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Assessment of the Conservation Status of the Great Island Channel SAC (001058)

JUNE 2014

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Report for
Cork County Council

June 2014

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Saltmarsh creek at Fota, Carrigtohill.

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1 Introduction

1.1 Rationale for the survey

Cork County Council appointed BEC Consultants Ltd. to conduct surveys on the Qualifying Interests of the Great Island Channel Special Area of Conservation (SAC) (site code 001058). The objective of these surveys was to determine the current conservation status of these features, and to assess the likely impacts on the SAC of increased waste water loadings generated by the 2022 population targets given in the draft Cork County Development Plan 2013.

A number of surveys of the area had previously been carried out. Intertidal surveys for the Annex I habitat 1140 Mudflats and sandflats not covered by seawater at low tide[1] were conducted in the Great Island Channel SAC in 2006 and 2011 by Aquafact and MERC respectively (Aquafact, 2006; MERC, 2012), and a subtidal survey, as part of a Water Framework Directive (WFD) assessment, was carried out by EcoServe on behalf of the Marine Institute in 2011. These data were used to determine the physical and biological characteristics of the SAC and overlapping areas of Cork Harbour Special Protection Area for birds (SPA) (NPWS, 2014a). Surveys of the Annex I habitat 1330 Atlantic salt meadows (Glauco-Puccinellietalia maritimae)[2] in the SAC were conducted as part of the Saltmarsh Monitoring Project (SMP) by McCorry & Ryle (2009). Further surveys, incorporating both aerial photograph interpretation and field surveys, were carried out by Atkins as part of the Blarney and Midleton Electoral Districts Habitat Surveys (O'Donoghue, 2008; O'Donoghue *et al*., 2009).

The field work carried out for the current project augments and updates the data collected during the previous surveys noted above and allows comparisons to be made.

1.2 Features of interest in Great Island Channel SAC

According to the Natura2000 viewer website (http://natura2000.eea.europa.eu), the Great Island Channel SAC covers an area of 1,443.22 ha. The website lists four Annex I habitats for the site: 1140 Mudflats and sandflats, 1330 Atlantic salt meadows, 1130 Estuaries and 1320 *Spartina* swards (Spartinion maritimae). However, the latter two Annex I habitats are listed in the Natura2000 website with a representativity of "D" (non-significant presence"), and 1320 *Spartina* swards (Spartinion maritimae) is now thought to be absent from Ireland (NPWS, 2013).

Therefore the latest site-specific conservation objectives available for the SAC from National Parks and Wildlife Service (www.npws.ie), dated June 2014, list only two Annex I habitats as Qualifying Interests for the site: 1140 Mudflats and sandflats, and 1330 Atlantic salt meadows. Of these, by far the more abundant is 1140 Mudflats and sandflats, which covers 894.79 ha, or 62% of the SAC area, while 1330 Atlantic salt meadows covers 28.86 ha, or just 2% of the SAC area (http://natura2000.eea.europa.eu). Only these two Annex I habitats, listed as Qualifying Interests for the SAC, are assessed in the current report.

Other Annex I habitats which are not listed on the Natura2000 website are also present in the SAC. For example, McCorry & Ryle (2009) recorded 1310 *Salicornia* and other annuals colonising mud and sand[3], and the National Survey of Native Woodlands recorded wet woodland at Belvelly which is referable to the priority Annex I habitat *91E0 Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (Alno-Padion, Alnion incanae, Salicion albae) (Perrin *et al.,* 2008; NPWS, 2013).

Great Island Channel SAC overlaps with Cork Harbour SPA, which is an internationally important wetland site supporting large populations of wildfowl, in particular wintering waterbirds. It also

[1] Referred to hereafter as 1130 Mudflats and sandflats
[2] Referred to hereafter as 1330 Atlantic salt meadows
[3] Referred to hereafter as 1310 *Salicornia* mud

supports a nationally important breeding colony of Common Tern (*Sterna hirundo*). The mudflats within the SAC support macroinvertebrates that are an important food source for the birds, and the saltmarshes provide high tide roosts.

1.3 Description of Qualifying Interests (Annex I habitats) in the SAC

1.3.1 Characteristics of 1140 Mudflats and sandflats, and main pressures

NPWS (2013) describes this habitat in detail, and the following description is summarised from that publication.

This habitat is found exclusively between the low water and mean high water marks, and is often a subset of the Annex I habitats *1160 Large shallow inlets and bays* and *1130 Estuaries*. The habitat is fundamentally composed of sediment ranging from 1 µm to 2 mm, the finer silt and clay sediments being dominant in mudflats and the larger sand fractions associated with areas exposed to significant wave energy. Close packing of small sediment particles may lead to low oxygen levels in underlying sediments due to minimal exchange of water.

The biological communities found in 1140 Mudflats and sandflats include invertebrates such as polychaete worms and bivalves. As noted above, the habitat forms an important feeding resource for birds, particularly the wildfowl that use it for overwintering.

Natural physical pressures operating on the habitat include fluctuations in salinity, temperature and immersion, while the main anthropogenic pressures identified at a national level include pollution, fishing and harvesting aquatic resources, bottom culture and suspension culture.

Not mentioned in NPWS (2013) is the issue of invasion by the non-native cord-grass (*Spartina anglica* and hybrids; hereafter called *Spartina*). This was seen during the current survey to be forming extensive swards in parts of the Great Island Channel SAC, most notably in Belvelly Channel.

1.3.2 Characteristics of 1330 Atlantic salt meadows, and main pressures

McCorry & Ryle (2009) give the following description of saltmarshes. Saltmarshes are wetland areas that are found in sheltered coastal areas such as in estuaries, and contain vegetation communities that have generally developed on soft mud or muddy sediments deposited by the sea. Saltmarsh is generally restricted to the area between mid-neap tide level and high water spring tide level. Fossitt (2000) describes two types of saltmarsh, CM1 Lower saltmarsh, and CM2 Upper saltmarsh. Lower saltmarsh may be covered by the tide twice a day, while the upper marsh may only be covered by higher tides (spring tides) several times each month (McCorry & Ryle, 2009). Zonation of vegetation develops in response to the gradient of the saltmarsh, which affects salinity and frequency of inundation, and at the landward side there are also generally transitional communities formed with other terrestrial habitats such as grassland, reed swamp and dunes.

The Annex I saltmarsh habitat 1330 Atlantic salt meadows may occur either on lower saltmarsh or upper saltmarsh. Throughout this report, classification of saltmarsh habitats is according to Fossitt (2000), and of Annex I saltmarsh is according to the CEC (2013) interpretation manual for Annex I habitats, with further definition and interpretation of Annex I saltmarsh habitats in an Irish context being made with reference to McCorry & Ryle (2009). Ongoing work by Perrin *et al*. (in prep.) has involved the analysis of saltmarsh relevés by fuzzy analysis, and additional resolution of saltmarsh vegetation communities has been provided by the application of their preliminary classification, in which two communities of Annex I 1330 Atlantic salt meadows vegetation have been identified, one from each of the Puccinellion maritimae and the Armerion maritimae alliances. These will hereafter be referred to as the Puccinellion-type and Armerion-type communities.

The main pressures operating on 1330 Atlantic salt meadows at a national level, according to NPWS (2013) and based largely on the work of McCorry & Ryle (2009), are intensive cattle and sheep grazing, erosion, invasive non-native species (*Spartina*), and paths, tracks and cycling tracks.

1.4 Conservation assessment of Annex I habitats

The national conservation assessment of Annex I habitats is carried out according to guidelines published by the EU (Evans & Arvela, 2011). It utilises four main parameters to assess the habitats: range, area (extent), structure and functions, and future prospects.

Assessment of area is concerned with detecting changes in the extent of the Annex I habitat over time, particularly habitat losses. The actual parameter measured is percent annual change for the period over which the change is being assessed.

The structure and functions assessment examines a number of criteria that measure the health and overall functioning of the Annex I habitat. These criteria vary, depending on the habitat being assessed. For example, terrestrial habitats such as saltmarsh, which support vegetation, often examine a range of criteria such as vegetation height, plant species cover and disturbance to gauge the condition of the habitat; but marine habitats such as mudflats, which lack vegetation, may be assessed by a single criterion, such as the composition of their invertebrate fauna, to derive their conservation status.

The future prospects parameter assesses how likely the Annex I habitat is to continue move towards, or remain at, favourable conservation status. According to Evans & Arvela (2011), the future prospects parameter is partly dependent on the area and structure and functions parameters, with impacts, threats and pressures operating on the Annex I habitat also taken into account to determine the likely future trend and status of the habitat.

Conservation assessments of individual sites, such as the Great Island Channel SAC, follow a similar methodology, used for a number of different national habitat studies such as the SMP (McCorry & Ryle, 2009), Coastal Monitoring Project (Ryle *et al*., 2009), Woodland Monitoring Project (O'Neill & Barron, 2012) and Irish Semi-natural Grasslands Survey (O'Neill *et al*., 2013), which utilises a "traffic light" system of assessment for the four criteria, as shown in Table 1. Range considers the national range (distribution) of a habitat, so it is omitted from assessments carried out on an individual site. In practice, assessment of the area of the habitat having *Favourable* or *Unfavourable* structure and functions is often estimated by the recording of assessment stops which represent the condition of the habitat. Structure and functions criteria are assessed at each stop, and each criterion has a target value which must be reached for it to pass. A failure of one or more criteria to meet to required target causes the stop to fail. The percentage of assessment stops that pass or fail the structure and functions assessment is used as a proxy for the percentage of the area that passes. This assumes that all assessment stops represent and assess a similar area of habitat.

Table 1. Summary matrix of the parameters and conditions required to assess the conservation status of Annex I habitats. Modified from Ryle *et al*. (2009).

	Favourable	***Unfavourable – Inadequate***	***Unfavourable – Bad***
Range	Stable	>0 - <1% decline per year	≥1% decline per year
Area	Stable	>0 - <1% decline per year	≥1% decline per year
Structure & functions	Stable	1 – 25% of area is unfavourable	> 25% of area is unfavourable
Future prospects	Prospects excellent or good, long-term viability of habitat assured	Intermediate between *Favourable* and *Unfavourable – Bad*	Severe impact from threats, habitat declining rapidly
Overall	*All parameters green*	*Combination of green and amber*	*One or more parameters red*

2 Methods

2.1 1140 Mudflats and sandflats

2.1.1 Area (Extent) assessment

Ordnance Survey of Ireland Orthophotography from the years 1995, 2000, 2005 and 2010 (where available), in addition to Bing Maps satellite images from 2012 (www.bing.com/maps/), were viewed to identify any changes to mudflat area on the landward side due to infilling or expansion of the saltmarsh area. It was not possible to assess changes to the seaward extent of mudflats due to differences in tidal levels between photographic series.

2.1.2 Structure and functions assessment

The field survey was carried out on 14th-15th May 2014 during low water spring tides. The methodology for the survey generally followed that of the Marine Monitoring Handbook (Davies *et al*., 2001). Intertidal core samples were taken along three transects using a 0.01 m^2 core to a depth of 15 cm. Transect locations were chosen to repeat the work carried out by Aquafact (2006) in order to allow a comparison of data to be made. Transects 1 (Ballyvodock West) and 2 (east of Belvelly) of Aquafact were resampled, while discrepancies between the mapped transect and the sample station coordinates for Transect 3 (north of Foaty Island) meant a new transect was set up in this area.

Three stations were sampled along each transect: upper shore, middle shore and lower shore. Access to the sample stations was facilitated by the use of specially designed mudshoes (www.Mudderboot.com). Four cores were taken at each sample station and pooled before being sieved and the residue retained for macroinvertebrate analysis. The samples were fixed in 10% formalin and placed in labelled containers, before being returned to the laboratory for sorting, identification and enumeration. One core was taken for sediment analysis, with one half of the full core retained, placed in a labelled container and placed in a cooler box before being returned to the laboratory where the samples were frozen prior to analysis for granulometry and Total Organic Carbon (TOC). On arrival in the laboratory, all samples, both macroinvertebrate and sediment, were logged on appropriate log sheets.

In the laboratory, macroinvertebrate samples were transferred from the fixative to 70% Industrial Methylated Spirits (IMS) for preservation prior to identification. Samples were sorted in a white tray,

with macroinvertebrates picked and placed in labelled containers. Macroinvertebrates were identified using binocular and compound microscopes.

Data collected on standard field sheets at each sample station included the following:

- Location
- Surveyors
- Sampler type
- Weather
- Date
- Time
- Station
- Irish Grid Reference
- Exposure
- Sieve size (mm)
- Core depth (cm)
- Sediment description
- Photo reference numbers

2.1.3 Future prospects (Impacts) assessment

Impacts and activities affecting the future prospects of the Annex I habitat were noted during the field survey. In addition, a desk study analysis was undertaken to collect other available information on the water quality of the site.

2.2 1330 Atlantic salt meadows

2.2.1 Area (Extent) assessment

Changes in area for 1330 Atlantic salt meadows were calculated by comparing the areas mapped during the SMP (McCorry & Ryle, 2009) with those mapped during the current survey. Additional areas which were surveyed and mapped for this project but not mapped by the SMP were assessed for area changes by comparing 2000 aerial photographs with the habitat boundaries mapped during the current survey and Bing Maps (www.bing.com/maps/).

2.2.2 Structure and functions assessment

The two sites within the Great Island Channel SAC that were surveyed as part of the SMP (McCorry & Ryle, 2009) were revisited. Additional survey sites were selected from polygons labelled by the SMP or Atkins (O'Donoghue, 2008; O'Donoghue *et al*. 2009) as potential 1330 or potential saltmarsh habitat. Survey priority was accorded to the SMP sites, followed by larger areas of potential 1330 / saltmarsh habitat mapped by the SMP and Atkins. The SMP sites surveyed were near Carrigtohill (beside Fota Island Golf Course) and Bawnard. Additional areas were surveyed for this project at Lough Atalia, Harpers Island, Slatty Bridge, Belvelly, Rossmore and Midleton.

The field survey of saltmarsh habitats was carried out on 14th-16th May 2014 during low water spring tides. The methodology for the structure and functions assessment generally followed that used by McCorry & Ryle (2009) for the SMP, with additional consultation carried out with Mark McCorry on the interpretation of some of the criteria. The assessment stop plots recorded for the SMP at Carrigtohill and Bawnard were repeated (except in one instance at Bawnard where access could not be gained) to allow for an assessment of change over time. Additional assessment stops were recorded in areas mapped by the SMP and Atkins as potential 1330 / saltmarsh if they were found to conform to the Annex I habitat. As it is recognised that 1330 Atlantic salt meadows are composed of a range of

different communities, the vegetation communities proposed by Perrin *et al.* (in prep.) were additionally applied to 1330 Atlantic salt meadows polygons visited and mapped during this survey, with the approximate percentage of each community indicated in the digitised polygon.

2.2.3 Future prospects (Impacts) assessment

Impacts and activities affecting the future prospects of the Annex I habitat were noted during the field survey. The SMP report (McCorry & Ryle, 2009) was also consulted for additional impacts not recorded during the current field survey.

3 Results

3.1 1140 Mudflats and sandflats

3.1.1 Description of sample areas

Overall, the site consisted of soft mud, with surface water at the time of sampling. Worm casts were observed at all stations.

Map 1 shows the location of the sample transects and stations.

Transect 1

Location: Ballyvodock West
Date: 14/05/2014

Transect sample stations	Upper shore	ITM 585575.5, 570685.4; IG W 85622 70623
	Mid shore	ITM 585595.5, 570562.4; IG W 85642 70500
	Lower shore	ITM 585632.4, 570382.4; IG W 85679 70320

Exposure: Very sheltered

Site description: Transect 1 was located on mudflats in a bay at Ballyvodock West, just west of the Ballynacorra River. The top of the shore was dominated by a mixed substratum of cobbles and brown seaweeds, with areas of green seaweed (*Ulva* spp.).

The results of the granulometric and Loss on Ignition analysis for each of the three stations on Transect 1 are presented in Table 2, while the results of the faunal analysis are presented in Table 3.

Table 2. Granulometry and Loss on Ignition results for Transect 1.

Wentworth class	**T1-1 Upper**	**T1-2 Middle**	**T1-3 Lower**
Fine Gravel %	0.00	0.00	0.00
Very Fine Gravel %	0.20	0.00	0.16
Very Coarse Sand	0.09	0.00	0.19
Coarse Sand %	0.12	0.09	0.24
Medium Sand %	0.31	1.24	0.24
Fine Sand %	2.06	24.99	10.35
Very Fine Sand %	52.37	40.32	16.81
Silt %	44.86	33.36	72.00
Total Organic Carbon %C	4.71	6.08	4.76

The upper and mid-shore stations were classed as Sandy Mud following Folk (1954), while the lower shore station was classed as Muddy Sand.

Table 3. Infauna species and abundance recorded on Transect 1.

Species	T 1-1	T 1-2	T 1-3
Polychaeta			
Ampharete finmarchica	10	1	-
Hediste diversicolor	2	1	-
Nephtys hombergii	17	3	5
Mollusca			
Scrobicularia plana	-	-	1
No. of species	3	3	2
No. of organisms	29	5	6

- **Station T1-1 (Upper shore)**

  Station description: The upper shore station consisted of soft mud with burrows and casts, and surface water. The redox layer was recorded from 1-5 cm depth. Three species were recorded at this station: the polychaete worms *Nephtys hombergii*, *Ampharete finmarchica* and *Hediste diversicolor.*

- **Station T1-2 (Mid-shore)**

  Station description: The mid-shore station consisted of soft mud with casts and surface water. The redox layer was recorded at <1 cm depth. Three species were recorded at this station: the polychaete worms *Nephtys hombergii*, *Ampharete finmarchica* and *Hediste diversicolor.*

- **Station T1-3 (Lower shore)**

  Station description: The lower shore station consisted of soft mud with casts and surface water. The redox layer was recorded from 1-5 cm depth. Two species was recorded at this station: the polychaete worm *Nephtys hombergii* and the bivalve *Scrobicularia plana*.

Transect 2

Location: East of Belvelly
Date: 15/05/2014
Transect sample stations:

	Upper shore	ITM 580092.6, 569986.5; IG W 80138 69924
	Mid shore	ITM 580465.5, 570277.5; IG W 80511 70215
	Lower shore	ITM 580781.5, 570534.4; IG W 80827 70472

Exposure: Very sheltered

Site description: Transect 2 was located on mudflats in a bay east of Belvelly, on Great Island. The transect begins within a channel through an area of saltmarsh. Green algal mats were present within the channel.

The results of the granulometric and Loss on Ignition analysis for each of the three stations on Transect 1 are presented in Table 4, while the results of the faunal analysis are presented in Table 5.

Table 4. Granulometry and Loss on Ignition results for Transect 2.

Wentworth class	T2-1 Upper	T2-2 Middle	T2-3 Lower
Fine Gravel %	0.00	0.00	0.00
Very Fine Gravel %	0.00	0.50	0.00
Very Coarse Sand	0.00	0.29	0.00
Coarse Sand %	0.07	0.48	0.00
Medium Sand %	0.35	0.39	0.07
Fine Sand %	4.98	0.77	0.22
Very Fine Sand %	43.73	33.13	67.50
Silt %	50.86	64.44	32.21
Total Organic Carbon %C	5.86	4.86	5.78

The upper and mid-shore stations were classed as Sandy Mud following Folk (1954), while the lower shore station was classed as Muddy Sand.

Table 5. Infauna species and abundance recorded on Transect 2

Species	T 2-1	T 2-2	T 2-3
Polychaeta			
Ampharete finmarchica	-	12	3
Hediste diversicolor	10	40	8
Nephtys hombergii	5	3	5
Polydora cornuta	-	-	1
Pygospio elegans	-	-	1
Streblospio benedicti	-	1	-
Oligochaeta			
Tubificoides benedii	-	-	2
Mollusca			
Scrobicularia plana	3	5	2
No. of species	3	5	7
No. of organisms	18	61	22

- **Station T2-1 (Upper shore)**

  Station description: The upper shore station consisted of soft mud with burrows and casts, and surface water. The redox layer was recorded from 1-5 cm depth. Three species were recorded at this station: the polychaete worms *Hediste diversicolor* and *Nephtys hombergii*, and the bivalve *Scrobicularia plana*.

- **Station T2-2 (Mid-shore)**

  Station description: The mid-shore station consisted of soft mud with burrows, casts and surface water. The cockle *Cerastoderma edule* and the furrow shell *Scrobicularia plana* were recorded around the sample station. The redox layer was recorded at <1 cm depth. Five species were recorded at this station: the polychaete worms *Hediste diversicolor*, *Ampharete finmarchica*, *Nephtys hombergii* and *Streblospio benedicti*, and the bivalve *Scrobicularia plana*.

- **Station T2-3 (Lower shore)**

  Station description: The lower shore station consisted of soft mud with burrows, casts and surface water. The redox layer was recorded from 1-5 cm depth. Seven species were recorded at this station: the polychaete worms *Hediste diversicolor*, *Nephtys hombergii*, *Ampharete finmarchica*, *Polydora cornuta* and *Pygospio elegans*, the oligochaete worm *Tubificoides benedii*, and the bivalve *Scrobicularia plana*.

Transect 3

Location: North of Foaty Island
Date: 14/05/2014
Transect sample stations:

Upper shore	ITM 580226.6	572500.0; IG W 80272 72438
Mid shore	ITM 580201.6	572556.0; IG W 80247 72494
Lower shore	ITM 580181.6	572603.0; IG W 80227 72541

Exposure: Extremely sheltered

Site description: Transect 3 was located on mudflats to the north of Foaty Island in the Slatty Water Estuary. The shore graded from saltmarsh into mixed substratum with brown seaweeds and finally to mudflat proper.

The results of the granulometric and Loss on Ignition analysis for each of the three stations on Transect 3 are presented in Table 6, while the results of the faunal analysis are presented in Table 7.

Table 6. Granulometry and Loss on Ignition results for Transect 3.

Wentworth class	T3-1 Upper	T3-2 Middle	T3-3 Lower
Fine Gravel %	0.00	0.00	0.00
Very Fine Gravel %	0.00	0.00	0.00
Very Coarse Sand	0.23	0.03	1.08
Coarse Sand %	0.17	0.10	0.01
Medium Sand %	0.48	0.05	0.04
Fine Sand %	18.37	0.28	0.16
Very Fine Sand %	52.45	51.22	43.78
Silt %	28.30	48.32	54.92
Total Organic Carbon %C	6.06	5.16	5.80

The upper and mid-shore stations were classed as Sandy Mud following Folk (1954), while the lower shore station was classed as Muddy Sand.

Table 7. Infauna species and abundance recorded on Transect 3.

Species	T3-1	T3-2	T3-3
Polychaeta			
Hediste diversicolor	66	21	-
Nephtys hombergii	-	3	-
Streblospio benedicti	-	1	1
Oligochaeta			
Tubificoides benedii	-	-	7
Mollusca			
Scrobicularia plana	3	4	-
No. of species	2	4	2
No. of organisms	69	29	8

- **Station T3-1 (Upper shore)**

  Station description: The upper shore station consisted of soft mud with burrows and casts, and surface water. The redox layer was recorded from 1-5 cm depth. Two species were recorded at this station: the polychaete worm *Hediste diversicolor* and the bivalve *Scrobicularia plana.*

- **Station T3-2 (Mid-shore)**

  Station description: The mid-shore station consisted of soft mud with burrows and surface water. The redox layer was recorded from 1-5 cm depth. Four species were recorded at this station; the polychaete worms *Hediste diversicolor*, *Nephtys hombergii* and *Streblospio benedicti*, and the bivalve *Scrobicularia plana.*

- **Station T3-3 (Lower shore)**

  Station description: The lower shore station consisted of very soft mud, with slight orange coloration on the surface and sloped down into the permanent channel. The redox layer was recorded at <1 cm depth. Two species were recorded at this station; the polychaete worm *Strebospio benedicti* and the oligochaete worm *Tubificoides benedii*.

3.1.2 Area (Extent) assessment

No noticeable change was detected from the aerial photography / satellite map analysis. For the purposes of this conservation assessment, it can be concluded that there has been no loss of mudflat area within the Great Island Channel SAC in the period 1995 to 2012. Therefore, the site passes this criterion and receives a *Favourable* assessment for area.

3.1.3 Structure and functions assessment

As noted above in section 1.4, the structure and functions assessment examines criteria that gauge the health and overall functioning of the Annex I habitat. For 1140 Mudflats and sandflats, the conservation objectives of the Great Island Channel SAC list a single assessment criterion for structure and functions, namely [invertebrate] community distribution. The target for this criterion is for the "Mixed sediment to sandy mud with polychaetes and oligochaetes" community complex to be conserved in a natural condition.

The following assessment of 1140 Mudflats and sandflats in this SAC is based on the data collected by the current survey, as well as data from the two intertidal surveys carried out in 2006 and 2011 (Aquafact, 2006; MERC, 2012). Assessment is made on the basis of the species present: their abundances, characteristics and tolerances to environmental variables such as organic enrichment.

There are a number of caveats associated with the data used to make the assessment. The intertidal species abundance data sets of the previous and current surveys involved different sampling methods, i.e., cores, dig-outs (MERC, 2012) and small van Veen grabs (Aquafact, 2006), due to a disparity in sampling conditions at the time. The current survey used an intertidal core, which is standard for intertidal surveys and comparable with the MERC (2012) survey. These discrepancies have the potential to return different abundance estimations of, in particular, larger taxa, as seen here. However, they remain useful in comparing community complexes and biotopes.

The current survey, in conjunction with the intertidal survey carried out in 2011 (MERC, 2012), confirms the presence of the biotope LS.LMu.MEst.HedMacScr: *Hediste diversicolor*, *Macoma balthica* and *Scrobicularia plana* in littoral sandy mud shores (see Appendix I), suggested by the relatively low intensity intertidal survey of the SAC in 2006 (Aquafact, 2006), which recorded the bivalve *Macoma balthica* located mid-estuary in the Great Island Channel. The current survey additionally recorded the peppery furrow shell *Scrobicularia plana* from cores, a species which was absent from the 2006 survey's grab samples but present within digs. The infauna of the above biotope is additionally characterised by a range of polychaete and bivalve species, including the ragworm *Hediste diversicolor*, *Pygospio elegans* and *Streblospio shrubsolii*. Another species that sometimes occurs in this biotope is the polychaete *Nephtys hombergii*, also recorded in the current survey.

The communities recorded reflect for the most part a relatively undisturbed habitat typical of mudflats and sandflats within sheltered middle estuarine environments. Intertidal sediments sampled across the three surveys range from mud to muddy sand to slightly gravelly sandy mud in texture, and from well-sorted to moderately sorted sediments. The channel can be subject to variable salinity and is flanked by sheltered shores. Typically, the sediment retains surface water at low tide and has an anoxic layer 1-5 cm below the surface.

Three species, namely the bivalve *Angulus tenuis*, the crustacean *Crangon crangon* and the amphipod *Urothoe elegans*, recorded from a previous survey (Aquafact, 2006) are species which are very sensitive to organic enrichment, are present under unpolluted conditions and are defined as Group I in the AMBI index. *Angulus tenuis* was recorded in single and paired occurrences at three stations during the 2006 survey, while *Urothoe elegans* was recorded at one station; none of these species were recorded in the current survey, which may imply an increase in organic enrichment since the 2006 survey (which would tally with the results of EPA monitoring; see Section 3.1.4), but may also be an artefact of differing survey methodologies (grab vs intertidal core). *Crangon crangon* and the polychaete *Ampharete grubei*, similarly very sensitive to organic enrichment, were recorded by MERC (2012), but not by the current survey. The majority of the other species recorded in all three surveys are indifferent and tolerant to enrichment, with the exception of *Tubificoides benedii*, *Heterochaeta costa* and *Capitella* sp., which are deposit feeders that proliferate in reduced sediments. *Tubificoides benedii* was recorded in all three surveys, while *Heterochaeta costa* and *Capitella* sp. were only recorded in 2011 (MERC, 2012), which was the most comprehensive survey of the SAC. A large number of those stations sampled during the 2011 survey revealed very low species diversity, however all recorded *Nephtys hombergii*, which is indifferent to enrichment and generally present in low densities with non-significant variations over time. Unfortunately in estuaries it can be very difficult to distinguish between natural mudflat/estuarine conditions and conditions in which there is a degree of enrichment.

This may be clarified by use of the Benthic Infaunal Quality Index (Benthic IQI). While this index is not applied for the assessment of the conservation status of 1140 Mudflats and sandflats in the SAC, it can be useful for monitoring water quality. Within the index, soft-bottom macrofauna are ordered into five groups according to their sensitivity to an increasing stress gradient (i.e. increasing organic matter enrichment), varying from very sensitive to organic enrichment to opportunistic species which proliferate in reduced sediments. Species from each of the groups were recorded in each of the three surveys, including the current survey, but the species contributing most to these complexes are

species tolerant to excess organic matter enrichment and whose populations are stimulated by organic enrichment. In each of the surveys, a number of stations were treated with caution due to a number of assumptions and constraints of the index; however, those tested resulted in the overall water body scoring 'moderate'. Therefore improvements/changes in land/water management are required. Taken in conjunction with the invertebrate communities present, 1140 Mudflats and sandflats are thus identified to be at less than favourable conservation status. These results relate to the entire area of the Annex I habitat within the SAC, therefore the structure and functions assessment is *Unfavourable – Bad*.

3.1.4 Future prospects (Impacts) assessment

Pollution to surface waters (impact code H01; Ssymank, 2010) is the activity having the greatest impact on the 1140 Mudflats and sandflats habitat in the SAC. While Fishing and harvesting aquatic resources (impact code F02) and Bottom culture (impact code F01.03) are also of high importance in the area, there has been a prohibition order in place on the harvesting of oysters in this shellfish area since 2002 due to viral contamination.

Invasion by *Spartina* (impact code I01) is an issue for mudflats in parts of the SAC. In Ireland, *Spartina* was first planted in Cork Harbour in 1925 and subsequently planted in other estuaries around Ireland; by the late 1940s it was reported to have formed dense mono-specific swards in Cork Harbour (McCorry *et al*., 2003). Its potential for reclamation of mudflats, protecting against coastal erosion and improvement of the physico-chemical characteristics of mudflats was recognised, and this encouraged its deliberate introduction (Hammond, 2001; McCorry et al., 2003). There is some debate about its negative effects. It may outcompete native species on saltmarsh in certain situations, but there is conflicting evidence regarding its effects on fauna, both the macroinvertebrates of the mudflats and the birds that feed on them, with studies showing both increases and decreases in abundance of macroinvertebrates under *Spartina* swards, while documented evidence of the negative effects on waterbird populations due to *Spartina* invasion is sparse (McCorry *et al*. 2003).

Waste water treatment plants (WWTPs) at Carrigtohill and Midleton discharge directly into the site and both are failing to meet the requirements of the Urban Waste Water Treatment Directive (91/271/EEC) (data available at http://www.eea.europa.eu/data-and-maps/uwwtd/interactive-maps/urban-waste-water-treatment-maps). Passage/Monkstown, Cobh, Ringaskiddy discharge into the broader Cork Harbour environment, and tidal/wind movements may result in effects on Great Island Channel SAC.

Leaks in the existing sewage network around the SAC, as well as pipes not tied in to the network, may be acting as a source of waste water into the SAC.

Rivers flowing into the site may bring nutrients from the broader catchment into the SAC. These include:

- Owennacurra River and tributaries – Midleton
- Dungourney River – Midleton
- Streams entering Slatty Water – Carrigtohill
- Other minor streams

Nutrient inputs to the Great Island Channel SAC are likely to include domestic and industrial septic tanks located within the catchment, as well as inputs from agricultural activity including the spread of slurry or fertilisers.

Results of the desktop analysis of water quality data from the EPA show the following:

- Owennacurra River – Cork Bridge, Midleton – Q3-4 in 2011 – Moderate status (EPA, 2014). The upstream sites are classed Q4, indicating the nutrient inputs in the vicinity of Midleton.

- Dungourney River – Bridge in Midleton – Q3 in 2011 – Poor status (EPA, 2014). The upstream sites are classed Q4, indicating the nutrient inputs in the vicinity of Midleton.
- North Channel Great Island (WFD Transitional and Coastal Water Quality) – Potentially eutrophic for the period 2007-2009, which is a disimprovement from Intermediate in the period 1999-2003 (Toner *et al*., 2005; McGarrigle *et al*., 2010).
- Slatty Water forms part of Lough Mahon WFD waterbody which is listed as Intermediate for the period 2007-2009, which is an improvement from Eutrophic in the period 1999-2003 (Toner *et al*., 2005; EPA, 2014).

Inadequate water quality is therefore an issue in this SAC, and the increased waste water loadings generated by the 2022 population targets within the Draft Cork County Development Plan 2013 would place further pressure on water quality in the SAC. Though some improvement is likely through the proposed Cork Lower Harbour Main Drainage Scheme, the main inputs from Carrigtohill and Midleton will remain until the waste water treatment plants serving these agglomerations are upgraded to provide sufficient capacity to cater for their catchment area and meet the required discharge quality standards. Thus, the future prospects assessment for 1140 Mudflats and sandflats is *Unfavourable – Bad*.

3.1.5 Overall condition assessment

Utilising the data collected on the area, structure and functions, and impacts affecting future prospects for 1140 Mudflats and sandflats, an overall assessment was made on the condition of the habitat within the SAC (Table 8). Erring on the side of caution and reflecting both the areas of high numbers of opportunistic species within some of the community complexes and the results of the water quality monitoring carried out by the EPA, the current conservation status of 1140 Mudflats and sandflats in the Great Island Channel SAC is *Unfavourable – Bad*.

Table 8. Summary of assessment results 1140 Mudflats and sandflats habitat in Great Island Channel SAC. F = *Favourable*; U-B = *Unfavourable – Bad*.

	Area	**Structure & Functions**	**Future Prospects**	***Overall assessment***
1140 habitat	F	U-B	U-B	***U-B***

3.2 1330 Atlantic salt meadows

3.2.1 General description of areas surveyed

Map 2 shows the locations of all areas surveyed for saltmarsh habitats.

- *Carrigtohill:*

Most of the area mapped by the SMP at Carrigtohill (SMP site code SMP0060), adjacent to Fota Golf Course, was revisited (Map 3), and the four assessment stops recorded for this survey were located as close as possible to the original SMP stops. The area at Slatty Bridge to the east of the site, originally included within the Carrigtohill site by the SMP, is described separately below.

A number of small areas of 1330 Atlantic salt meadows are present at this site, all of the Puccinellion-type community. Most of these are CM1 Lower saltmarsh, but one larger area of CM2 Upper saltmarsh is present in the east of the site. Some very small areas of the Annex I habitat 1310 *Salicornia* mud, mapped during the SMP, were also relocated, although the time of year was early for *Salicornia* spp. and cover of the species was therefore low. Creeks and pans were present in some

areas. A small area of infilling was noted in one part of the site, but apart from this, recent human interference with the structure of the saltmarsh was absent. A small embankment or accretion ridge, apparently present for some time and now supporting upper saltmarsh species, was recorded in one part of the site, but as saltmarsh vegetation is present on lower ground on either side of this ridge, it does not appear to be having any deleterious effect on the saltmarsh habitats adjacent to it. Woodland beside the saltmarsh is shading out some of the adjacent saltmarsh vegetation.

No change was noted between the Annex I saltmarsh habitats mapped in 2008 during the SMP and those mapped during this survey.

The SMP describes this site in detail, and reference should be made to McCorry & Ryle (2009), SMP site code SMP0060, for further information.

- *Bawnard:*

The entire area mapped by the SMP at Bawnard (SMP site code SMP0057) was revisited (Map 4), and three of the four stops for this survey were relocated as close as possible to the original SMP stops and reassessed. One of these three stops was found to be located in habitat that no longer conformed to 1330 Atlantic salt meadows, so the stop was relocated to a position as close as possible to the SMP stop location but within 1330 Atlantic salt meadows habitat. Part of this site (where two of the stops were recorded) includes narrow strips of saltmarsh habitat being subjected to coastal squeeze (in which saltmarsh is unable, in the event of rising sea levels, increases in tidal ranges or increases in wind and wave energy, to retreat in a landward direction because of a physical barrier; JNCC, 2004) by a seawall on one side, and to *Spartina* encroachment on the other side. There was also evidence at this site of damage from the winter storms of 2013/14, with a large uprooted tree noted at the eastern end of the site. It is thought that some areas of bare shingle may have been newly exposed because of extreme wave action.

The SMP describes this site in detail, and reference should be made to McCorry & Ryle (2009), SMP site code SMP0057, for further information.

- *Lough Atalia:*

O'Donoghue *et al.* (2009) identified 1330 Atlantic salt meadows adjacent to Lough Atalia lagoon. The current survey agreed with their habitat assignment, two monitoring stops were recorded and the area was mapped (Map 5). Both the Armerion- and Puccinellion-type communities were recorded in this area, with discrete areas of *Atriplex portulacoides, Armeria maritima* and *Juncus gerardii*[4], as well as transitions between the different types. The area appears to be undisturbed, apart from a small ditch where *Spartina* is present but confined, and the saltmarsh is well developed. This saltmarsh conforms to the lagoon type of saltmarsh, the occurrence of which is described by Curtis (2003) as rare in Ireland.

- *Harpers Island:*

O'Donoghue (2008) noted the development of saltmarsh at Harpers Island (Map 6) due to a seawall breach which was allowing sea water onto what had previously been improved agricultural grassland. A lagoon has formed, and water now appears to be entering the lagoon from under the embankment that surrounds the island. This area, 11 ha in size, is now grazed by a small number of horses (two at the time of survey). *Juncus gerardii* grows by the lagoon edge, which is almost entirely mud and green algae (*Enteromorpha* sp.). *Salicornia* sp. is present, emerging from the mud, with the remains of last year's *Salicornia* plants still in evidence and covering a large area. In a band adjacent to the mud is a strip of CM1 Lower saltmarsh vegetation, with *Glaux maritima, Carex otrubae, Potentilla anserina* and *Elytrigia repens*. This vegetation grades into GS1 Dry neutral grassland. However,

[4] All English names of plants given in Appendix III

zonation within the saltmarsh vegetation areas is minimal due to the overall flat nature of the site and the lack of water level fluctuation.

To the southeast of the lagoon, the habitat is a combination of: GA1 Improved agricultural grassland with locally abundant *Bellis perennis*; CM2 Upper saltmarsh, characterised by *Agrostis stolonifera, Rumex crispus, Potentilla anserina, Bolboschoenus maritimus* and *Carex otrubae*; and pioneer CM1 Lower saltmarsh, characterised by large areas of bare mud being colonised by *Salicornia* sp., with *Atriplex prostrata, Potentilla anserina, Juncus gerardii* and *Spergularia media* also present in this habitat. Green algae are locally abundant. This area was deemed to be likely to conform to the Annex I habitat 1310 *Salicornia* mud, which is not a qualifying interest for the SAC and was therefore not assessed.

This potentially represents (or will develop into) a lagoon saltmarsh.

- *Slatty Bridge:*

An area of 3 ha at Slatty Bridge was surveyed (Map 7) as it was identified and mapped by O'Donoghue *et al.* (2009) as 1330 Atlantic salt meadows with *Agrostis stolonifera, Alopecurus geniculatus, Aster tripolium* and *Carex otrubae* recorded as present. The SMP, however, identified this area as non-saltmarsh. On walking this polygon for the current survey, no saltmarsh species were in evidence, the only species in common with the O'Donoghue *et al*. (2009) survey being *Agrostis stolonifera*, with the entire area now referable to GA1 Improved agricultural grassland rather than CM2 Upper saltmarsh. On the basis that the SMP did not assign this area to Annex I habitat, this is not regarded as a loss of habitat since the SMP survey.

- *Belvelly:*

To the east of Belvelly Castle, large areas of *Spartina* swards are visible on the mudflats. O'Donoghue *et al*. (2009) mapped 1330 Atlantic salt meadows on the area fringing the *Spartina* swards to the south. The current survey agreed with this habitat assignment, two 1330 monitoring stops were recorded and the area mapped (Map 8). The main species present in this extensive area is *Puccinellia maritima*, with good cover also of species such as *Triglochin maritimum, Plantago maritima* and *Glaux maritima*. While *Spartina* is extensive adjacent to these areas, the presence of erosion cliffs between the 1330 Atlantic salt meadows and the *Spartina* swards prevents or impedes spread of the latter into the Annex I habitat.

- *Rossmore:*

Annex I saltmarsh was mapped by Atkins at Rossmore, and this area was visited to characterise the current status of this habitat. Pioneer 1330 Atlantic salt meadows habitat was surveyed and mapped (Map 9) adjacent to a lagoon, and one assessment stop was recorded. Cover of *Salicornia* sp. was high, particularly considering the early time of year for this species. Cover of green algae was also high. This area was deemed to be pioneer 1330 Atlantic salt meadows rather than 1310 *Salicornia* mud due to the presence of *Puccinellia maritima*, which is a characteristic species of 1330 Atlantic salt meadows but is not associated with 1310 *Salicornia* mud.

As for Lough Atalia and Harpers Island, the saltmarsh at this area is of the lagoon type.

- *Midleton:*

A large area of potential 1330 Atlantic salt meadows habitat identified from a desktop study by the SMP was visited at Midleton. This area was mapped as CM2 Upper saltmarsh by O'Donoghue *et al*. (2009). However, the current survey found that this area conformed more to a grassland habitat, intermediate between GS2 Dry meadows and GS4 Wet grassland. Species recorded here include *Elytrigia repens, Festuca rubra, Poa pratensis, Calystegia sepium, Filipendula ulmaria, Cardamine pratensis, Urtica dioica, Holcus lanatus, Galium aparine, Potentilla anserina, Epilobium hirsutum, Iris*

pseudacorus, Oenanthe crocata and *Solanum dulcamara*. Small amounts of *Schoenoplectus tabernaemontani* were also present.

A smaller area of habitat identified by O'Donoghue *et al*. (2009) as CM2 Upper saltmarsh, Annex I habitat 1130 (*sic*), located approximately 200 m to the southeast of the area described above, was also surveyed. This area was found to be CM2 Upper saltmarsh dominated by *Elytrigia repens* and *Agrostis stolonifera*, and was therefore not deemed to conform to 1330 Atlantic salt meadows. Areas fringing small brackish pools (too small to map) were found to contain a greater diversity of more typical saltmarsh species such as *Triglochin maritimum, Aster tripolium* and *Beta vulgaris* ssp. *maritima*, and similar habitat was seen on the small island directly to the west across the estuary (Map 10), although this was not walked. While the surveyed area was flat with little or no zonation, the island was slightly sloping, with some zonation of vegetation evident.

3.2.2 Area (Extent) assessment

Table 9 shows the extent of 1330 Atlantic salt meadows habitat mapped in the SAC by the SMP in 2008, and its current area mapped for this project. Results show a slight decrease in the extent of this Annex I habitat between 2008 (McCorry & Ryle, 2009) and 2014. No change in extent could be detected from aerial photographs or Bing Maps between 2000 and 2014 for areas of 1330 Atlantic salt meadows habitat not mapped during the SMP. The main loss of habitat was noted at Bawnard, where a combination of coastal squeeze and storm damage resulted in the loss of 0.02 ha of the Annex I habitat.

When the 3.12 ha areas of additional 1330 Atlantic salt meadows habitat mapped by this survey (including mosaics and the viewed area of probable 1330 at Midleton) are taken into account, this represents a loss of 0.45% of the 4.48 ha of 1330 habitat mapped in the Great Island Channel SAC, an annual loss of 0.07% over the six years from 2008 to 2014. Referring to Table 1 for area decline percentage thresholds, this gives an assessment result of *Unfavourable – Inadequate* for the Area (extent) criterion.

Table 9. Area (Extent) of 1330 Atlantic salt meadows recorded in Great Island Channel SAC in 2008 (SMP) and resurveyed in 2014.

Site	Area in SAC in 2008 (ha)*	Area in 2014 (ha)	Change in area (ha)	% annual change (over 6 years)
Bawnard	0.35	0.33	-0.02	0.95 (loss)
Carrigtohill	1.03	1.03	0	0
Additional areas	3.12	3.12	0	0
Total	*4.50*	*4.48*	*-0.02*	*0.07 (loss)*

* Note: some areas of 1330 surveyed by the SMP and resurveyed for this project were located outside the SAC but included in the SMP area totals, so this figure differs from that presented in McCorry & Ryle (2009) for the extent of 1330 habitat at these sites.

3.2.3 Structure and functions assessment

A total of 12 monitoring stops were recorded for the assessment of the 1330 Atlantic salt meadows habitat recorded in the Great Island Channel SAC. This included the recording of full 2 m x 2 m relevés, with percentage cover recorded for each species (see Appendix II). Assessment was made on the basis of five main criteria, following the SMP methodology (McCorry & Ryle, 2009).

Physical structure: This relates to the condition of creeks and pans (if any), with particular reference to human alteration of these physical saltmarsh features, the target being no further human alteration of creek function, for example, by recent drainage (McCorry & Ryle, 2009). Creeks or pans were

present in the vicinity of 6 of the 12 stops assessed. There was no evidence of human alteration of the physical structure of the 1330 Atlantic salt meadows habitat at any of the areas assessed in the current survey.

Vegetation structure: There are three components to vegetation structure, namely zonation, plant height and cover of bare ground.

- Zonation: McCorry & Ryle (2009) describe the main target of the zonation component as the maintenance of a range of plant zonation typical of the site, taking account of site size, and noting any evidence of coastal squeeze. Coastal squeeze was noted at two of the 12 stops, while normal zonation was exhibited in the vicinity of the other ten stops.
- Plant height: The main target of the plant height component was to maintain site-specific structural variation in the sward, McCorry & Ryle (2009) giving a reference guideline ratio of 25% tall to 75% short vegetation throughout the whole saltmarsh for the SMP. While actual threshold heights for tall and short were not supplied, it was assumed for this survey that low woody species such as *Limonium humile* and *Atriplex portulacoides* would be of a height typical of the tall vegetation referred to by McCorry & Ryle (2009), while the majority of the herbaceous vegetation, comprising species such as *Puccinellia maritima* and *Spergularia media*, would have heights typical of the short vegetation. Uniform plant height was recorded at 25% of the stops, with a further 25% of stops having a high proportion (>75%) of tall vegetation. One stop (8%) had equal amounts (50:50 ratio) of tall and short vegetation. The remaining 42% of stops had a relatively low proportion (25-33%) of tall vegetation, in line with the guideline ratio. McCorry & Ryle (2009) assessed this criterion over the habitat as a whole rather than at individual stops. On this basis, there was sufficient height variation throughout the different areas surveyed to pass this criterion.
- Cover of bare ground: Cover of bare ground was assessed at 10 of the 12 stops, stops with more than 5% bare ground in low to upper salt marsh failing the criterion. The two stops that were not assessed were in pioneer saltmarsh, so this criterion is not deemed to apply to them.

Vegetation composition: Two criteria are assessed under this heading: typical species and negative indicator species.

- Typical species: This relates to the presence of a threshold number and cover of typical species, with the typical species varying depending on the habitat zone in which the stop was recorded. However, the criteria cited in the SMP report were set at the beginning of the SMP project, and McCorry & Ryle (2009) noted the difficulty of setting typical targets for each Annex I habitat due to the dependence of species diversity on zonation, and a degree of expert judgement was used during the SMP for the assessment of this criterion (McCorry, pers. comm.). Following consultation with McCorry, species composition of stops was compared with that of SMP stops, where applicable; all were broadly in line with those recorded in 2008 except one stop (stop 7), which had suffered a decline in species diversity and cover and an increase in dominance by one species since 2008. For the five stops recorded *de novo*, expert judgement was exercised with relation to the nature of the species present, and all were found to have a typical assemblage of species present. Thus one stop was judged to have failed this criterion.
- Negative indicator species: Only one stop failed this criterion, *Spartina* appearing to be in the process of expanding in the vicinity of one stop in Bawnard since the SMP stop was recorded in 2008.

Other negative indicators: Other indicators of negative effects on the habitat were assessed, including reclamation, drainage, pollution, vehicle tracks, poaching and overuse. Two stops failed on this criterion, one through pollution/litter and overuse (presence of trampling), the other through pollution alone.

Indicators of local distinctiveness: No indicators of local distinctiveness were noted at any of the surveyed areas, so this criterion was not assessed at any of the stops.

Two of the 12 stops failed their assessment. Both of these stops were at Bawnard and the problems were due to a combination of coastal squeeze and pollution. This is a 17% failure rate for the stops carried out within the SAC as a whole, which, on referring to Table 1, corresponds to a structure and functions assessment of *Unfavourable – Inadequate.* However, the area represented by these two stops is limited in extent, comprising just 0.125 ha, or 2.8% of the total area of Annex I saltmarsh habitat surveyed and assessed. Referring to Table 1, this still gives a structure and functions assessment of *Unfavourable – Inadequate*, but the goal of attaining favourable conservation status (less than 1% of the area of Annex I habitat failing on structure and functions) can be seen to be achievable.

3.2.4 Future prospects (Impacts) assessment

A number of impacts were recorded during the field survey (Table 10). None of the negative impacts recorded have a high adverse effect on the saltmarsh habitats surveyed, although many impacts with low negative effects were recorded. The future prospects for the saltmarsh habitats in the Great Island Channel SAC appear to be generally *Unfavourable – Inadequate* (based on a cumulative score of -2 for the impacts noted; see O'Neill *et al*. (2013) for scoring system used). The main effects are from the seawall at Bawnard. Tree shading is also causing some suppression of saltmarsh vegetation. Pollution was noted at the time of survey, as well as outflow (not necessarily polluted) from a number of open pipes into the bay. This, taken in conjunction with the water quality data given in section 3.1.2, may give cause for concern as eutrophication can affect the development of saltmarsh if the resulting growth of algal mats is extensive (Boorman, 2003). Storm damage caused the loss of some 1330 Atlantic salt meadows habitat at Bawnard. This may be linked to climate change, the future impacts of which are as yet unknown in relation to this SAC. *Spartina* invasion is a constant threat to saltmarsh in this SAC, although comparisons with the SMP data indicate that it is not expanding significantly (if at all) in the areas surveyed. The seawall breach at Harpers Island is listed as a positive impact on saltmarsh habitats; though not yet supporting 1330 Atlantic salt meadows habitat, the area affected is certainly developing saltmarsh vegetation. Management intervention may be required to expedite the formation of Annex I saltmarsh at Harpers Island, and thereafter to help it to reach or maintain favourable conservation status.

The SMP report was checked for any additional impacts not noted during this survey, but there were none, apart from overgrazing in a field in the northeast of Bawnard site, a problem which since appears to have been rectified.

Table 10. Impacts and activities recorded during the survey that affect 1330 Atlantic salt meadows habitat within Great Island Channel SAC. Impact codes are according to Ssymank (2010), and scoring is according to O'Neill *et al*. (2013). Intensity: High (H), Medium (M) or Low (L); Influence Positive (+), Neutral (0) or Negative (-).

Impact code	Impact recorded in Great Island Channel SAC	Intensity	Influence	% Annex I habitat affected	Score
J02.09.01	Breach in seawall (Harpers Island)	M	+	0 (not yet Annex I habitat here)	0
J02.11.01	Seawall (Bawnard)	M	-	1-25	-1
J02.11	Embankment/accretion ridge (Carrigtohill)	L	0 (1330 habitat both sides)	<1	0
K01.01	Erosion: natural (all sites)	L	0	1-25	0
L07	Storm damage (Bawnard)	L	-	<1	-0.25
H05.01	Litter (Carrigtohill)	L	0	<1	0
H01.03/ H01.08	Pollution (outflow pipes/discharge) (Bawnard, Carrigtohill, Belvelly)	L	-	1-25	-0.5
A04	Rabbit grazing (Bawnard, Carrigtohill)	L	+	1-25	0.5
K06	Shade from treelines (Bawnard, Carrigtohill, Belvelly)	M	-	<1	-0.5
I01	*Spartina* invasion (Bawnard)	L	-	<1	-0.25
M	Climate change (all sites)	L	?	100	?

3.2.5 Overall condition assessment

Table 11 summarises the assessment results. Based on the results for assessments of area, structure and functions, and future prospects, the overall assessment for 1330 Atlantic salt meadows is *Unfavourable – Inadequate*, due to shortcomings in all three criteria assessed.

Table 11. Summary of assessment results for 1330 Atlantic salt meadows habitat in Great Island Channel SAC. U-I = *Unfavourable – Inadequate*.

	Area	Structure & Functions	Future Prospects	***Overall assessment***
1330 habitat	U-I	U-I	U-I	***U-I***

4 Discussion

4.1 Site-specific conservation objectives and targets for the SAC

The site-specific conservation objectives for the Great Island Channel SAC (NPWS, 2014a) are as follows:

- *1140 Mudflats and sandflats not covered by seawater at low tide*

To maintain the favourable conservation condition of this habitat in the SAC in terms of its:

(a) area (the target is for the area to be stable or increasing, subject to natural processes), and

(b) community distribution, i.e. to conserve in a natural condition the *Mixed sediment to sandy mud with polychaetes and oligochaetes* community complex.

- *1330 Atlantic salt meadows (Glauco-Puccinellietalia maritimae)*

To restore the favourable conservation condition of this habitat in the SAC in terms of its:

(a) area (target is for the area to be stable or increasing, subject to natural processes),

(b) distribution (target is for no decline or change, subject to natural processes),

(c) physical structure/sediment supply (target is the maintenance or restoration of natural circulation of sediments and organic matter without any physical obstructions),

(d) physical structure/creeks and pans (target is their maintenance or restoration, subject to natural processes),

(e) physical structure/flooding regime (target is to maintain the natural tidal regime),

(f) vegetation structure/zonation (target is to maintain a range of coastal habitats including transitional zones, subject to natural processes),

(g) vegetation structure/height (target is to maintain structural variation within the sward),

(h) vegetation structure/vegetation cover (target is to keep more than 90% area outside creeks vegetated),

(i) vegetation composition/typical species (target is to maintain a range of sub-communities with typical species listed in the SMP (McCorry & Ryle, 2009); and

(j) vegetation structure/negative indicator species (target is for no significant expansion of *Spartina anglica*, with an annual spread of less than 1% where it is known to occur).

Therefore any management that takes place in the SAC must work towards achieving these objectives and targets.

It is further stated in NPWS (2014a) that: "Assessments cannot consider an attribute in isolation from the others listed for that habitat or species, or for other habitats and species listed for that site. A plan or project with an apparently small impact on one attribute may have a significant impact on another." This is particularly true in the case of the two Annex I habitats listed for the Great Island Channel SAC, as both mudflats and saltmarshes form a complex of interrelated habitats, subject to most of the same natural processes (such as erosion and accretion), anthropogenic impacts (such as eutrophication) and species invasions (*Spartina*), although responding to these processes and impacts in different ways.

4.2 Water quality issues in Great Island Channel SAC

A review of the current status of waste water treatment plants (WWTPs) in the vicinity of the Great Island Channel SAC shows that Midleton WWTP is operating over capacity, despite recent upgrade works to increase capacity from 10,000 to 15,000 PE. Additional works to be carried out are set out in the Waste Water Discharge Authorisation (D0056-01) by the EPA in relation to the Midleton WWTP. Carrigtohill WWTP (D0044-01) is also operating over capacity. Funding is available for the upgrading of this plant and tenders were to go out in 2012.

According to data submitted to the EU, no WWTP in Cork Harbour (Carrigtohill, Midleton, Passage/Monkstown, Cobh, Ringaskiddy) is compliant with the Urban Waste Water Treatment Directive, and Ireland is lagging behind almost every other country in the EU in relation to the implementation of this Directive (data available at http://www.eea.europa.eu/data-and-maps/uwwtd/interactive-maps/urban-waste-water-treatment-maps).

The background document to the Programme of Measures for Discharges from Urban Waste Water Treatment Plants (Mott MacDonald Ireland, 2010) lists Carrigtohill WWTP as requiring an increase in capacity of the plant (Priority 1), while Midleton WWTP requires investigation of the need for an increase in capacity (Priority 2).

4.3 Annex I saltmarsh habitats in Great Island Channel SAC

The total area of 1330 Atlantic salt meadows habitat mapped within the SAC during the current survey was 4.48 ha. This includes an additional 3.1 ha not mapped by the SMP, which is far short of the additional 17.6 hectares cited in the conservation objectives backing document for the Great Island Channel SAC (NPWS, 2014b). It is certainly likely that other small areas of saltmarsh, unrecorded by this and other recent surveys, exist within the SAC; however, it is also true that some areas which were listed, following desktop research, as potential 1330 Atlantic salt meadows sites by the SMP or by the Blarney and Midleton Electoral District surveys (O'Donoghue, 2008; O'Donoghue *et al.*, 2009) were found by the current survey to be non-Annex habitat.

This survey found a close correspondence between the polygons mapped during the SMP and the extent of the habitat recorded in 2014. However, there is evidence of coastal squeeze (in which saltmarsh is unable, in the event of rising sea levels, to retreat in a landward direction because of a physical barrier) caused by a seawall at Bawnard (which was evident during the SMP also), and this is likely to continue while the wall remains. Development of new saltmarsh at Harpers Island, caused by a breach in the seawall surrounding the island, is likely to offset these losses in the future. While the saltmarsh at Harpers Island is not yet 1330 Atlantic salt meadows, it is likely that, with suitable management, conditions conducive to the development of this habitat could be brought about. Pioneer saltmarsh vegetation is already establishing on what was formerly improved agricultural grassland, and the Annex I habitat 1310 *Salicornia* mud appears to be establishing on bare mud. The situation at Harpers Island is a unique opportunity to observe the processes of saltmarsh development in action, and further regular monitoring of this area is highly recommended, regardless of whether direct management is implemented or the situation is left to develop naturally, to gain insight into processes that are as yet poorly understood.

The current survey repeated seven of the eight stops recorded during the SMP by McCorry & Ryle (2009), and an additional five stops were recorded in areas mapped by the SMP as potential saltmarsh. A number of the original SMP stops were placed in narrow areas of the habitat where it was impossible to exclude other non-Annex habitats such as *Spartina* beds from the relevé. While these are representative of a small proportion of the habitat, future monitoring should expand the number of stops, or exclude these narrow areas of the habitat altogether (unless monitoring the rate of coastal squeeze), as they are not large or wide enough to function properly as saltmarsh.

The SMP concluded that the overall assessment of the 1330 Atlantic salt meadows at Bawnard was *Unfavourable – Inadequate*, with negative effects attributable to overgrazing and presence of the seawall, while the habitat at Carrigtohill was assessed as *Unfavourable – Bad* overall, the poor result due solely to decrease in area of the habitat due to infilling, as both structure and functions and future prospects received a *Favourable* assessment. The current survey has also assessed the 1330 Atlantic salt meadows at Bawnard as *Unfavourable – Inadequate* overall, due to losses that have occurred from coastal squeeze and extreme storms (an impact that could be regarded as natural unless taken to be associated with anthropogenic climate change); the overgrazed field in the SAC with Annex I habitat is no longer overgrazed, and so this does not currently appear to be a threat to the habitat. No further habitat loss has occurred at Carrigtohill, and the current survey assesses the overall condition of the Annex I habitat there as *Favourable*.

Condition of saltmarsh habitat surveyed in the other non-SMP sites has been assessed as *Favourable* overall. Taking all saltmarsh sites collectively into account, the overall conservation

assessment for the habitat in the Great Island Channel SAC is *Unfavourable – Inadequate*, due mainly to the potential for losses in marginal areas of saltmarsh from coastal squeeze, and to the possible impacts of pollution on the habitats. *Spartina* expansion into the areas surveyed, while a possibility, appears to be a low risk, based on the presence in most saltmarsh areas surveyed of erosion cliffs that prevent the spread of *Spartina* upwards into the saltmarsh. *Spartina* expansion may be an issue at Belvelly, where extensive *Spartina* swards are present, and at Bawnard, where no erosion cliffs are present and the Annex I saltmarsh habitats grade into the *Spartina* areas: a small area of *Spartina* not mapped during the SMP was noted during the current survey. However, as the patch recorded was very small, it is possible that the SMP did not map it for this reason. Local residents provided photographic evidence that *Spartina* cover is actually decreasing in the area of the SAC at Bawnard, and it is possible that *Spartina* is beginning to die back in Cork Harbour, as it has done in Baldoyle, Co. Dublin, and in Poole Harbour, in the UK (McCorry *et al.*, 2003).

4.4 Management changes required to restore favourable conservation status

4.4.1 Water quality

To maintain/restore the favourable conservation status of 1140 Mudflats and sandflats, a number of measures are recommended:

- As a priority, the waste water infrastructure of the greater Cork Harbour Area should be upgraded to meet the requirements of the Urban Waste Water Treatment Directive (91/271/EEC), transposed into Irish law by the Urban Waste Water Treatment Regulations 2001 (S.I. 254 of 2001); target dates for compliance with the provision of secondary treatment were 31st December 2000 for > 15,000 Population Equivalent (P.E.), 31st December 2005 for 10,000-15,000 P.E., and 31st December 2005 for discharges to freshwater and estuaries for agglomerations of 2,000-10,000 P.E., so this should be tackled as a matter of urgency.

  The Lee Estuary/Lough Mahon and the Owennacurra Estuary/North Channel waterbodies were included in the 'sensitive areas' list by the Urban Waste Water Treatment (Amendment) Regulations 2004 (S.I. 440 of 2004), with the associated requirement to provide, by 31 May 2008:

  > "…*more stringent treatment than secondary treatment or an equivalent treatment in respect of all discharges from agglomerations with a population equivalent of more than 10,000 into sensitive areas or into the relevant catchment areas of sensitive areas where the discharges contribute to the pollution of these areas* (S.I. 254 of 2001)."

  It is therefore a priority to implement these improvements at Carrigtohill WWTP, which discharges directly into the Lee Estuary/Lough Mahon and Great Island Channel SAC, and the Midleton WWTP, whose primary discharge point is outside the SAC boundary, but within the Owennacurra Estuary/North Channel sensitive area.

  The Urban Waste Water Regulations set out the standards necessary to meet the requirements of the Regulations with regard to sensitive areas (Parts 1 and 2 of the Second Schedule); however, given the fact that these WWTPs discharge into, or adjacent to, Natura 2000 sites, it may be necessary to apply more stringent standards to meet the requirements of other Community Directives (e.g. Habitats Directive).

  The options available in this case are that:

  a) the discharge point for the relevant WWTPs be relocated outside the sensitive areas/Natura 2000 sites (and at a distance such that there will be no negative effect from tidal/wind effects carrying the discharge into those waters). This would lessen the standards required by the Urban Waste Water Treatment Regulations; or

b) the Carrigtohill and Midleton WWTPs be upgraded in terms of capacity and treatment ability to ensure that the required standards are met with regard to the discharge quality prior to release into sensitive areas/Natura 2000 sites. As set out in the Urban Waste Water Directive and the Urban Waste Water Treatment Regulations, this means greater than secondary treatment (i.e. nutrient reduction). As noted above, the target date for the implementation of this requirement at these WWTPs was 31 May 2008.

   Such WWTP upgrades would need to result in the discharge standards being consistently met and the limitation of pollution of receiving water due to storm water overflows.

Any works proposed to be carried out on these WWTPs and their infrastructure with the potential to have a significant adverse effect on a Natura 2000 site require an Appropriate Assessment to be carried out under Article 6 of the Habitats Directive.

- The Cork Great Island North Channel Pollution Reduction Programme (DEHLG, 2010) should be implemented. This programme is aimed at meeting the requirements of the Shellfish Directive (2006/113/EC). A number of measures are set out in this programme to address the issues affecting shellfish waters and these measures would have a positive effect on the mudflats of the Great Island Channel SAC.
- A number of water management practices are already in place by Cork County Council, and these should continue to be implemented, e.g., continued implementation of the regulation of the Water Services (Amendment) Act 2012, which requires the registration and inspection of all on-site septic tanks or domestic wastewater treatment plants; and continued implementation and enforcement of the Nitrates Directive (91/676/EEC) in order to protect surface waters from pollution emanating from agricultural sources.

The above measures will also have a positive effect on the 1330 Atlantic salt meadows habitat as possible detrimental effects on pioneer saltmarsh communities from excessive green algae growth resulting from eutrophication will be reduced.

4.4.2 Spartina *management*

Spartina invasion is of some concern for the condition of both the 1140 Mudflats and sandflats and the 1330 Atlantic salt meadows habitats in the SAC. Extensive *Spartina* flats exist in Belvelly Channel in particular, where both of these Annex I habitats have been recorded during the current survey. As discussed above, the threat posed by *Spartina* invasion is a topic for some debate, the advantages and disadvantages of the plant discussed by McCorry *et al.* (2003) and Hammond (2001). It has also been noted above that there is anecdotal and photographic evidence that *Spartina* has actually declined in cover over the last few decades in some parts of the Great Island Channel SAC, at Bawnard, and there is a possibility that *Spartina* die-back may be occurring here. Control or elimination of *Spartina* is an expensive and labour-intensive option that requires sustained effort for success; it may also introduce new problems (McCorry *et al.,* 2003). The following recommendation is made with regard to *Spartina* in the SAC:

- to map the current extent of *Spartina* as accurately as possible (particularly at Belvelly), using sub-metre GPS mapping, permanent markers, aerial photography, or a combination of these methods;
- to monitor the change in extent (increase or decrease) of these existing *Spartina* populations on a 3-yearly basis;
- to record any new populations of *Spartina* that are establishing, and to monitor them on a 3-yearly basis;

- to adhere to the conservation objective for the SAC that states that there should be no significant expansion of *Spartina* into new areas within the SAC, and an annual spread of less than 1% where it is already known to occur.

4.4.3 Increasing the area of Annex I 1330 Atlantic salt meadows

As current structure and functions of the saltmarsh habitat are otherwise generally favourable, apart from the area at Bawnard where coastal squeeze is occurring, and damaging impacts in general are either low or addressed by remedies for improving the conservation status of 1140 Mudflats and sandflats, the best additional measures for restoring favourable conservation status for saltmarsh habitats in the SAC should take the form of creating new saltmarsh habitat to compensate for on-going losses due to coastal squeeze, and past losses due to road construction. Recent habitat surveys in the Great Island Channel SAC, including the current one, show that the area of saltmarsh in the SAC is relatively restricted and patchy. Boorman (2003) noted the important role played by saltmarshes in flood defence as they absorb and dissipate high wave energy during storms, while retaining deposited material for later accretion elsewhere, either on saltmarsh or mudflats. The wider the saltmarsh, the greater the protection it affords, with the scale of constructed coastal defences being reduced proportionally. Boorman (2003) cites an example in Essex of a seawall of 3 m being sufficient protection where saltmarsh of 80 m wide is present on the seaward side, the seawall height having to increase to 5 m if only 30 m of saltmarsh were present, and to 12 m if no saltmarsh were present. Given the recent increase in frequency of extreme weather events and storm surges, saltmarsh buffers could provide critical additional protection, although due to the physical configuration of the SAC, such extensive swathes of saltmarsh are unlikely to be creatable, and more modest targets should be set.

Sourcing suitable areas for saltmarsh recreation must not be at the expense of other Annex I habitats, particularly 1140 Mudflats and sandflats. Non-Annex habitats such as improved agricultural grassland could be suitable, depending on the accessibility of natural tidal processes. A number of potential areas exist:

- At Bawnard, a system of managed retreat could be implemented, in which the seawall is moved landwards and the saltmarsh allowed to develop further in a landward direction. It should be noted, however, that the area on the landward side of the seawall is not within the SAC. At Bawnard also, there may be potential for managing the saltmarsh and transitional habitat at the north-eastern section of the site, with a view to favouring the development of the transitional habitat to saltmarsh.
- At Harpers Island, grassland is already in the process of transition to saltmarsh. This area could be left to develop fully to saltmarsh naturally and monitored to assess the changes that are taking place; or more active intervention, in the form of reflooding and physically reconfiguring the area to introduce a slope (the island is currently very flat) and thus enhance conditions for the development of zoned saltmarsh vegetation, could be implemented and its progress monitored by the use of the assessment criteria already in place for 1330 Atlantic salt meadows. The plan for this area is to be converted to a BirdWatch Ireland bird-watching facility, making use of and enhancing the site's existing popularity as a roosting and feeding site for birds, especially wintering wildfowl such as Black-tailed Godwit (*Limosa limosa*) (Wilson, 2011). Allowing the development of Annex I saltmarsh would not be in conflict with this plan, and should serve to enhance the value of the area for wintering wildfowl.
- At Slatty Bridge, there is improved agricultural grassland adjacent to the mudflats and tidal inlet, which may be suitable for conversion to a small area of saltmarsh (some of these areas are likely to have been saltmarsh in the past). There is already an area of brackish reed swamp to the

north. However, changes here would be dependent on the operation of the sluice gates in Slatty Bridge.

It would be expected that such habitat restoration would also have positive repercussions for compliance with the Water Framework Directive in the SAC.

A large project to convert hundreds of hectares of non-saltmarsh habitat into new saltmarsh and wetland habitats has been ongoing for a number of years in the Steart Peninsula of Somerset (http://steart.wwt.org.uk), with benefits expected for wildlife and flood defences in the area. First proposed in 2009, works began in 2012, and the area is expected to be opened up to the sea in autumn 2014. This project, though of a greater scale than would be required in Cork, is a useful blueprint for a similar project here.

4.4.4 Monitoring

In terms of monitoring of the Annex I habitats in the Great Island Channel SAC, the following general recommendations are made:

- Where no major impacts are operating on the Annex I habitat, a monitoring frequency in accordance with the requirements for Habitats Directive Article 17 reporting, i.e., every 6 years, is sufficient. For Annex I Mudflats and sandflats, monitoring of water quality (as currently carried out by the EPA) and of intertidal invertebrate communities should be conducted. For Annex I 1330 Atlantic salt meadows, the monitoring methodology used by the SMP, with additional criteria listed in the site-specific conservation objectives, should be used.
- Where management is required to address impacts, monitoring should be carried out after the first year following the management change, and every 3 years thereafter.
- If a new impact is introduced into the SAC, appropriate management should be introduced, if possible, and monitoring should be carried out after the first year following the introduction of the impact, and every 3 years thereafter, until the impact is mitigated.

4.5 Prospects for recovery of features of interest

With the removal of inputs of nutrients to the Great Island Channel SAC through the implementation of the required changes, the functioning of the 1140 Mudflats and sandflats will recover. The time for this recovery will depend on a number of factors including the time for nutrients to be removed from the system through natural processes and the availability of areas that continue to support the characteristic species of the mudflats within the SAC to allow recolonisation nearby. It is not possible to put a timeframe on this due to the highly complex nature of nutrient cycles in marine sediments, particularly in estuaries, where nutrients settling in fine sediment can remain until physical or biological disturbance releases them back into the water column to make them available for use by primary producers or to be flushed from the system.

The situation for saltmarsh restoration is less certain, as saltmarsh creation processes are complex. At Harpers Island, there is a good chance of success as saltmarsh vegetation is already present, and regular monitoring should help to detect any issues with relation to its development. Saltmarsh development, however, depends on a number of factors, such as sediment deposition, tidal movements and wave action, and these are highly site-specific. As such, it is difficult to set targets or project time frames until the sedimentary and tidal processes operating at those specific sites are known. In all cases of restoration, regular monitoring is essential, both to monitor progress and to document the processes that are occurring. This is important both for determining future management actions and as a research and academic exercise, to elucidate the processes of saltmarsh creation.

5 Conclusions

5.1 1140 Mudflats and sandflats

- Current condition: *Unfavourable – Bad*.
- Prospects of recovery: Good, if recommendations are followed.
- Main issues: pollution, *Spartina* invasion.
- Main management recommendations:
    - Adherence to statutory and EU regulations regarding water quality, e.g. Urban Waste Water Treatment Directive, Water Framework Directive;
    - Continued monitoring of water quality in the SAC;
    - Monitoring of *Spartina* populations in the SAC.
- The conservation status of 1140 Mudflats and sandflats will not be compromised by the population targets of the Draft Cork County Development Plan once the proposed upgrades to the WWTPs are in place in advance of any population increase, and provided that on-going monitoring is carried out to track any changes in the water quality of the discharges and surface water; this will ensure that treatment systems are operating effectively and the licensed Emission Limit Values continue to be set at an appropriate level. The upgrading of water treatment facilities in the vicinity of the Great Island Channel SAC does not negate the need for on-going monitoring of the mudflats to ensure that favourable conservation status is being reached / maintained, and to ensure that water quality standards are likewise being adhered to. If monitoring detects a failure of water quality standards which causes a deviation from favourable conservation status of the 1140 Mudflats and sandflats, further management measures may be required to ensure that favourable conservation status is restored to the Annex I habitat.

5.2 1330 Atlantic salt meadows

- Current condition: *Unfavourable – Inadequate*.
- Prospects of recovery: Fair-Good, if recommendations are followed; time frame uncertain due to complexity of processes involved and insufficient data on the physical sedimentary and tidal processes in the SAC.
- Main issues: coastal squeeze, *Spartina* invasion, erosion.
- Main management recommendations:
    - Creation of new areas of saltmarsh habitat;
    - Monitoring of *Spartina* populations in the SAC.

6 References

Aquafact (2006) *A survey of intertidal mudflats and sandflats in Ireland*. Report to National Parks and Wildlife Service, Dublin, Ireland.

O'Donoghue, P. (2008) Blarney Electoral District Habitat Survey & Mapping 2008.

O'Donoghue, P., Gittings, T., O'Hora, K. & Delaney, E. (2009) Midleton Electoral District Habitat Survey & Mapping 2009.

Boorman, L. A (2003) *Saltmarsh review: an overview of coastal saltmarshes, their dynamic and sensitivity characteristics for conservation and management*. JNCC Report, No. 334. JNCC Peterborough, UK.

CEC (Commission of the European Communities) (2013) *Interpretation manual of European Union habitats.* EUR 28. European Commission, DG Environment.

Curtis, T.G.F., 2003. Salt marshes. *In:* Otte, M.L. (Ed.) *Wetlands of Ireland. Distribution, ecology, uses and economic value*. UCD Press, Dublin, pp. 31-43.

Curtis, T.G.F. & Sheehy Skeffington, M. (1998) The saltmarshes of Ireland: an inventory and account of their geographical variation. *Biology and Environment, Proceedings of the Royal Irish Academy* **98B**, 87-104.

Davies, J., Baxter, J., Bradley, M., Connor, D., Khan, J., Murray, E., Sanderson, W. Turnbull, C. & Vincent, M. (2001) *Marine Monitoring Handbook*. Joint Nature Conservation Committee. ISBN 1861075243.

DEHLG (2010) Cork Great Island North Channel Pollution Reduction Programme. Prepared by the Department of the Environment, Heritage and Local Government, Dublin, Ireland.

EPA (2014) Envision mapper – Surface Water Quality. Accessed at http://gis.epa.ie/Envision on 06/06/2014. Environmental Protection Agency, Wexford, Ireland.

Evans, D. & Arvela, M. (2011) *Assessment and reporting under Article 17 of the Habitats Directive. Explanatory notes & guidelines for the period 2007-2012.* European Topic Centre on Biological Diversity. Paris, France.

Folk (1954) The distinction between grain size and mineral composition in sedimentary-rock nomenclature. *The Journal of Geology* **62(4)**, 344-359.

Fossitt, J.A. (2000) *A Guide to Habitats in Ireland*. The Heritage Council, Kilkenny.

JNCC (Joint Nature Conservation Committee) (2004). Common Standards Monitoring Guidance for Saltmarsh Habitats (August 2004 version) ISSN 1743-8160 (online).

McCorry, M.J., Curtis, T.G.F. & Otte, M.L., 2003. *Spartina* in Ireland. *In:* Otte, M.L. (Ed.) *Wetlands of Ireland. Distribution, ecology, uses and economic value*. UCD Press, Dublin, Ireland, pp. 44-50.

McCorry, M.J & Ryle, T. (2009) *Saltmarsh Monitoring Project 2007-2008: Final report*. Report to National Parks and Wildlife Service, Dublin, Ireland.

MERC (2012) Intertidal Benthic Survey of Great Island Channel SAC and Cork Harbour SPA. Unpublished report for the Marine Institute.

Mott MacDonald Ireland (2010) Background document to the Programme of Measures: Discharges from Urban Waste Water Treatment Plants.

NPWS (2014a) Conservation Objectives for Great Island Channel SAC. (Version 1, June 2014.) Department of Arts, Heritage and the Gaeltacht.

NPWS (2014b) Great Island Channel SAC (site code 1058) Conservation Objectives supporting document – coastal habitats (Version 1, May 2014).

NPWS (2014c) Great Island Channel SAC (site code 1058) Conservation Objectives supporting document – marine habitats (Version 1, May 2014).

NPWS (2013) *The status of EU protected habitats and species in Ireland. Habitat assessments.* Volume 2. Version 1.1. Unpublished report, National Parks and Wildlife Service. Department of Arts, Heritage and the Gaeltacht, Dublin, Ireland.

O'Neill, F.H. & Barron, S.J. (2013) Results of monitoring survey of old sessile oak woods and alluvial forests. *Irish Wildlife Manuals*, No. 71. National Parks and Wildlife Service, Department of Arts, Heritage and the Gaeltacht, Dublin, Ireland.

O'Neill, F.H., Martin, J.R., Devaney, F.M. & Perrin, P.M. (2013) The Irish Semi-natural Grasslands Survey 2007-2012. *Irish Wildlife Manuals,* No. 78. National Parks and Wildlife Service, Department of Arts, Heritage and the Gaeltacht, Dublin, Ireland.

McGarrigle, M., Lucey, J. & Ó Cinnéide, M. (2010) Water Quality in Ireland 2007-2009. Environmental Protection Agency, Wexford, Ireland.

Perrin, P.M., Devaney, F.M., McCorry, M.J., Roden, C., Sheehy Skeffington, M.J. & Wymer, E.D. (in prep.). Fuzzy analysis of saltmarsh vegetation in Ireland.

Perrin, P.M., Martin, J.R., Barron, S.J., O'Neill, F.H., McNutt, K.E. & Delaney, A. (2008) National Survey of Native Woodlands 2003-2008: Volumes I and II. Unpublished report for National Parks and Wildlife Service, Dublin.

Preston, C.D., Pearman, D.A. & Dines, T.D. (eds.) (2002) *New Atlas of the British and Irish Flora*. Oxford University Press, Oxford, UK.

Ryle, T., Murray, A., Connolly, C. & Swann, M. (2009). Coastal Monitoring Project 2004-2006. Unpublished Report for National Parks and Wildlife Service, Dublin.

Ssymank, A. (2010) Reference list Threats, Pressures and Activities (final version). http://bd.eionet.europa.eu/activities/Natura_2000/Folder_Reference_Portal/Ref_threats_pressures_FINAL_20110330.xls. Accessed July 2013.

Toner, P., Bowman, J., Clabby, K., Lucey, J., McGarrigle, M., Concannon, C., Clenaghan, C., Cunningham, P., Delaney, J., O'Boyle, S., MacCárthaigh, M. & Quinn, R. (2005). *Water Quality in Ireland 2001-2003*. Environmental Protection Agency, Wexford, Ireland.

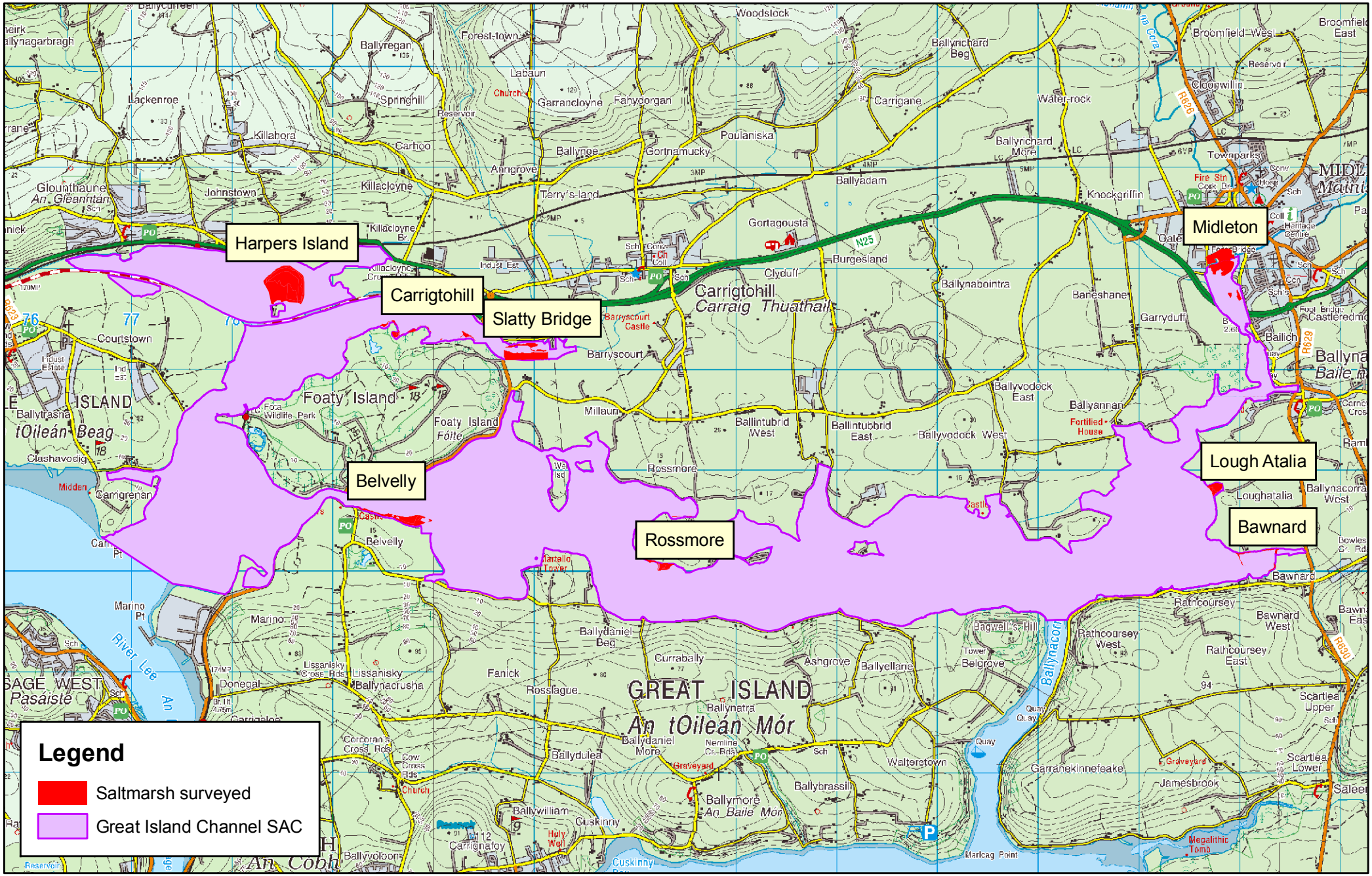
Wilson, J. (2011) Species focus: Black-tailed godwit. *Wings*, Autumn 15-17.

Map 1. Transect and sample point locations in the Great Island Channel SAC (2014).

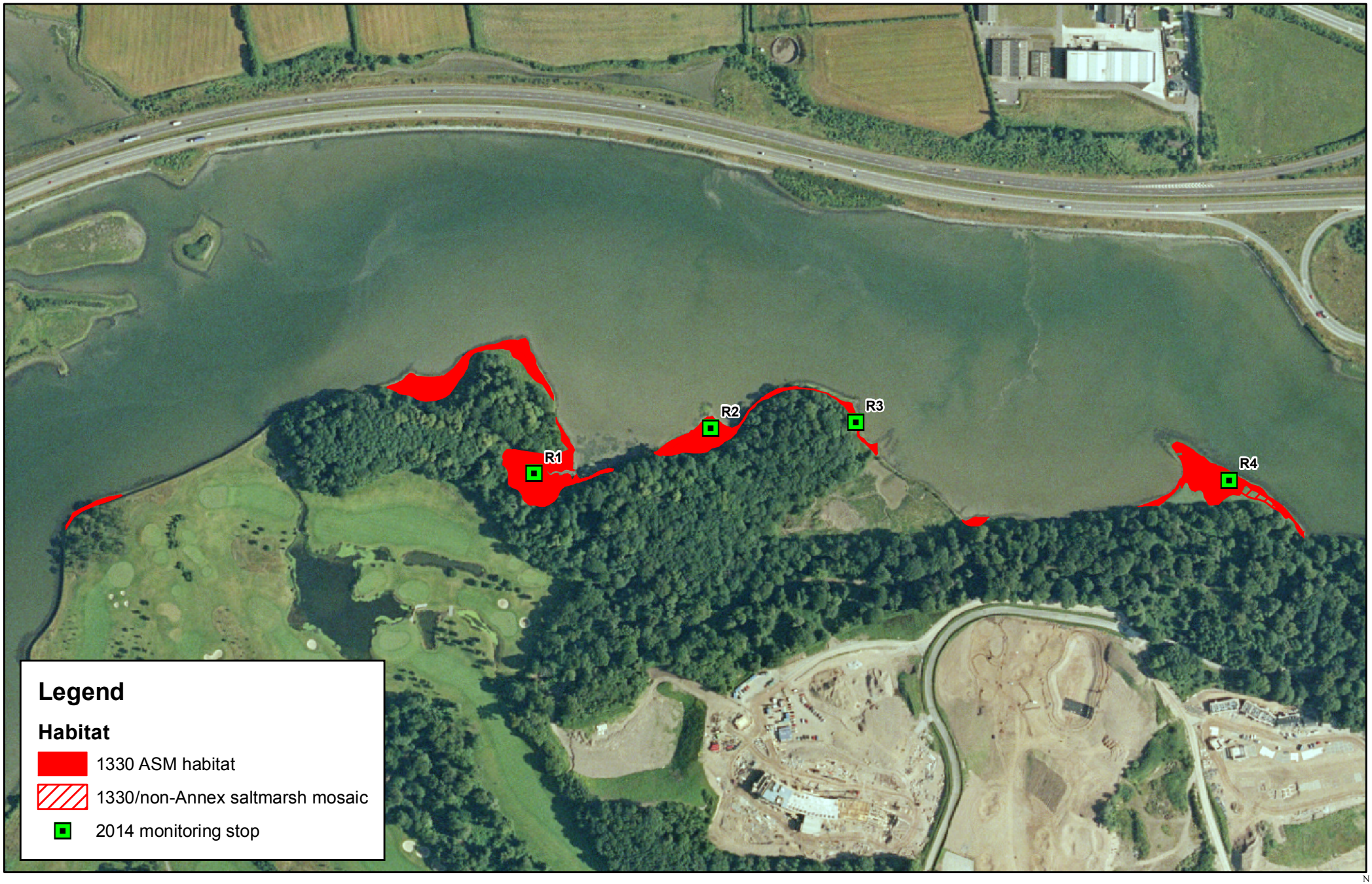
0.25 0.125 0 0.25 0.5 0.75 1 Kilometers

N

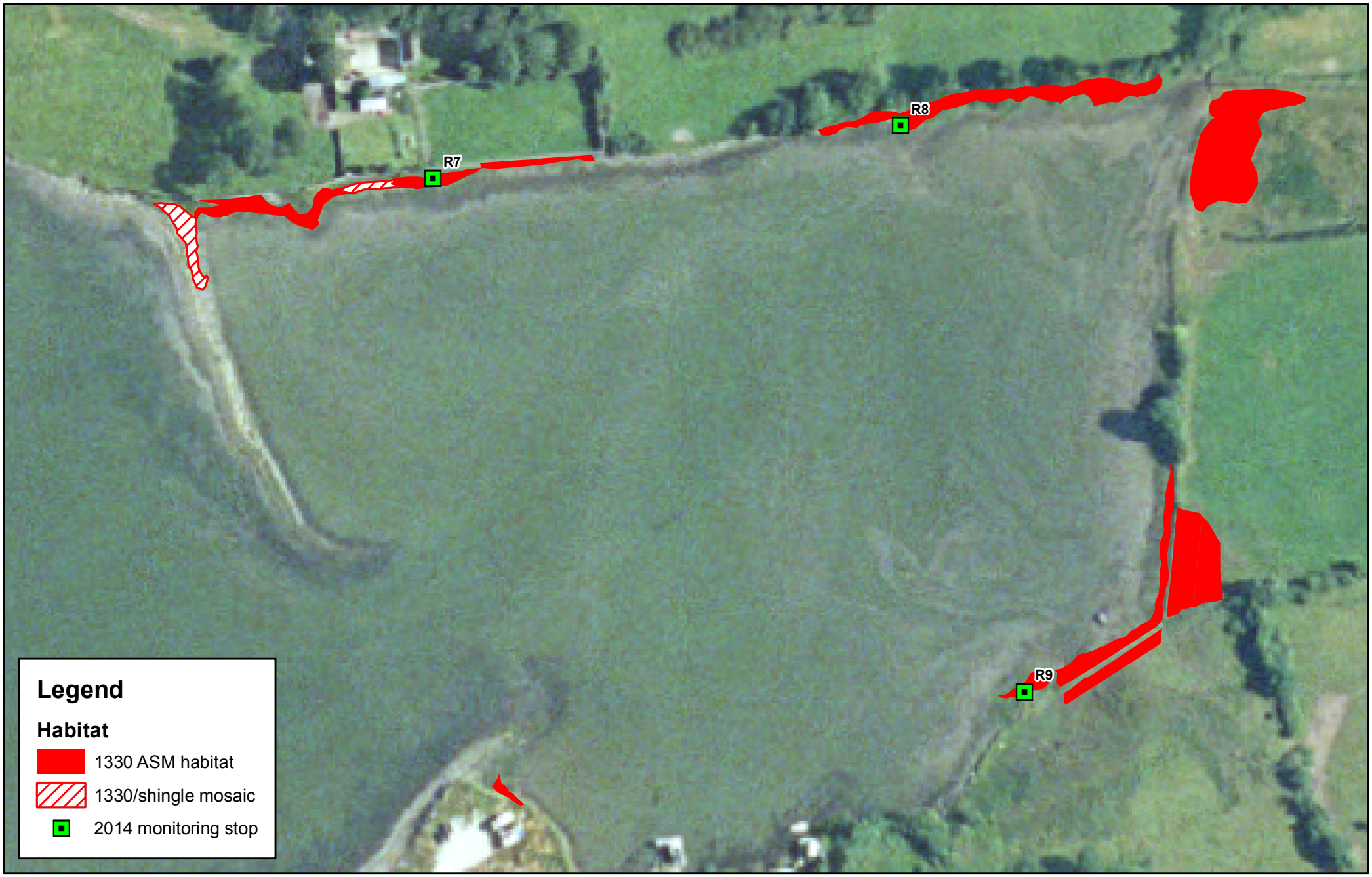
Map 2. Location of saltmarsh sites surveyed in the Great Island Channel SAC (2014).



Map 3. Annex I 1330 Atlantic Salt Meadows at Carrigtohill.



Map 4. Annex I 1330 Atlantic Salt Meadows at Bawnard.



25 12.5 0 25 50 75 100 Meters

N

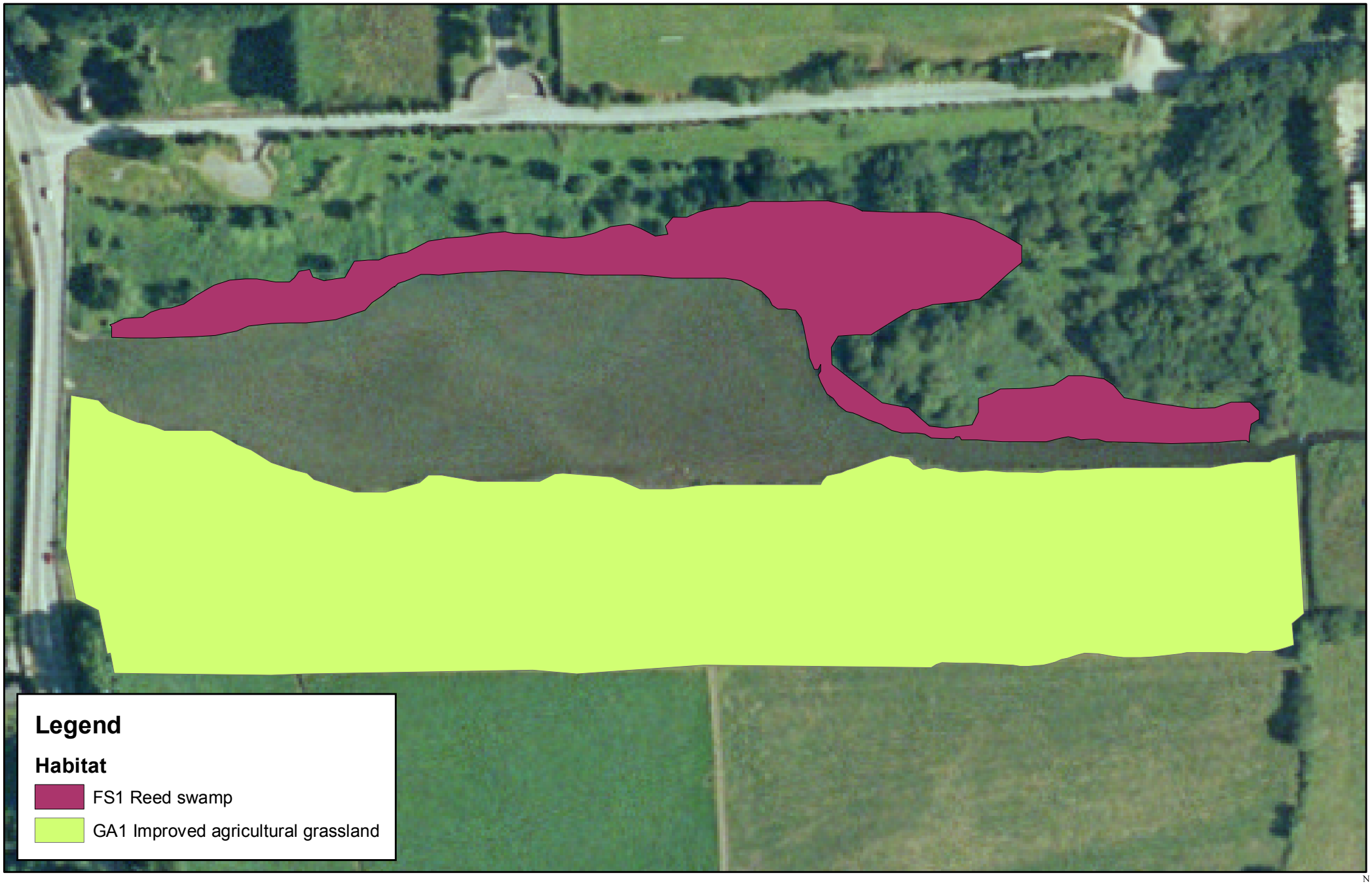
Map 5. Annex I 1330 Atlantic Salt Meadows and other habitats at Lough Atalia.

Map 6. Habitats at Harpers Island.

25 12.5 0 25 50 75 100
Meters

N

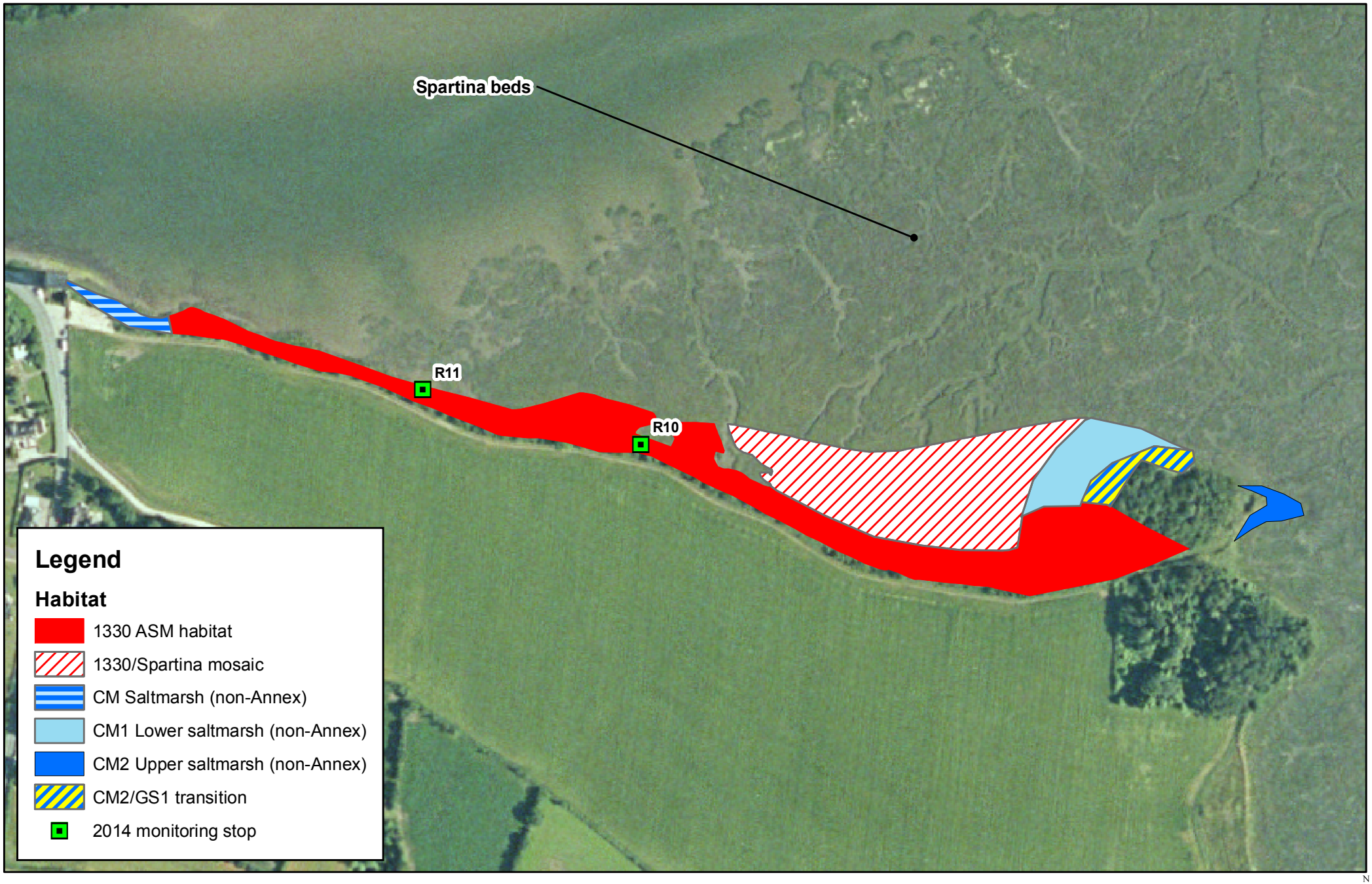
Map 7. Habitats at Slatty Bridge.



25 12.5 0 25 50 75 100 Meters

N

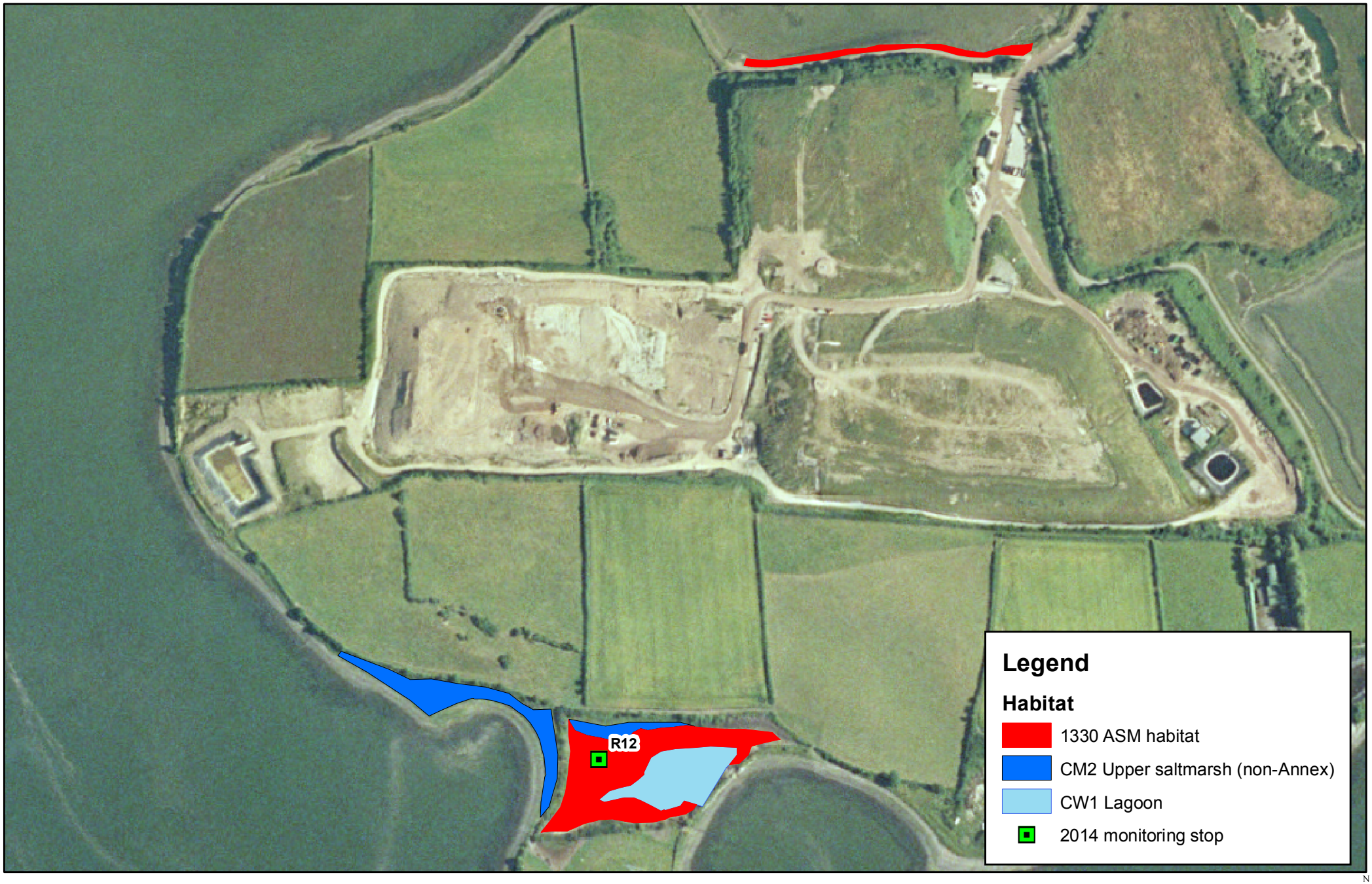
Map 8. Annex I 1330 Atlantic Salt Meadows and other habitats at Belvelly.



25 12.5 0 25 50 75 100
Meters

N

Map 9. Annex I 1330 Atlantic Salt Meadows and other habitats at Rossmore.



Map 10. Annex I 1330 Atlantic Salt Meadows and other habitats at Midleton.

25 12.5 0 25 50 75 100
Meters

N

Appendix I: Biotopes

LS.LMu.UEst.Hed.Str
***Hediste diversicolor* and *Streblospio shrubsolii* in littoral sandy mud**

Biotope description

Mud and sandy mud shores in sheltered marine inlets and estuaries subject to variable or reduced salinity. The biotope is typically found on the mid and lower shores and is often associated with shallow layers of cobbles and pebbles in the sediment in the upper and mid estuary. The sediment is anoxic close to the surface and remains water saturated during low tide. The infaunal polychaete community is dominated by dense *Hediste diversicolor*, as well as species with a limited salinity range tolerance such as *Streblospio shrubsolii* and *Manayunkia aestuarina*. Oligochaetes, including *Heterochaeta costata* and *Tubificoides benedii,* are often abundant, and the amphipod *Corophium volutator* is often common.

LS.LMu.MEst.HedMacScr
***Hediste diversicolor*, *Macoma balthica* and *Scrobicularia plana* in littoral sandy mud**

Biotope description

Mainly mid shore mud or sandy mud subject to variable salinity on sheltered estuarine shores. Typically, the sediment is wet in appearance and has an anoxic layer below 1 cm depth. The surface of the mud has the distinctive 'crow's foot' pattern formed by the peppery furrow shell *Scrobicularia plana*. The infauna is additionally characterised by a range of polychaete and bivalve species, including the ragworm *Hediste diversicolor*, *Pygospio elegans*, *Streblospio shrubsolii*, *Tharyx killariensis* and the baltic tellin *Macoma balthica*. Oligochaetes, most notably *Tubificoides benedii*, and the spire shell *Hydrobia ulvae* may be abundant. Other species that sometimes occur in this biotope are the cockle *Cerastoderma edule*, the sand gaper *Mya arenaria* and the polychaetes *Eteone longa* and *Nephtys hombergii*.

Appendix II: Relevé (assessment stop) data

Relevé (Stop)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Site	**Carrigtohill**	**Carrigtohill**	**Carrigtohill**	**Carrigtohill**	**Lough Atalia**	**Lough Atalia**	**Bawnard**	**Bawnard**	**Bawnard**	**Belvelly**	**Belvelly**	**Rossmore**
Link with SMP	SMP stop 4	SMP stop 2	SMP stop 3	SMP stop 1	-	-	SMP stop 4	SMP stop 3	SMP stop 1	-	-	-
Date recorded	14/5/2014	14/5/2014	14/5/2014	14/5/2014	14/05/2014	14/05/2014	14/05/2014	14/05/2014	14/05/2014	16/05/2014	16/05/2014	16/05/2014
Grid code	W 79618 72351	W 79801 72398	W 79951 72404	W 80338 72344	W 87760 70776	W 87718 70826	W 88078 70190	W 88248 70206	W 88292 70005	W 79584 70543	W 79452 70576	W 82264 70055
Hab_type	CM1	CM1	CM1	CM2	CM2	CM2	CM2	CM1	CM1	CM1	CM1	CM1
Annex_i	1330	1330	1330	1330	1330	1330	1330	1330	1330	1330	1330	1330
Substrate	Mud	Mud	Mud	Mud	Mud	Mud	Mud	Mud/shingle	Mud/shingle	Mud	Mud	Mud
Veg. height (cm)												
Herb	8	8	8	30	10	18	0	3	14	10	15	2
Grass	8	8	3	30	0	7	40	0	8	12	12	2
Shrub	9	13	8	18	5	27	38	9	10	0	0	5
% cover												
Bare ground	0	0	0	0	0	0	15	0	5	0	0	0
Plants	90	95	60	100	100	100	85	35	95	100	100	80
Forbs	65	80	55	40	100	40	0	1	65	100	80	30
Algae	0	3	60	0	10	10	5	80	15	0	0	35
Leaf litter	10	3	1	0	0	1	3	5	0	0	1	0
Plant species												
Agrostis stolonifera	.	.	.	.	.	.	.	.	.	.	0.3	.
Armeria maritima	.	.	.	.	35	15	.	.	.	1	.	.
Aster tripolium	20	0.1	.	0.7	5	0.7	.	.	1	3	15	.
Atriplex portulacoides	.	.	.	.	.	50	0.01	.	.	.	.	25
Atriplex prostrata	0.7	.	.	0.1	.	.	.	.	.	.	0.3	.
Cochlearia officinalis	35	.	0.3	0.7	0.5	0.7	.	.	3	.	0.1	.
Festuca rubra	.	.	.	40	.	0.5	.	.	.	.	.	.

Relevé (Stop)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Site	**Carrigtohill**	**Carrigtohill**	**Carrigtohill**	**Carrigtohill**	**Lough Atalia**	**Lough Atalia**	**Bawnard**	**Bawnard**	**Bawnard**	**Belvelly**	**Belvelly**	**Rossmore**
Glaux maritima	45	80	55	0.1	.	0.7	.	.	10	80	60	.
Juncus gerardii	.	.	.	.	0.3	.	.	.	.	5	.	.
Limonium humile	20	30	10	0.5	7	15	0.01	35	35	.	.	0.3
Plantago maritima	.	.	0.3	40	65	15	.	.	7	60	0.5	.
Puccinellia maritima	55	35	40	40	.	.	5	.	10	.	55	25
Salicornia species	.	.	0.5	.	0.3	.	.	.	.	.	.	.
Spartina anglica	.	.	.	.	.	.	80	0.1	.	.	0.1	.
Spergularia media	.	.	.	.	.	.	.	0.7	.	.	.	1
Suaeda maritima	7	15	1	.	.	.	.	0.1	.	.	.	15
Triglochin maritimum	.	.	.	.	0.3	10	.	.	20	20	3	.
No. of species	*7*	*5*	*7*	*8*	*8*	*9*	*4*	*5*	*7*	*6*	*9*	*6*

Appendix III: Scientific/English names of plants recorded.

Names are according to Preston *et al*. (2002)

Scientific name	**English (Common) name**
Agrostis stolonifera	Creeping bent
Armeria maritima	Thrift
Aster tripolium	Sea aster
Atriplex portulacoides	Sea-purslane
Atriplex prostrata	Spear-leaved orache
Bellis perennis	Daisy
Beta vulgaris ssp. *maritima*	Sea beet
Calystegia sepium	Hedge bindweed
Cardamine pratensis	Cuckooflower
Carex otrubae	False fox-sedge
Cochlearia officinalis agg.	Common scurvygrass
Elytrigia repens	Common couch
Epilobium hirsutum	Great willowherb
Festuca rubra	Red fescue
Filipendula ulmaria	Meadowsweet
Galium aparine	Cleavers
Glaux maritima	Sea-milkwort
Holcus lanatus	Yorkshire fog
Iris pseudacorus	Yellow iris
Juncus gerardii	Saltmarsh rush
Oenanthe crocata	Hemlock water-dropwort
Limonium humile	Lax-flowered sea lavender
Plantago maritima	Sea plantain
Poa pratensis	Smooth meadow-grass
Potentilla anserina	Silverweed
Puccinellia maritima	Common saltmarsh-grass
Rumex crispus	Curled dock
Salicornia sp.	Glasswort
Schoenoplectus tabernaemontani	Grey club-rush
Bolboschoenus maritimus	Sea club-rush
Solanum dulcamara	Bittersweet
Spartina anglica	Common cord-grass
Spergularia media	Greater sea-spurrey
Suaeda maritima	Annual sea-blite
Triglochin maritimum	Sea arrowgrass
Urtica dioica	Common nettle

Appendix IV: Plates

Photograph showing extent of Annex I habitat 1140 Mudflats and sandflats habitat at Belvelly (Transect 1)

Spartina invasion of Annex I mudflat and saltmarsh habitats at Belvelly

Armerion-type Annex I 1330 Atlantic salt meadows community at Lough Atalia

Puccinellion-type Annex I 1330 Atlantic salt meadows community at Lough Atalia with *Atriplex portulacoides* shrub and *Puccinellia maritima* saltmarsh grass

Non-annex saltmarsh developing at Harpers Island. Bleached green algae visible in fore- and mid-ground

Saltmarsh vegetation at Harpers Island (*Salicornia* sp., *Suaeda maritima, Atriplex prostrata, Potentilla anserina*)

Coastal squeeze and disturbance of Annex I 1330 Atlantic salt meadows at Bawnard

Pioneer 1330 Atlantic salt meadows at Rossmore

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