been recorded from several hectads within and adjacent to the current Galway City Outer Bypass marsh fritillary study area. No known records exist for the hectad M32 despite suitable habitat being recorded within this area during the course of this survey.

In a landscape with fragmented areas of suitable habitat, like that in the greater Galway City area, marsh fritillary metapopulations may consist of discrete local populations connected by migration, the magnitude of which depends on landscape structure and habitat quality, as well as on the migration of the species (Hanski, 1999, Hanski and Gaggiotti, 2004, Orsini *et al*., 2008). The greater Galway City area has experienced a significant number of one-off housing projects and ribbon development within the surveyed areas. Consequently suitable habitat is likely to be more fragmented than when marsh fritillary was previously recorded in the region. Some new habitat creation was observed where soil disturbance occurred during remedial drainage, scrub clearance and electricity services works. These new areas could be important as linkage areas between existing mature habitats.

It is likely that the marsh fritillary found during the current survey is a subpopulation that exists at the edge of a population located to the north or the west. Alternatively it may be a remnant of a larger

population once centred near Barna. Currently, there is suitable, available habitat locally and, given that suitable management (grazing) is in place, conditions remain favourable for a local colony. However, in a broader context the population may be isolated and too small to persist. The exact distance to other viable populations is unknown at present as the nearby breeding/web records are historic.

In summary suitable habitat was found throughout the study area and one small population was found within the survey area. Review of the aerial photographs has indicated a further 19 locations where suitable habitat may occur but these have not been surveyed on the ground (Appendix III). These include locations close to historic records for marsh fritillary.

Current NRA guidance (NRA, 2009) adopts a precautionary stance with regard to marsh fritillary due to the ephemeral nature of sub-populations, stating that *"their absence from otherwise suitable sites in the vicinity of existing populations in a given year cannot rule-out the use of the area in subsequent seasons. As such, suitable but currently unoccupied habitat near to existing populations should also be considered of value, as these habitats may be critical to the long-term survival of the population."*

Additional survey work will be required to establish whether a core population exists near to the known population.

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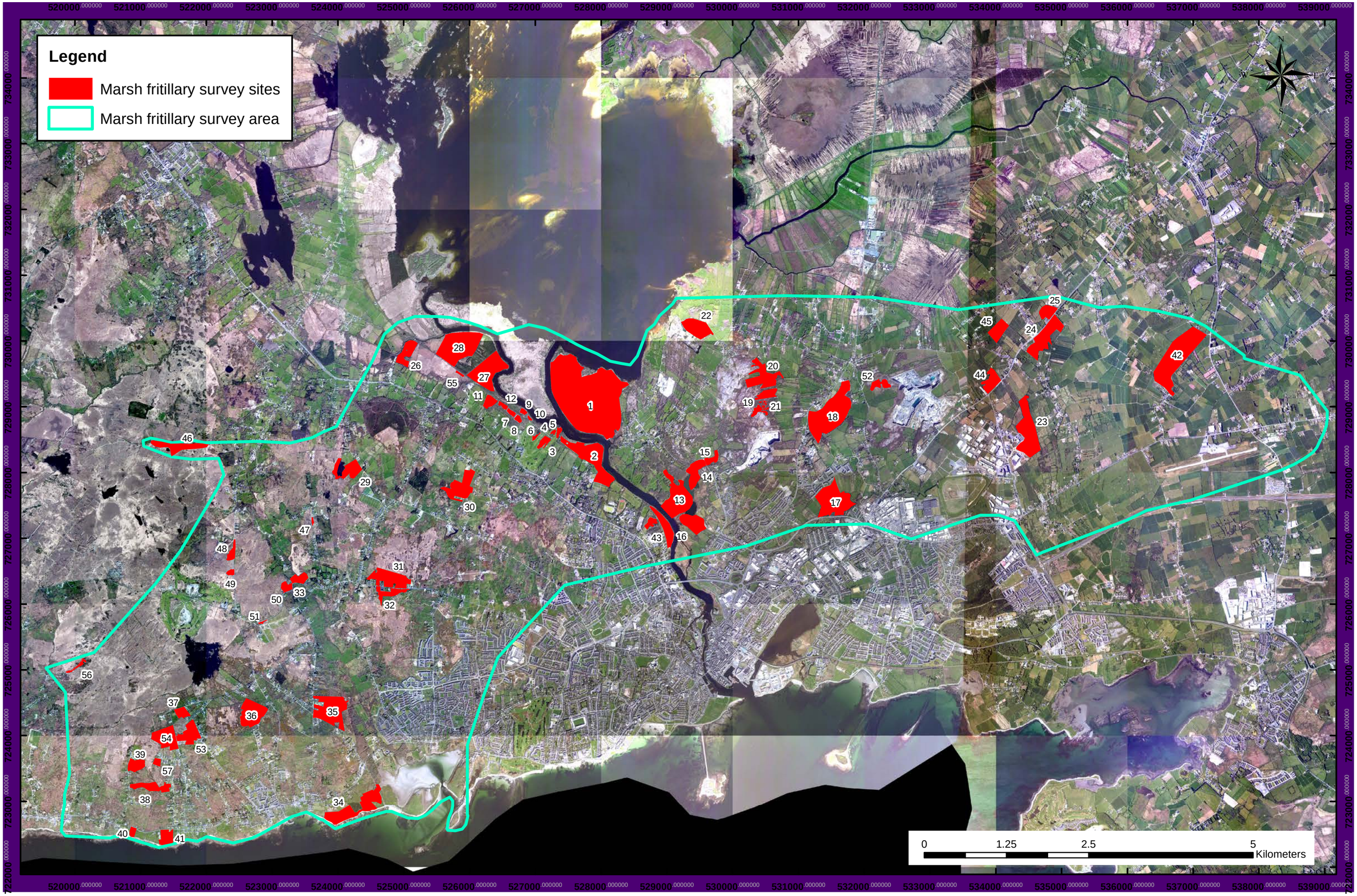
Appendix I – Galway City Outer Bypass marsh fritillary survey area and survey sites

Appendix I. Galway City Outer Bypass marsh fritillary survey area and survey sites



Appendix II - Areas of suitable marsh fritillary habitat identified during the Galway City Outer Bypass marsh fritillary survey

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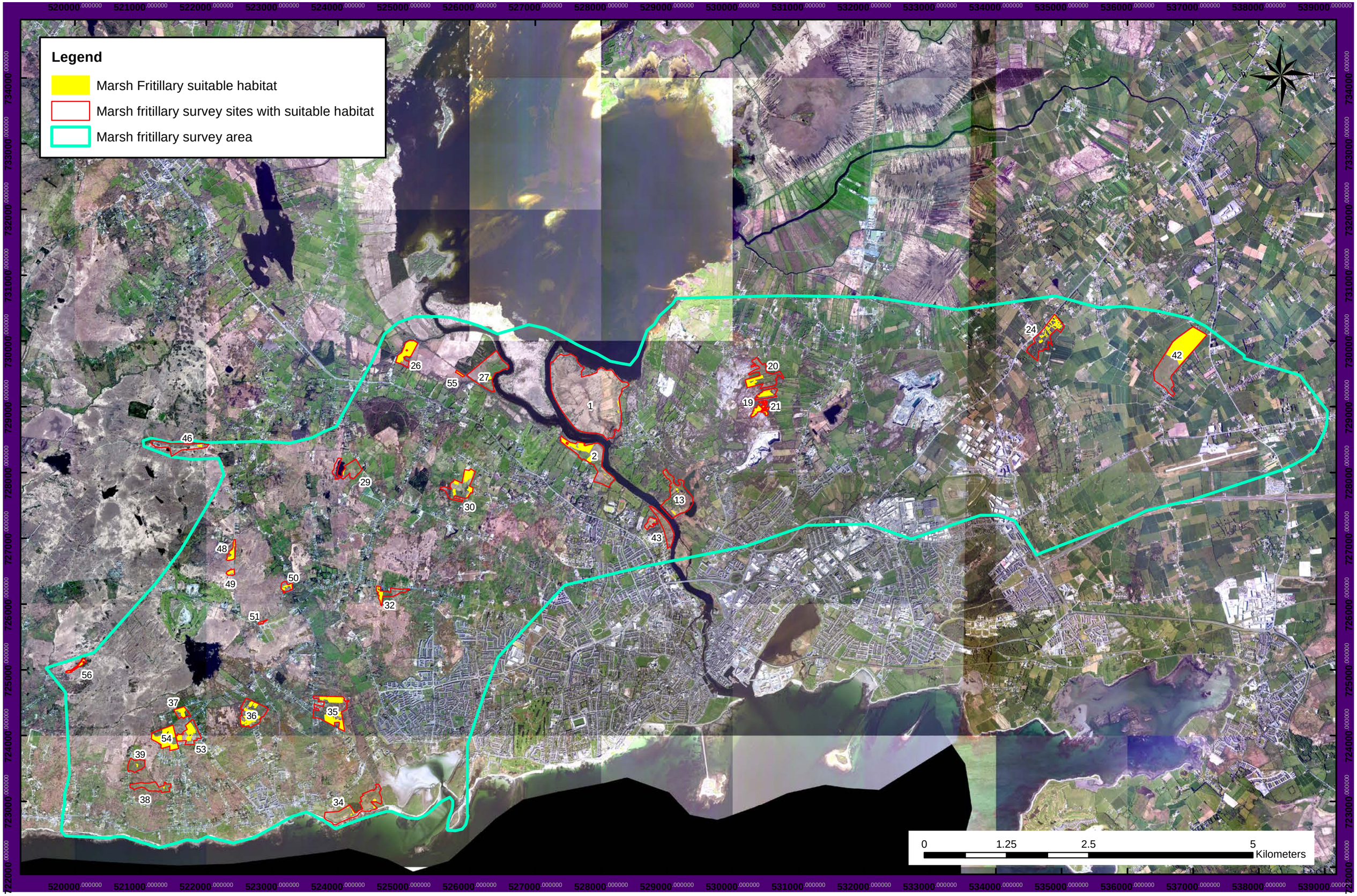

Appendix III – Recommended additional survey sites

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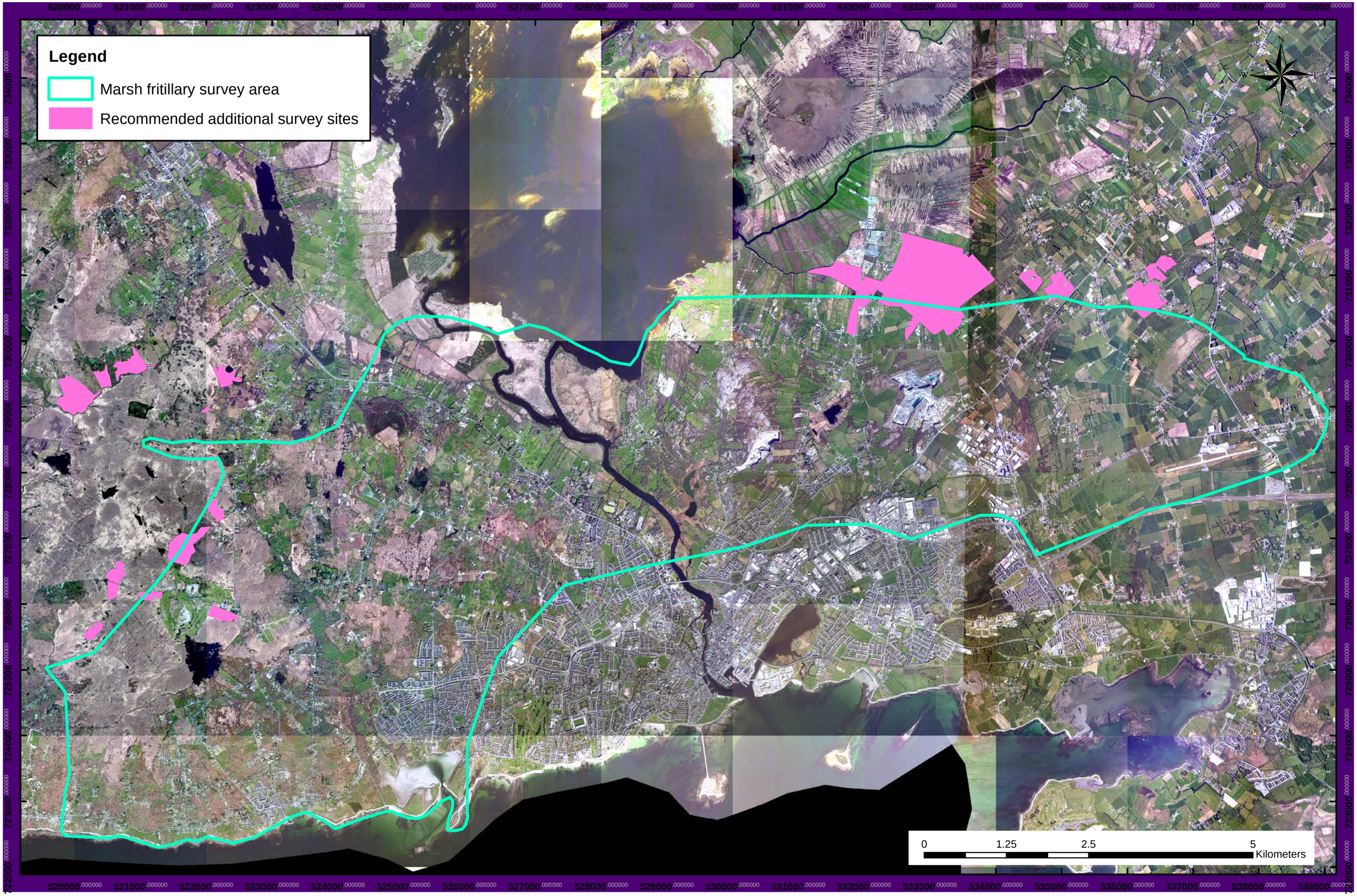

Appendix IV - Photographs

Plate 1. Overview of Site 37 looking northwest

Plate 2. Marsh fritillary larval web – Site 37

Plate 3. Marsh fritillary larvae on web – Site 37

Plate 4. Succisa pratensis leave showing signs of larval grazing – Site 37

Plate 5. Marsh fritillary winter hibernaculum – Site 37

Plate 6. Example of suitable habitat patch from field southwest of Site 37

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