Article 6 Assessment of Aquaculture and Fisheries in Inner Donegal Bay SAC (Murvagh, 0133), SPA (Donegal Bay, 004151), SPA (Durnesh Lough, 004145)

Annex II

Assessment of Aquaculture and Fisheries in Donegal Bay (004151) and Durnesh Lough (004145) SPAs

Notice

Document History

JOB NUMBER: RK2927			DOCUMENT REF: 2927Dg12_Donegal Bay AA_Rev0.doc			
0	Draft for Comment	TG & PO'D	TG	PO'D	JN	2-7-2013
1	Final	TG & PO'D	TG	PO'D & OT (MI)	JN	4-7-2013
Revision	Purpose Description	Originated	Checked	Reviewed	Authorised	Date

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Executive Summary

This report contains the Appropriate Assessment of aquaculture and risk assessment of fisheries on the Donegal Bay Special Protection Area (site code 004075). Durnesh Lough SPA (site code 004145) is also considered in this report, because of its close proximity to the Donegal Bay SPA, and the potential interchange of birds between the two SPAs.

The assessment is based on a desktop review of existing information, combined with the results of a short study of Light-bellied Brent Goose and Sanderling distribution and habitat usage carried out for this assessment (the trestle watch study). Where relevant, it identifies information gaps that may affect the reliability of the conclusions of this assessment.

Limitations to this assessment

The existing information on waterbird distribution within Donegal Bay, from the Irish Wetland Bird Survey (I-WeBS) and the National Parks and Wildlife Service Baseline Waterbird Survey (NPWS BWS) is of variable quality and resolution. Some additional data collected by local NPWS staff was also available and allowed us to compare as appropriate against the NPWS BWS data.

The only systematic information available on low tide distribution is limited to four low tide counts in the winter of 2009/10.

The precise nature of the response of Light-bellied Brent Goose appears to be complex, and may vary seasonally and with levels of disturbance. The results of a separate trestle watch study provides detailed data for the late winter period, but we do not have any comparable data for the autumn and early winter; here we are more reliant on our understanding of the species behaviour and feeding ecology.

The assessment of cumulative impacts provides a general assessment of issues such as recreational impacts, but without detailed information on other activities a precise quantification of these potential impacts is outside the scope of this assessment. General comments are, however, included as appropriate.

Methodology

For the purposes of analysing waterbird distribution for this assessment, the subsites used for waterbird monitoring have been grouped into three broad zones: the Inner Bay (the area enclosed by the Murvagh peninsula, and also including the Eddrim Estuary), the Outer Bay (the area from Doorin Point to Rossnowlagh), and the Southern Bay (Creevy Pier-Bundoran).

Three broad habitat zones have been defined for this assessment: intertidal, shallow subtidal (< 0.5 deep) and deep subtidal (> 0.5 m deep).

Most of the analyses of the likely impacts of activities covered in this assessment are based on assessment of spatial overlap between the SCI species distribution and the spatial extent of the activities. These assessments focus on distribution patterns of feeding, or potentially feeding birds, as the main potential impacts will be to the availability and/or quality of feeding habitat, although we have included assessment of potential impacts on roosting birds, where relevant.

The methodology used to identify potentially significant impacts is focused on the Conservation Objectives, and their attributes, that have been defined and described for the Donegal Bay SPA. Impacts that will cause displacement of 5% or more of the total Donegal Bay population of a SCI species have been assessed as potentially having a significant negative impact.

Conservation objectives

The Special Conservation Interests (SCIs) of the Donegal Bay SPA include non-breeding populations of Light-bellied Brent Goose, Common Scoter, Great Northern Diver and Sanderling. The conservation objectives for these species are to maintain their favourable conservation condition, which are defined by

there being stable or increasing long-term population trends and no significant decrease in numbers or range of areas used within Donegal Bay.

The wetland habitats within the Donegal Bay SPA and the waterbirds that utilise this resource are an additional SCI (the wetlands and waterbirds SCI). The conservation objective for this SCI is to maintain its favourable conservation condition, which is defined by there being no significant decrease in the permanent area occupied by wetland habitats.

The SCIs of the Durnesh Lough SPA are the wintering populations of Whooper Swan and Greenland White-fronted Goose. The conservation objectives for the Whooper Swan and Greenland White-fronted Goose wintering populations at Durnesh Lough are to maintain or restore their favourable conservation condition, NPWS have not defined site-specific attributes and targets to define the favourable conservation condition of these species for this SPA.

Screening

Whooper Swan and Greenland White-fronted Goose were screened out from any further assessment because they do not have any significant spatial overlap with any of the activities being assessed.

For the purposes of this Appropriate Assessment, the broad habitat zones used by the remaining SCI species for feeding and/or roosting have been classified. The activities covered in this assessment can generally be broken down into components that affect intertidal/shallow subtidal and deep subtidal habitat zones separately. SCI species that are not associated with a habitat zone have been screened out from assessment of activity components affecting that habitat zone.

The Conservation Objectives define the favourable conservation condition of the wetlands and waterbirds SCI at Donegal Bay purely in terms of habitat area. None of the activities being assessed will cause any change in the permanent extent of wetland habitat. Therefore, the activities being assessed are not likely to have any significant impact on this SCI and it has been screened out from any further assessment.

Waterbird status and distribution

The only SCI species in the Donegal Bay SPA with an unfavourable conservation condition is Great Northern Diver. Both Light-bellied Brent Goose and Sanderling have shown substantial increases in their population indices over the monitoring period. However, for Sanderling, poor coverage in some years of the long-term dataset and a resulting relatively high level of data imputation during the indexing and trend analysis leads to some caution being necessary when examining the trend for this species, and the apparent increase in recent winters may be an artefact of increased coverage.

The four SCI species mainly occur within the Outer and Southern Bay zones of Donegal Bay. Light-bellied Brent Goose and Great Northern Diver do regularly occur within the Inner Bay zone, but usually in small numbers. Common Scoter and Sanderling occur almost entirely within the Outer Bay zone, apart from the Inner Bay Eddrim Estuary subsite in which Sanderling do regularly occur.

Suspended oyster culture

The existing and proposed suspended oyster cultivation in Donegal Bay all involves bags and trestles in the intertidal and shallow subtidal zones. Within the Donegal Bay SPA there are currently 17 plots licensed for intertidal oyster culture and 11 applications covering a total area of 99 ha. In addition, there are two plots with Fishery Orders, covering a total area of 30 ha. Most of the licensed plots and one of the Fishery Order areas contain blocks of oyster trestles. The other Fishery Order area (in the Murvagh NE subsite) is not, and has never been, active, and was not considered further in this assessment.

Suspended oyster culture causes a significant physical alteration to the structure of intertidal and subtidal habitat through the placement of physical structures (oyster trestles) in the habitat and may also cause impacts to benthic invertebrates through sedimentation, eutrophication and compaction. It may also cause impacts to waterbirds through disturbance associated with husbandry activities. The main area of intertidal oyster cultivation is in the Mountcharles subsite, with additional areas in various subsites in the Inner Bay. The intertidal zone of the Mountcharles subsite north of the main tidal channel forms an ecological unit with

the Eddrim Estuary that is physically discrete from other significant areas of intertidal sandflats, and these areas (collectively referred to as the Mountcharles/Eddrim Estuary area) have been considered together in analysing waterbird distribution in the following assessments.

Light-bellied Brent Goose

Light-bellied Brent Goose regularly occur within the Mountcharles/Eddrim Estuary area, where the main concentration of intertidal oyster cultivation applications and licenses occur. They occur less frequently in the Inner Bay zone where most of the remaining intertidal oyster cultivation applications and licenses occur.

Oyster trestles appear to be an attractive habitat for Light-bellied Brent Goose in Donegal Bay, particularly in the autumn/early winter, although disturbance from aquaculture operations may limit their utilisation of the habitat at times. Even if it was the case that the negative impact from disturbance outweighed the positive impact, the overall impact would not be complete exclusion of Light-bellied Brent Goose from the trestle blocks, but rather reduced utilisation of the area occupied by the trestle blocks compared to the utilisation of this area before trestles were introduced. Therefore, it seems likely that intertidal oyster cultivation has an overall positive impact on Light-bellied Brent Goose and, even if the overall impact was negative, it is extremely unlikely to cause significant displacement impacts.

Sanderling

The pattern of distribution of the Sanderling flocks recorded in the trestle watch study of this assessment is suggestive of Sanderling avoiding the trestles, although, because of the low total number of observations of Sanderling flocks, the dataset does not have sufficient statistical power to demonstrate significant avoidance of the trestle blocks. However, previous work has also reported a negative association between Sanderling and intertidal oyster trestles (although this again was based on limited data), and it is reasonable to conclude from the weight of the evidence that Sanderling show more or less complete avoidance of oyster trestles.

Sanderling regularly occur within the Mountcharles/Eddrim Estuary area. The proportion of the Donegal Bay population that occur within this area at some point during the low tide period may be around 25%, although some flocks may only spend a short time within this area. Full occupation by trestles of the oyster licenses and applications within this area could potentially cause displacement of 5-10% of the Donegal Bay population, compared to the distribution that would be expected in the absence of any trestles.

Common Scoter and Great Northern Diver

The distribution of Common Scoter and Great Northern Diver in Donegal Bay does not show significant spatial overlap with main areas of suspended oyster cultivation licenses and applications.

Oyster bottom culture

Within the Donegal Bay SPA there is one application for oyster bottom culture (covering 31 ha) in subtidal waters in the Doorin Point-Salthill Pier subsite.

Bottom culture of oysters in subtidal waters is considered disturbing to the subtidal biotopes affected. Therefore, it could potentially have negative impacts on Common Scoter, which feeds on benthic invertebrates in deep subtidal waters. However, the oyster bottom culture plot does not appear to support significant numbers of Common Scoter. Therefore, oyster bottom culture in this plot will not cause significant displacement of Common Scoter.

It is considered unlikely that ongrowing of oysters in subtidal waters would impact negatively on fishes as the oysters, along with shell ‘hash’, provides a low relief habitat that will increase general heterogeneity in overall structure and which has been shown to increase diversity and abundance of fish species. Therefore, there are unlikely to be negative impacts on food resources for the mainly fish-eating Great Northern Diver.

Light-bellied Brent Goose only feed in shallow waters (e.g., just below the tideline) and the water depth within the oyster bottom culture plot (2-5 m) is too deep for it to be suitable feeding habitat for this species.

The relaying of the oysters and the stock movements during ongrowing also has the potential to cause disturbance impacts to Great Northern Diver and Common Scoter, as well as, possibly, roosting Light-bellied

Brent Goose. However, these activities will only occur for short periods of time, and will only affect limited areas of habitat at any one time, so any disturbance impacts will be of short duration and will not affect the availability of resources in this area. Therefore, there are no potentially significant disturbance impacts that are likely to arise from the ongrowing of oysters in subtidal waters.

Intertidal culture of sea urchins

There is a single application to ongrow young sea urchins in an area of intertidal and shallow subtidal pools east of Doorin Point. Small numbers of Common Scoter and Great Northern Diver are recorded using these coastal waters. However, it should be noted that intertidal sea urchin farming plots will only be available for use by Great Northern Divers and Common Scoter during the high tide period. Taking the above factors into account any sea urchin farming in these plots will not cause significant displacement of Great Northern Divers. No impacts on Sanderling are envisaged. While Light-bellied brent geese may occur the level of proposed activities will not cause significant impacts on or displacement of this species.

Fisheries

There are a number of ongoing fisheries which largely take place in Outer Donegal Bay in waters outside the SPA. These include pelagic trawling (herring & sprat); potting (lobster, edible crab, pink shrimp & Dublin bay prawn); draft netting for Atlantic salmon; line fishing (mackerel & squid) and mixed / *Nephrops* demersal trawling. These fisheries will not negatively impact upon use of intertidal habitats by Sanderling and Light-bellied Brent Geese. Furthermore, none of these fisheries target bivalve species which dominate the diet of Common Scoter. The limited extent of spatial and temporal overlap between these fisheries and both the over-wintering Common Scoter and Great Northern Diver is such that these fishery activities will not cause significant impacts on or displacement of the species for which Donegal Bay is designated. Although continued low biomass of herring and unlimited fishing for sprat may reduce suitability of Donegal SPA for Great Northern Diver the risk is regarded as low.

Cumulative impacts

This assessment considered the potential cumulative impacts of the combined effects of the three aquaculture activities covered in the assessment, and of the aquaculture activities in combination with other activities within the SPA (including beach recreation, hand collection of shellfish, bait digging, boat traffic, and effluent discharge).

There is no potential for the combined effects of the three aquaculture activities covered in this assessment to cause significant cumulative impacts.

If suspended oyster cultivation has an overall negative effect on Light-bellied Brent Goose, it is possible that the effects of beach recreation and/or shellfish gathering could, in combination with suspended oyster cultivation, cause a significantly greater impact than the impact of suspended oyster cultivation by itself. However, it seems likely that suspended oyster cultivation in Donegal Bay has an overall positive impact on Light-bellied Brent Goose.

There is potential for the combined effects of suspended oyster cultivation and beach recreation to cause cumulative impacts on Sanderling. However, evidence from the scientific literature indicates that recreational disturbance does not significantly affect the spatial distribution of waders on sandy beaches. Therefore, it seems unlikely that recreational disturbance is having significant impacts on the spatial distribution of Sanderling in Donegal Bay.

No other potentially significant cumulative impacts have been identified in this assessment.

1. Introduction

1.1 Atkins (Ecology) was commissioned by the Marine Institute to provide ornithological services in relation to the appropriate assessment of aquaculture and shellfisheries on coastal Special Protection Areas (SPAs).

1.2 This report contains the Appropriate Assessment of aquaculture on the Donegal Bay SPA (site code 004151) and a risk assessment of fishing activities in the Inner Bay. Durnesh Lough SPA (site code 004145) is also considered in this report, because of its close proximity to the Donegal Bay SPA, and the interchange of birds between the two SPAs. The boundaries of these two SPAs are shown in Figure 1.1.

1.3 As part of the preparation of this assessment, a need for further data on Light-bellied Brent Goose and Sanderling was identified, as previous work (Gittings and O'Donoghue, 2012) indicated that both species could be negatively affected by intertidal oyster cultivation, but there were limitations to the available data on their distribution and habitat usage in Donegal Bay. In addition, the precise nature of the response of Light-bellied Brent Goose to intertidal oyster cultivation was not clear from the previous work. Therefore, a short study of Light-bellied Brent Goose and Sanderling distribution and habitat usage in the main areas occupied by intertidal oyster trestles (referred to as the trestle watch study) was carried out between January-March 2013.

1.4 This assessment is based on a desktop review of existing information, combined with the results of the trestle watch study. Where relevant, it identifies information gaps that may affect the reliability of the conclusions of this assessment.

1.5 Tom Gittings designed the trestle watch study, which was carried out by Mike Trewby (bird surveys) and Eamonn Delaney (oyster trestle survey). The data analysis and report writing was done by Tom Gittings. Paul O'Donoghue assisted with project design, document preparation and undertook document review. Data entry was carried out by Eamonn Delaney.

1.6 Scientific names and British Trust for Ornithology (BTO) species codes of bird species mentioned in the text are listed in Appendix A.

Structure of this report

1.7 The structure of the report is as follows: -

- Section 2 of the report describes the methodology used for the assessment.
- Section 3 of the report lists the Special Conservation Interests (SCIs) of the Donegal Bay and Durnesh Lough SPAs, and describes the Conservation Objectives, and their attributes and targets, that have been defined for these SCIs.
- Section 4 of the report contains a preliminary screening assessment that screens out SCIs that do not show any significant spatial overlap with the activities being assessed. It also includes a habitat screening that is used to define which of the remaining SCIs are assessed in relation to activities affecting particular habitat zones.
- Section 5 of the report contains a brief summary of the status and distribution of the SCI species, and their habitats, in the Donegal Bay SPA[1]. This section only contains a very brief summary of distribution patterns; detailed analyses of distribution patterns of individual, species are carried out, as appropriate, in the impact assessment sections of relevant activities later in the document.

[1] The SCIs of the Durnesh Lough SPA have been screened out from further assessment in Section 3.

- Sections 6-8 contain the assessments of the following activities covered by this Appropriate Assessment: suspended oyster culture, oyster bottom culture, and intertidal sea urchin culture.
- Section 9 contains a risk assessment of fishing activity to the SCIs.
- Section 10 contains an assessment of cumulative impacts.

1.8 Each of the assessments in Sections 6-9 first contains a brief description of the scope of the activity indicating the area(s) affected by the activity. The characteristics of the activity are then described. The impact assessment considers both the impacts of habitat alteration and the impacts of disturbance. The potential impacts are first discussed and then the likely significant impacts are assessed. The discussion of the potential impacts of habitat alteration describes the physical changes to the habitat structure and considers the potential impacts on food resources before assessing which of the SCI species could potentially be affected by these changes. Each of these species is then assessed with reference to its spatial distribution and/or habitat usage, and the criteria described in the methodology section are applied to assess whether there are likely to be any significant negative impacts. Finally, the conclusions of the assessment are presented. These list the SCI species for which likely significant impacts, with reference to the attributes and targets of the Conservation Objectives, may result from the activity.

Limitations to this study

1.9 The existing information on waterbird distribution within Donegal Bay, from the Irish Wetland Bird Survey (I-WeBS) and the National Parks and Wildlife Service Baseline Waterbird Survey (NPWS BWS) is of variable quality and resolution.

1.10 I-WeBS monitoring data for most winters only consists of two or three monthly counts, mainly in mid-winter. Therefore, there is little information available about waterbird distribution in the autumn/early winter period.

1.11 The I-WeBS counts of Donegal Bay were not considered to produce consistent data for Common Scoter and Great Northern Diver (NPWS, 2012b), as is typical for these species (Crowe, 2005), due to the difficulty of counting these species from land-based vantage points. Our review of I-WeBS and NPWS BWS data indicates that there are also issues with the consistency of the count data for Sanderling (see paragraph 7.45). Therefore, the I-WeBS dataset may not produce a very precise indication of the distribution of these species across subsites.

1.12 While there are a small number of low tide counts of individual subsites in the I-WeBS dataset, and there is data on low tide distribution in the main areas containing oyster trestles from the trestle watch study, the only systematic information available on low tide distribution is limited to four low tide counts in the winter of 2009/10.

1.13 The precise nature of the response of Light-bellied Brent Goose appears to be complex, and may vary seasonally and with levels of disturbance. The trestle watch study provides detailed data for the late winter period, but we do not have any comparable data for the autumn and early winter.

1.14 The assessment of cumulative impacts provides a general assessment of issues such as recreational impacts, but without detailed information on other activities it is not possible to precisely quantify these potential impacts. General comments are, however, included as appropriate.

Figure 1.1 – Donegal Bay and Durnesh Lough SPAs

2. Methodology

General

2.1 This assessment is based mainly on a desktop review of existing information about waterbird population trends and distribution in Donegal Bay. This was supplemented by a site reconnaissance visit in January 2013. In addition, a short study was carried out in January-March 2013, which examined the spatial distribution of Light-bellied Brent Geese and Sanderling around the main areas of intertidal oyster cultivation (referred to as the trestle watch study).

Data sources

2.2 The spatial extents of the aquaculture activities have been derived from shapefiles supplied by the Marine Institute.

2.3 Details of existing and proposed activities have been taken from the draft Appropriate Assessment for the Donegal Bay Special Area of Conservation (SAC AA) and from two Appropriate Assessment reports prepared for individual oyster farms in Donegal Bay (Holstein Consultancy, 2011a, b).

2.4 The waterbird data sources used for the assessment are as follows:

- Irish Wetland Bird Survey (I-WeBS) counts 1994/95-2010/11;
- NPWS Baseline Waterbird Survey (NPWS BWS) 2009/10 counts;
- The descriptions of waterbird distribution within Donegal Bay in the SPA Conservation Objectives Supporting Document (NPWS, 2012b);
- Consultation with the I-WeBS coordinator; and
- The trestle watch study, in January-March 2013, which examined the spatial distribution of Light-bellied Brent Geese and Sanderling around the main areas of intertidal oyster cultivation (Appendix B).
- Miscellaneous waterbird counts carried out by NPWS conservation staff.
- Fisheries data were provided by MI and BIM.

2.5 The distribution of biotopes within the Donegal Bay SPA is based upon the NPWS biotope map, as shown in Figure 2 of the SAC supporting document (NPWS, 2011b). However, some of the areas mapped as the subtidal fine sands biotope can occur within the intertidal zone (as defined in this assessment; see paragraph 2.15). Where these areas are exposed during low tide periods, we have treated them as belonging to the intertidal muddy sand to fine sand biotope as it seems unrealistic to expect that significant biological differences will be defined by an arbitrary line derived from out of date mapping. Based on our field observations, there are no obvious differences in substrate type between these areas and those classified as the intertidal muddy sand to sand biotope, and it seems reasonable to assume that if these areas were classified as an intertidal biotope, they would be classified as that biotope.

2.6 The extent and timing of exposure of intertidal habitats around the main areas of intertidal oyster cultivation are based upon tideline mapping and habitat observations from the trestle watch study.

2.7 The depths of subtidal habitats are based on Admiralty Chart data, and represent the depth below the lowest astronomical tide.

2.8 Data on the timing and height of low tides were obtained from the United Kingdom Hydrographic Offices Admiralty EasyTide website (http://easytide.ukho.gov.uk/). Low tide times for Donegal

harbour (Salt Hill Quay) were used. However, low tide heights were not available for this tidal station, so low tide heights for Killybegs were used.

2.9 Information on other activities (such as recreational use and boat activity) was obtained primarily from the data on potentially disturbing activities recorded during the NPWS BWS counts and the trestle watch study.

Subsites

2.10 Donegal Bay has been divided into 19 subsites for the purposes of waterbird monitoring (Figure 5.1 and Figure 5.2). The same subsites were used for both the I-WeBS and the NPWS BWS counts, with the exception of Creevy Pier-Kildoney Point, which was not included in the NPWS BWS counts. The subsites cover most of the shoreline of the SPA, with the exception of a section of shoreline between Rossnowlagh and Kildoney and another short section of shoreline at the northern side of the mouth of the Erne Estuary. There are large areas of offshore subtidal habitat which are not included in any of the subsites. However, in practice, birds in subtidal habitat beyond a subsite boundary will be counted as part of the subsite if they are visible (John Cromie, pers. comm.). Nevertheless, I-WeBS and NPWS BWS monitoring data on Common Scoter and Great Northern Diver will be of limited accuracy, due to the difficulty of counting birds that may be far offshore from land-based vantage points.

2.11 Most of the analyses and assessments in this document are based on the division of Donegal Bay into these subsites. The full name of most of the subsites is of the form “[Inner or Outer] Bay/Section [number]: [Name]”. For ease of reference in this text, only the [Name] part is used for referring to the subsites: e.g., “Inner Bay/Section 1: Revlin Pt.” is referred to as “Revlin Pt.”.

2.12 Note that some of the early I-WeBS counts used different arrangement of subsites. However, our analyses are based mainly on recent I-WeBS data, which uses the subsites discussed above.

2.13 For the purposes of analysing waterbird distribution at a broader scale, the subsites have been grouped into three broad zones: the Outer Bay, the Inner Bay and the Southern Bay (Figure 3.3).

Definition of habitat zones

2.14 Three broad habitat zones have been defined for this assessment: intertidal, shallow subtidal (< 0.5 deep) and deep subtidal (> 0.5 m deep). The rationale for the distinction between the shallow and deep subtidal zones is that Light-bellied Brent Goose generally does not feed in waters greater than 0.5 m deep.

2.15 The NPWS biotope map (Figure 6.1) shows a boundary between the intertidal and subtidal zones: i.e., the boundary between the three intertidal biotopes (estuarine fine sands, intertidal hard substrate and intertidal muddy sand to sand) and the subtidal fine sands biotope. However, this boundary is apparently derived from Ordnance Survey Discovery Series mapping, which, in turn, appears to be based on the 1930s six inch mapping. Therefore, the details of the boundaries between the intertidal and subtidal zones are likely to have changed, particularly in areas of mobile sandflats in the Outer Bay zone. For the purposes of this assessment, we used the results of the tideline mapping carried out during the trestle watch study to define the extent of the intertidal zone around the main areas of trestles in the Mountcharles, Eddrim Estuary, St. Ernan’s Isl. and Dungally Strand subsites. This means that some areas classified as the subtidal fine sands biotope in the NPWS biotope map are treated as intertidal habitat in our assessment. In the other areas considered in this assessment, we have followed the intertidal/subtidal division indicated by the NPWS biotope mapping. In most of these areas, any discrepancies between this division and the actual division are likely to be minor, due to changes over time, either because the intertidal zone is a rocky shoreline (in the Doorin Point-Salthill Pier subsites), or because the subtidal habitat is limited to narrow tidal creeks (in most of the remaining Inner Bay subsites).

2.16 The shallow subtidal zone has been defined as the zone between the intertidal/subtidal boundary and the 0 m contour on the Admiralty Chart, which represents the lowest astronomical tides. It should be noted that the Admiralty Chart mapping dates back over 100 years or more. Also, in reality the spatial extent of the shallow subtidal zone will vary on each low tide, but the overall distribution of the zone between subsites is likely to remain similar.

Analyses of waterbird distribution

2.17 The analyses of waterbird distribution in this assessment focuses on distribution patterns of feeding, or potentially feeding birds, as the main potential impacts will be to the availability and/or quality of feeding habitat. Most waterbird species will roost at high tide in shoreline or terrestrial areas, which will not be affected by the activities being assessed. However, we have included assessment of potential impacts on roosting birds to species that may roost in subtidal habitats.

2.18 Waterbird distribution has been mainly analysed by reviewing count data across subsites from the I-WeBS and/or NPWS BWS dataset. However, we have only calculated percentage distributions where we consider the data to be consistent (i.e., excluding counts with poor coverage and/or low numbers). In addition, NPWS BWS flock map data has also been used.

I-WeBS

2.19 Waterbird distribution has been monitored as part of the Irish Wetland Bird Survey (I-WeBS) each winter since 1995/96. The I-WeBS scheme aims to carry out monthly counts each winter between September and March in all sites that are important for non-breeding waterbird populations. However, this level of coverage is not always possible to achieve in a volunteer-based scheme. At Donegal Bay, between one to four complete (or nearly complete) counts have been carried out each winter, apart from 2001/02 (when no counts were carried out). The level of coverage has increased in recent years with only one count in most winters prior to 2004/05 and two-four counts in the winters from 2004/05. Most counts have been carried out in the mid-winter period (December-February). The counts are carried out by a coordinated team of six volunteers, normally within a period of 1-2 days.

2.20 For the analyses in this assessment we have used the I-WeBS dataset for the most recent six winters available (2006/07-2010/11 and 2012/13), because waterbird distribution between subsites may have changed over time, and coverage is generally better.

2.21 In 2006/07, there was incomplete coverage during some counts, with the Murvagh NE subsite not covered in January 2007 and the Durnesh Lough, Murvagh, Rossnowlagh-Inishfad and Rossnowlagh subsites not covered in February 2007. I-WeBS counts during the other winters had complete coverage of all the subsites, except the September 2008 count, for which the subsite coverage is unknown as it used non-standard subsites. In most of the counts, all the subsites were counted on the same day, with the exception of the October and December 2008 counts (subsites counted over four days) and the January 2009 count (subsites counted over two days). On most individual counts, the various subsites were counted over a range of tidal states, often including all four possible tidal states (rising tide, high tide, falling tide and low tide).

2.22 There were a number of counts with data recorded as poor quality and/or low accuracy, and/or affected by poor visibility or disturbance (Table 2.1). Where counts were recorded as of poor quality and/or low accuracy, it is likely that the count was significantly affected. The interpretation of count data that was recorded as affected by poor visibility or disturbance, but were not recorded as of poor quality and/or low accuracy is less clear. In some cases, the counter may have simply omitted to record the quality and accuracy. In other cases, particularly with disturbance, the counter may have recorded disturbance as having occurred, but the disturbance did not affect the count quality or accuracy.

Table 2.1 – Subsites in I-WeBS counts with data recorded as poor quality/low accuracy and/or affected by disturbance or poor visibility

Winter	Month	Poor quality/low accuracy	Disturbance	Poor visibility
2006/07	Nov	Revlin Pt., Muckros Strand, St. Ernan's Isl., Dungally Strand and Murvagh NE	none	Revlin Pt., Muckros Strand, St. Ernan's Isl., Dungally Strand and Murvagh NE
	Dec	Muckros Strand	none	Muckros Strand
	Jan	none	none	
	Feb		none	
2007/08	Dec	none	none	none
	Jan	none	none	none
2008/09	Sep	Entire site?	none	none
	Oct	none	none	none
	Dec	none	none	none
	Jan	none	none	none
2009/10	Dec	Aughrus Pt -Bundoran	Aughrus Pt -Bundoran, Creevy Pier-Kildoney Point, Eddrim Estuary, Doorin Pt.-Salthill Pier, Murvagh and Rossnowlagh-Inishfad	none
	Jan	All Inner Bay subsites, Doorin Pt.-Salthill Pier and Mountcharles	Aughrus Pt -Bundoran, Murvagh and Rossnowlagh	none
2010/11	Dec	none	Aughrus Pt - Bundoran, Eddrim Estuary, Murvagh and Rossnowlagh	none
	Jan	none	Aughrus Pt - Bundoran, Mountcharles, Murvagh, Rossnowlagh - Inishfad and Rossnowlagh	none
2012/13	Sep	Rossnowlagh	none	Rossnowlagh
	Oct	none	none	none
	Dec	none	none	none
	Jan	Eddrim Estuary	Erne Estuary	Aughrus Pt - Bundoran, Creevy Pier - Kildoney Point, Durnesh Lough, Erne Estuary, Murvagh, Rossnowlagh - Inishfad, Rossnowlagh
	Feb	none	Eddrim Estuary and Murvagh	none

NPWS BWS

2.23 Details of the NPWS BWS methodology and results at Donegal Bay are described in Cummins and Crowe (2010) and NPWS (2012b).

Counts

2.24 In the winter of 2009/10, waterbird counts were carried out as part of the National Parks and Wildlife Service's Baseline Waterbird Survey (NPWS BWS). Four low tide and one high tide count were carried out, as well as a separate high tide roost survey. The counts were carried out by a coordinated team of professional counters. Each count was completed in a single day and there was complete coverage on each count (Cummins and Crowe, 2010). However, the November count was affected by poor visibility, with heavy rain and strong winds, and with big swells affecting detectability of offshore species (divers and scoters).

2.25 The NPWS BWS counted feeding and roosting birds separately. However, we have not analysed their distribution separately. In general, birds at low tide usually roost in the same area as they feed and often the roosting birds are mainly just roosting for short periods of time before resuming feeding. Therefore, the division between feeding and roosting may be a matter of chance depending upon the exact timing of the count.

NPWS BWS flock maps

2.26 As part of the NPWS BWS the approximate position of the main flocks encountered were mapped. These flock map data have been used to supplement the analyses of species distribution from the I-WeBS and/or NPWS BWS counts. In particular, the flock map data is useful in indicating relationships between species distributions and broad topographical/habitat zones, such as biotopes, edges of tidal channels, upper shore areas, etc.

2.27 There are some limitations to the interpretation of flock map data because of the difficulties of accurately mapping positions of distant flocks from shoreline vantage points and also the different observers may have varied in the extent to which they mapped flocks.

Trestle watch study

2.28 The objectives of the study were:

- to obtain data on the low tide numbers of Brent Goose and Sanderling in the Donegal Bay subsites with significant areas of licenses and/or applications for intertidal oyster cultivation;
- to examine the distribution of Brent Goose and Sanderling within these subsites in relation to the distribution of oyster trestles; and
- to assess the proportion of the overall Donegal Bay Brent Goose population that occurs within these subsites.

2.29 The trestle watch study was carried out on five dates between 29th January and 12th March 2013. In addition, some data from the reconnaissance visit in 11th-12th January 2013 have been incorporated into the analyses. The study included two components:

- monitoring of the main areas of oyster trestles across half a low tide period; and
- a census of Light-bellied Brent Goose and Sanderling across the Outer and Southern Bay zones of the Donegal Bay on the rising/falling tide.

2.30 The study methodology is summarised below. Full details of the study methodology and results are included in Appendix B.

Monitoring of the main areas of oyster trestles

2.31 In this component of the study, a single observer monitored the main areas of trestles, and adjoining areas of intertidal habitat, from a vantage point on Hassans, which provided good

visibility across the trestle blocks. The area monitored covered all of the Mountcharles and St. Ernan's Isl, subsites and the outer parts of the Eddrim Estuary and Dungally Strand subsites.

2.32 The monitoring covered half a low tide period: i.e., from the time that the trestles start to become exposed on the receding tide begins to low tide, or from low tide to the time that the trestles are fully covered on the flooding tide.

2.33 During the monitoring period, the surveyor continually scanned the visible area and recorded any Light-bellied Brent Goose or Sanderling detected. For each detection, the surveyor recorded the location of the bird(s) (by sketching their position on a map), the habitat in which they occurred, the times of the initial and final detections, the number of birds, and their activity (feeding or roosting/other). In addition, the position of the tideline was sketched at 30 minute intervals, and records were kept of the timing and intensity of husbandry activity within the trestle blocks.

2.34 During the reconnaissance visit, the trestle areas in the Mountcharles were walked on 11th January, and the trestle areas in the St. Ernan's Isl. / Dungally Strand subsites were walked on 12th January. On each day, the observer was in the respective areas for half a low tide period. Therefore, the survey effort is comparable to the trestle watch study, although there are some limitations in terms of visibility of distant areas, etc.

Census of Light-bellied Brent Goose and Sanderling across the Outer and Southern Bay

2.35 The aim of this component of the study was to obtain a total count of the Brent Goose population in Donegal Bay. Sanderling were also be counted, but, given, the potential difficulty of detecting Sanderling at long ranges, and the time constraints, it was anticipated that it would not be possible to fully census their numbers.

2.36 The census was limited to the Outer and Southern Bay zones as the I-WeBS data indicated that Light-bellied Brent Goose and Sanderling mainly occur in these zones. However, in 2012/13, unusually large numbers of Light-bellied Brent Goose were recorded in the Inner Bay zone during I-WeBS counts. Therefore, most of the census counts appear to have significantly underestimated the Light-bellied Brent Goose and the January and February I-WeBS count data has been used instead for comparison with the numbers recorded in the trestle monitoring.

Assessment methodology

Identification of potential impacts

2.37 Potential negative impacts to SCI species have been identified where the activity may cause negative impacts to prey resources, where there is evidence of a negative response to the activity by the species from previous work, and/or where a negative response is considered possible by analogy to activities that have similar types of impacts on habitat structure and/or by analogy to ecologically similar species.

Assessment of impact magnitude

2.38 Where potential impacts from an activity on a SCI species have been identified, or cannot be ruled out, the spatial overlap between the distribution of the species and the spatial extent of the activity was calculated, or qualitatively assessed when quantitative data was not available. This overlap is considered to represent the potential magnitude of the impact, as it represents the maximum potential displacement if the species has a negative response to the activity. Where appropriate, information on species habitat usage was used to refine the assessment of likely impact magnitude.

Assessment of impact significance

2.39 The methodology used for this Appropriate Assessment is focussed on the Conservation Objectives, and their attributes, that have been defined and described for the Donegal Bay SPA (NPWS, 2012a, b). These conservation objectives are the same for all the SCI species.

2.40 Conservation Objective 1 defines two types of attributes to assess conservation condition: long term population trends and numbers or range (distribution) of areas used. This assessment focuses on assessing potential impacts on the spatial distribution of the SCI waterbird species within Donegal Bay and, in particular, whether the activities will cause displacement of a significant proportion of the Donegal Bay population from the affected area(s). If the activities are not predicted to cause significant displacement, then the activities are not likely to affect the long term population trends. If the activities are predicted to cause significant displacement, then the activities could affect the long term population trends (but see below). In the cases where the activities are predicted to cause significant displacement, the impacts on distribution and population size are assessed separately.

2.41 The basis for the assessments are datasets that indicate the distribution of waterbird species between different broad sectors of Donegal Bay (the I-WeBS and NPWS BWS counts) and the distribution within the main areas containing oyster trestles (the trestle watch study). The datasets allow calculation, or qualitative assessment, of the proportion of the Donegal Bay population that would be affected if aquaculture activities cause displacement of birds from areas occupied by the activities under consideration. This approach can be considered as a very simple form of habitat association model and represents a conservative form of assessment (see Stillman and Goss-Custard, 2010): the population-level consequences of displacement will depend upon the extent to which the remaining habitat is available (i.e., whether the site is at carrying capacity). In general this assessment method "*will be pessimistic because some of the displaced birds will be able to settle elsewhere and survive in good condition*" (Stillman and Goss-Custard, 2010).

2.42 The assessment of potential disturbance impacts is based mainly on the potential for disturbance to cause displacement of birds from areas they would otherwise occupy. However, where there is limited availability of alternative habitat, or where the energetic costs of moving to alternative habitat is high, disturbance may not cause displacement of birds but may still have population-level consequences (e.g., through increased stress, or reduced food intake, leading to reduced fitness) (Gill *et al.*, 2001). However, assessing these types of potential impacts would require detailed population modelling, which would require a major research effort that is beyond the scope of this assessment.

Assessment of significance

2.43 The significance of any potential impacts identified has been assessed with reference to the attributes and targets specified by NPWS (2012a) for this conservation objective. Potential negative impacts are either assessed as significant (if the assessment indicates that they will have a detectable effect on the attributes and targets) or not significant. The significance levels of potential positive impacts have not been assessed.

Attribute 1 – Long term population trends

2.44 The criteria that we have used for assessing significance with reference to attribute 1 of the conservation objectives are summarised in Table 2.1 and are described below.

2.45 If the impact is predicted to cause spatial displacement of >25% of the total Donegal Bay population of a SCI species, then the impact could, pessimistically, cause the long term population trend to show a decrease of 25% or more. Therefore, the impact would be potentially significant with reference to attribute 1 of the conservation objective.

2.46 If the long-term population trend of the species is a decrease of 25% or more, and the impact is predicted to cause spatial displacement of 5% or more (see criteria under Attribute 2), then the impact could prevent the potential recovery of the population. Therefore, the impact would be potentially significant with reference to attribute 1 of the conservation objective.

2.47 If the long-term population trend of the species is a decrease of less than 25%, but the combination of the long-term population trend and the predicted spatial displacement (where the latter is assessed to be significant; see criteria under Attribute 2) would equal or exceed 25%,

then the impact could cause the long term population trend to show a decrease of 25% or more. Therefore, the impact would be potentially significant with reference to attribute 1 of the conservation objective.

Table 2.2 – Criteria for assessing significance with reference to attribute 1 of the conservation objectives

Long-term population decrease (P)	Spatial displacement (S)	Additional criteria	Impact
-	≥ 25%	-	Significant
≥ 25%	≥ 5%	-	Significant
< 25%	≥ 5%	P + S ≥ 25%	Significant

Attribute 2 – Number or range (distribution) of areas used

2.48 Assessing significance with reference to attribute 2 is more difficult because the level of decrease in the numbers or range (distribution) of areas that is considered significant has not been specified by NPWS. There are two obvious ways of specifying this threshold: (i) the value above which other studies have shown that habitat loss causes decreases in estuarine waterbird populations; and (ii) the value above which a decrease in the total Donegal Bay population would be detectable against background levels of annual variation.

2.49 There have been some studies that have used individual-based models (IBMs; see Stillman and Goss-Custard, 2010) to model the effect of projected intertidal habitat loss on estuarine waterbird populations. West *et al*. (2007) modelled the effect of percentage of feeding habitat of average quality that could be lost before survivorship was affected. The threshold for the most sensitive species (Black-tailed Godwit) was 40%. Durell *et al*. (2005) found that loss of 20% of mudflat area had significant effects on Oystercatcher and Dunlin mortality and body condition, but did not affect Curlew. Stillman *et al*. (2005) found that, at mean rates of prey density recorded in the study, loss of up to 50% of the total estuary area had no influence on survival rates of any species apart from Curlew. However, under a worst-case scenario (the minimum of the 99% confidence interval of prey density), habitat loss of 2-8% of the total estuary area reduced survival rates of Grey Plover, Black-tailed Godwit, Bar-tailed Godwit, Redshank and Curlew, but not of Oystercatcher, Ringed Plover, Dunlin and Knot. Therefore, the available literature indicates that generally quite high amounts of habitat loss are required to have significant impacts on estuarine waterbird populations, and that very low levels of displacement are unlikely to cause significant impacts. However, it would be difficult to specify a threshold value from the literature as these are likely to be site specific.

2.50 If a given level of displacement is assumed to cause the same level of population decrease (i.e., all the displaced birds die or leave the site), then displacement will have a negative impact on the conservation condition of the species. However, background levels of annual variation in recorded waterbird numbers are generally high, due to both annual variation in absolute population size and the inherent error rate in counting waterbirds in a large and complex site. Therefore, low levels of population decrease will not be detectable (even with a much higher monitoring intensity than is currently carried out). For example, a 1% decrease in the baseline population of Great Northern Diver would be a decrease of one bird. The minimum error level in large-scale waterbird monitoring is considered to be around 5% (Hale, 1974; Prater, 1979; Rappoldt, 1985). Therefore, any population decrease of less than 5% is unlikely to be detectable and, for the purposes of this assessment, 5% has been taken to be the threshold value below which displacement effects are not considered to be significant. This is a conservative threshold, as error levels combined with natural variation are likely to, in many cases; prevent detectability of higher levels of change.

Summary

2.51 Impacts have been assessed as potentially having a significant negative impact on attribute 1 of the conservation objectives (the species' long-term population trend), if they are predicted to cause:

- Displacement of 25% or more of the Donegal Bay total; or
- Significant displacement levels (i.e., 5% or greater) that combined with current long-term population trends, could result in a long-term population decline of 25%; or
- Significant displacement levels (i.e., 5% or greater) where the current long-term population trends is already equal to or greater than 25%.

2.52 Impacts that will cause displacement of 5% or more of the total Donegal Bay population of a SCI species have been assessed as potentially having a significant negative impact on attribute 2 of the conservation objectives (the species' distribution within Donegal Bay).

Risk Assessment for Fisheries

2.53 The risk assessment framework follows, where feasible, EC Guidance (2012) and includes elements of risk assessment from Fletcher (2005). The qualitative and semi-quantitative framework is described in Marine Institute (2013); criteria for risk categorization are shown in Tables 2.3 below.

2.54 The framework uses categorical conditional probability matrices of *likelihood* and *consequence* to assess the risk of an activity to a conservation feature. Categorical likelihood and consequence scores for each such 'incident' (fishery-designated feature interactions) are provided by expert judgement and literature review for each habitat type (in the case of SACs) and species (in the case of SACs and SPAs) defined in the Conservation Objectives.

2.55 Separate conditional probability matrices for habitats and designated species are used to assess risk where both SACs and SPAs are under consideration. In the case of habitats the consequence criteria largely follow the definitions and methodologies used for Appropriate Assessment (AA) of projects and plans. In the case of species the consequence categories relate to the degree to which populations and their supporting habitats may be negatively affected by the given activity. In the case of Donegal Bay while areas of the bay are designated as both SAC and SPA; the SPA is far larger in extent and it is only this designation which overlaps with fisheries in Donegal Bay.

2.56 Categorising and defining consequence and likelihood (of the consequence) is the key issue in Risk Assessment (RA). In qualitative RA frameworks it is imperative that assessment of consequence has a clear rationale, is transparent and is linked to the objectives. Different sets of objectives (what is being conserved and how) may legitimately lead to different consequence scoring.

2.57 Likelihood is the probability of the consequence occurring given the current level of activity and asks what is the likelihood, based on data on current fishing activity at a site, that a given consequence will arise considering the sensitivity of that habitat / species to the activity. Likelihood scores might change if the level of activity was reduced or increased. The Risk (of impact) is the product of likelihood and consequence. Risk in turn indicates the level of management response required.

Table 2.3 - Risk categorization for fisheries and designated species interactions (Marine Institute 2013). High risk (9-16) interactions require mitigation, moderate risk (6-8) probably require mitigation, low risk (<6) interactions should be reviewed individually to determine if mitigation is needed.

Species		Consequence criteria				
		Non disturbing to individuals in the population	Direct or indirect mortality or sub-lethal effects caused to individuals but population remains self-sustaining	In site population depleted but regularly subvented by immigration. No significant ex situ pressure	Population depleted by ex situ and/or in situ fishing pressures	Population depleted and supporting habitat significantly depleted and unable to support population
Likelihood		**0**	**1**	**2**	**3**	**4**
Highly likely (>95%)	**4**	0	4	8	12	16
Probable (> 50%)	**3**	0	3	6	9	12
Possible (10-50%)	**2**	0	2	4	6	8
Unlikely (<10%)	**1**	0	1	2	3	4
None (0%)	**0**	0	0	0	0	0

Risk level	Species	
	Risk scores	**Management response**
1	0	None
2	1_5	Mitigation case by case review
3	3_4	Mitigation probably needed
4	>5	Mitigation required

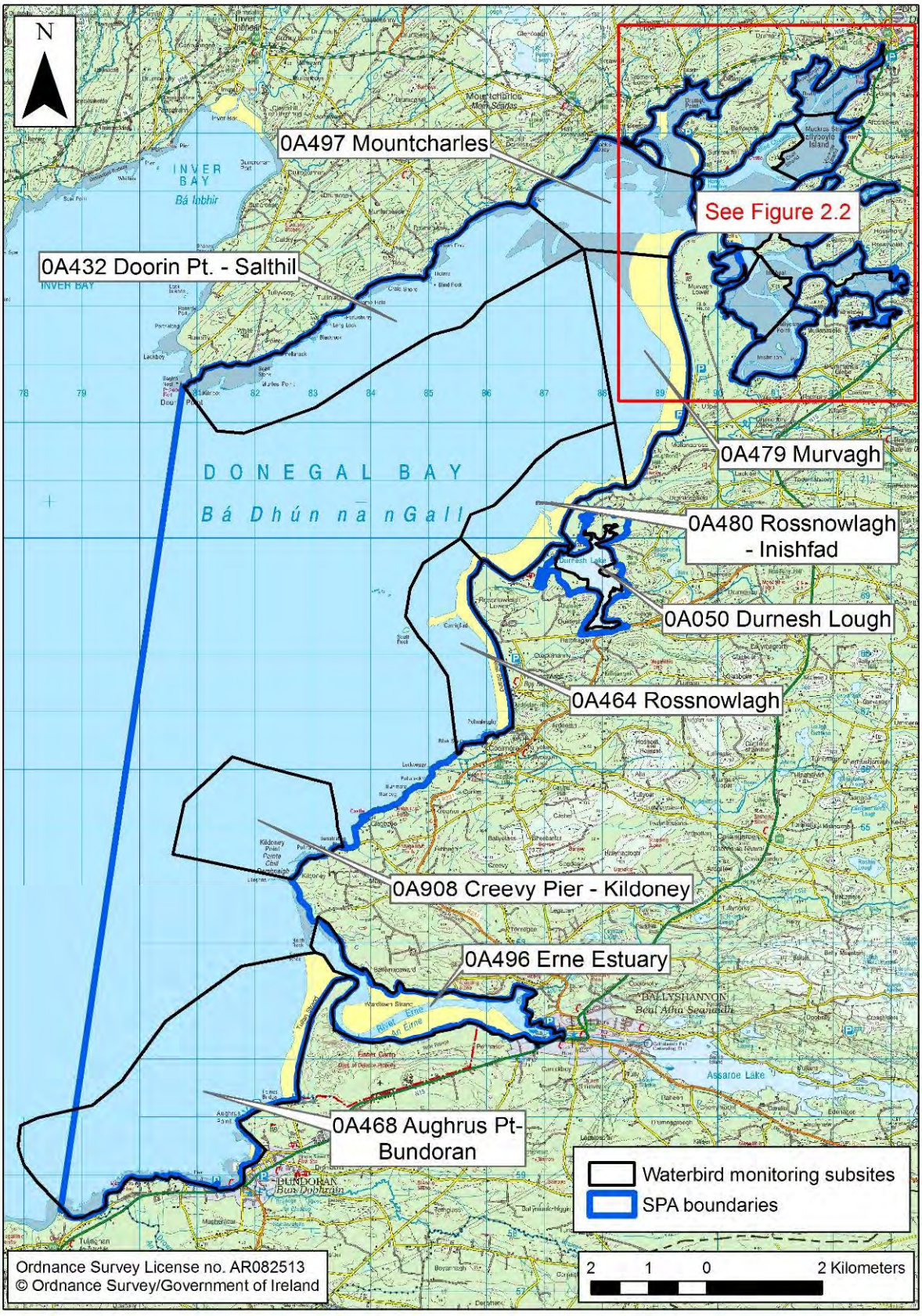

Figure 3.1 – Waterbird monitoring subsites in Donegal Bay (Outer Bay)

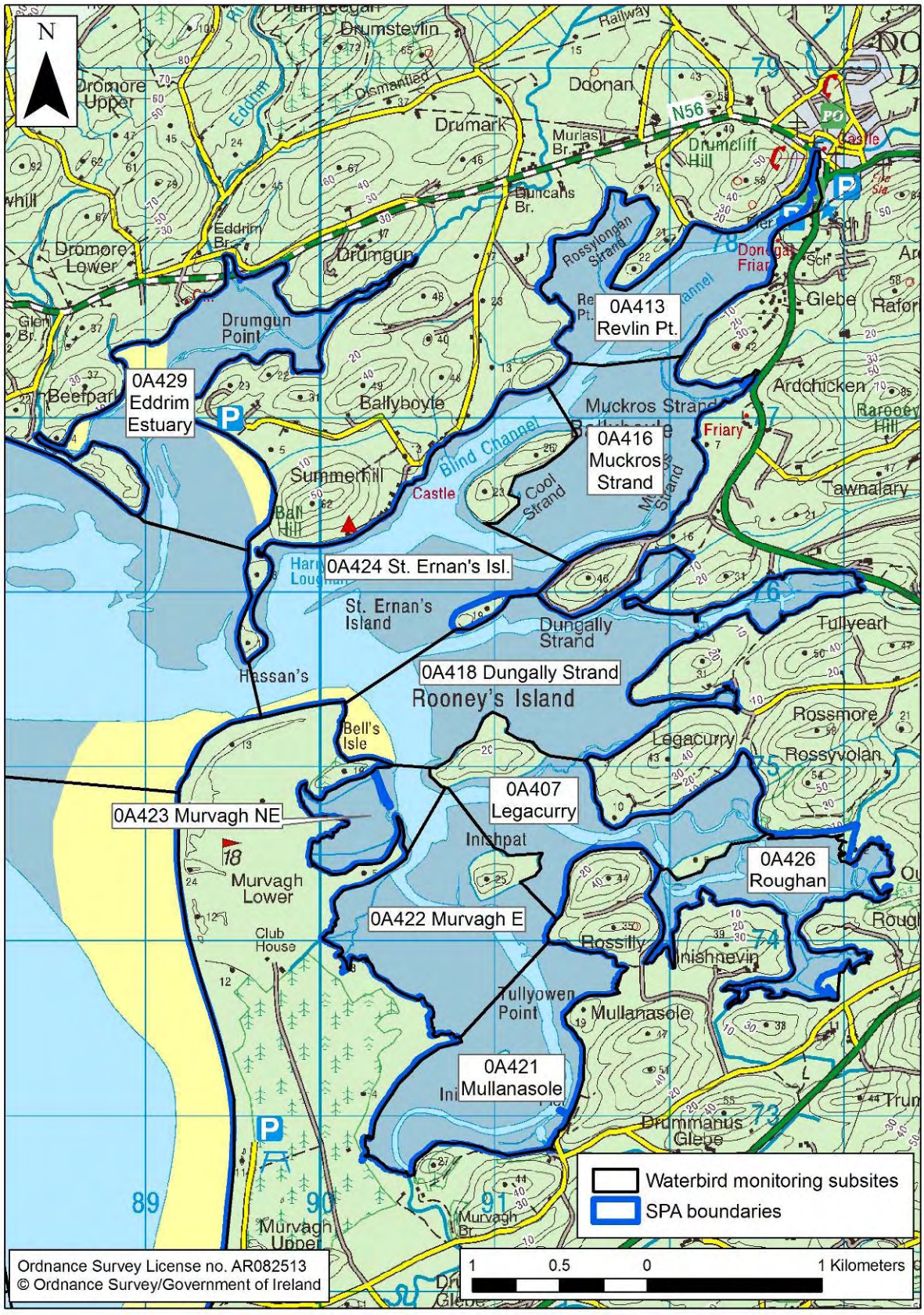

Figure 3.2 - Waterbird monitoring subsites in Donegal Bay (Inner Bay)

Figure 3.3 – Zones used for broad-scale analysis of waterbird distribution

4. Conservation objectives

Donegal Bay SPA

Qualifying features

4.1 The Special Conservation Interests (SCIs) of the Donegal Bay SPA include wintering populations of Light-bellied Brent Goose, Common Scoter, Great Northern Diver and Sanderling.

4.2 In addition:

The wetland habitats contained within Donegal Bay SPA are identified to be of conservation importance for non-breeding (wintering) migratory waterbirds. Therefore the wetland habitats are considered to be an additional Special Conservation Interest.

(NPWS, 2012b)

4.3 The SCIs are divided into Selection Species and Additional Special Conservation Interests. However, this distinction has no relevance for the Appropriate Assessment process and is, therefore, not referred to further in this assessment.

Conservation objectives

SCI species

4.4 The conservation objectives for the Light-bellied Brent Goose, Common Scoter, Great Northern Diver and Sanderling non-breeding populations at Donegal Bay are to maintain their "favourable conservation condition" (NPWS, 2012a).

4.5 The favourable conservation conditions of these species at Donegal Bay are defined by various attributes and targets, which are shown in Table 4.1.

Table 4.1 – Attributes and targets for the conservation objectives for Light-bellied Brent Goose, Common Scoter, Great Northern Diver and Sanderling at Donegal Bay.

Attribute	Measure	Target	Notes
1 Population trend	Percentage trend	Long term population trend stable or increasing	Waterbird population trends are presented in part four of the conservation objectives supporting document (NPWS, 2011b).
2 Distribution	Range, timing and intensity of use of areas	There should be no significant decrease in the range, timing or intensity of use of areas by Common Scoter, Sanderling, Light-bellied Brent Goose and Great Northern Diver, other than that occurring from natural patterns of variation	As determined by regular low tide and other waterbird surveys. Waterbird distribution from the 2009/10 waterbird survey programme is discussed in part 5 of the conservation objectives supporting document.

Source: NPWS (2012b)

Attributes are not numbered in NPWS (2012b), but are numbered here for convenience

Wetlands and waterbirds

4.6 The conservation objective for wetlands and waterbirds at Donegal Bay is to "*maintain the favourable conservation condition of the wetland habitat at Donegal Bay SPA as a resource for the regularly-occurring migratory waterbirds that use it*" (NPWS, 2012a).

4.7 The favourable conservation condition of the wetland habitat at Donegal Bay is defined by a single attribute and target, which is shown in Table 4.2.

Table 4.2 – Attribute and target for the conservation objective for wetlands and waterbirds at Donegal Bay.

Attribute	Measure	Target	Notes
Habitat area	Hectares	The permanent area occupied by the wetland should be stable and not significantly less than the areas 10,461 ha other than that occurring from natural patterns of variation.	The wetland habitat area was estimated as 10,461 ha Using OSi data and relevant orthophotos. For further information see part three of the conservation objectives supporting document

Source: NPWS (2011a)

Durnesh Lough SPA

Qualifying features

4.8 The Special Conservation Interests (SCIs) of the Durnesh Lough SPA are the wintering populations of Whooper Swan and Greenland White-fronted Goose.

Conservation objectives

4.9 The conservation objectives for the Whooper Swan and Greenland White-fronted Goose wintering populations at Durnesh Lough are to maintain or restore their “favourable conservation condition” (NPWS, 2011a).

4.10 NPWS have only published generic conservation objectives for the Durnesh Lough SPA. Therefore, there are no site-specific attributes and targets to define the favourable conservation condition of these species.

5. Screening

SCI species

Preliminary screening

5.1 All of the SCI species (Common Scoter, Light-bellied Brent Goose, Sanderling and Great Northern Diver) make significant use of subtidal and/or intertidal habitat at Donegal Bay. The activities covered in this assessment will affect large areas of subtidal and intertidal habitat and have the potential to cause significant changes to habitat structure and/or food availability. Therefore, the activities being assessed could potentially have significant impacts on SCIs that use subtidal and/or intertidal habitat and full appropriate assessment is required.

Habitat screening

5.2 For the purposes of this Appropriate Assessment, the broad habitat zones used by the SCI species for feeding and/or roosting have been classified (Table 5.1).

5.3 The activities covered in this assessment can generally be broken down into components that affect intertidal/shallow subtidal and deep subtidal habitat zones separately.

Table 5.1 - Habitat zones and major prey resources likely to be used by SCI species at Donegal Bay

Species	Intertidal	Shallow subtidal (< 0.5 m)	Deep subtidal (> 0.5 m)	Major prey resources
Light-bellied Brent Goose	Feeding and roosting	Feeding and roosting	Roosting	Plants (eel grass, *Enteromorpha/Ulva* and coastal grassland)
Common Scoter		Feeding and roosting	Feeding and Roosting	Benthic invertebrates, aquatic plants, freshwater crustaceans and bivalve molluscs
Great Northern Diver		Feeding and roosting	Feeding and Roosting	Fish, crustaceans, molluscs, invertebrates and amphibians
Sanderling	Feeding and roosting			Benthic invertebrates, crustaceans

Major prey resources refer to intertidal and subtidal habitats only

Activity screening

5.4 The spatial patterns of occurrence of some of these species, and/or scientific evidence about the nature of their response to particular activities, may mean that potential impacts can be screened out without detailed analyses. However, for clarity this secondary screening is carried out in the individual sections of this assessment dealing with each activity.

Wetlands and waterbirds

5.5 The Conservation Objectives define the favourable conservation condition of the wetlands and waterbird SCIs at Donegal Bay purely in terms of habitat area.

5.6 None of the activities being assessed will cause any change in the permanent area occupied by wetland habitat. Therefore, the activities being assessed are not likely to have any significant impact on this SCI and it has been screened out from any further assessment.

Durnesh Lough SPA

5.7 The SCI species for Durnesh Lough SPA (Whooper Swan and Greenland White-fronted Goose) do not make significant use of intertidal or subtidal habitats within the Donegal Bay SPA (John Cromie, pers. comm.). Therefore, there are no potential impacts from the activities being assessed to these species and they have been screened out from any further assessment.

6. Waterbird status and distribution

Waterbird status

6.1 The conservation condition and trends of the non-breeding waterbird SCI species at Donegal Bay are summarised in Table 6.1. The only species with an unfavourable conservation condition is the Great Northern Diver. Both Light-bellied Brent Goose and Sanderling have shown substantial increases in their population indices over the monitoring period. However, there are some limitations to the reliability of the population trends calculated from I-WeBS data in Donegal Bay, due to the limited I-WeBS coverage in several winters and a general pattern of an increase in coverage in recent winters (see paragraph 2.19).

6.2 For Light-bellied Brent Goose, our understanding is that the I-WeBS data was supplemented by species-specific survey data in the calculations for the trend analyses, so the calculated trend should be fairly reliable.

6.3 For Sanderling, poor coverage in some years of the long-term dataset and a resulting relatively high level of data imputation during the indexing and trend analysis leads to some caution being necessary when examining the trend for this species. Our analysis of the recent I-WeBS data shows that there are large month-to-month variations in total numbers recorded on counts and it is likely that many of the counts miss significant numbers of Sanderling (see paragraph 7.45). It is possible that increased coverage in recent winters has biased the trend analysis: as the number of counts increase it is more likely that at least one count will manage to be reasonably accurate (i.e. will not miss significant numbers of Sanderling). In fact, there appears to be a correlation between the number of complete counts[2] and the peak Sanderling count and with the unsmoothed index values[3] (Figure 6.2), supporting our interpretation.

Table 6.1 – Conservation condition and population trends of non-breeding waterbird SCI species at Donegal Bay.

Special Conservation Interests (SCIs)	Site Conservation Condition	12 year site population trend[1] 12YR[b]	5 year site population trend[2] 5YR	Current all-Ireland Trend[3]	Current international trend[4]
Light-bellied Brent Goose	Favourable	+140.9	+15.1	+58.0	Increase
Common Scoter	Favourable	n/c		n/c	Stable
Great Northern Diver	Unfavourable	n/c		n/c	n/c
Sanderling	Favourable	+186.6	+28.0	+109.4	Stable

Source: Tables 4.2 and 4.3 in NPWS (2012b)

n/c = not calculated. [1]site population trend analysis, 12 yr = 1996–2008; [2] site population trend analysis, 5 yr = 2003–2008; [3]all-Ireland trend calculated for period 1994/95 to 2008/09; [4] international trend after Wetland International (2006); [4]trend based on two five year averages (see text)

[2] Where a complete count is defined as including the main subsites that are important for Sanderling (see paragraphs 7.40-7.50).
[3] Unsmoothed index values were read off the graph on page 11 of NPWS (2012); no index values were available for the winters since 2009/10.

Waterbird habitats and distribution

Habitats

6.4 The intertidal and subtidal habitats in the Donegal Bay SPA have been classified into five biotopes (NPWS, 2011b; see Figure 6.1[4]). The intertidal zone includes areas of estuarine fine sands in the Inner Bay at Drumgun Point, Muckross Strand, Rosslongan Strand and Inishnabo, and in the upper part of the Erne Estuary. Intertidal muddy sand occupy the majority of the intertidal zone, occurring west of the Murvagh and both north and south of Rooney's Islands, and over most of the Erne Estuary. The intertidal hard substrate biotope occupies the narrow intertidal zones along the northern side of the bay and sections of the southern side of the bay. The entire subtidal habitat within Donegal Bay is classified as the subtidal fine sands biotope.

6.5 Note that, some of the areas mapped as the subtidal fine sands biotope can occur within the intertidal zone (as defined in this assessment; see paragraph 2.15). Where these areas are exposed during low tide periods, we have treated them as belonging to the intertidal muddy sand to fine sand biotope (see paragraph 2.5)

Distribution

6.6 Detailed analyses of species distribution patterns are included in the impact assessment sections of relevant activities later in this document. The following text summarises the broad distribution patterns derived from these analyses.

6.7 The four SCI species considered in this assessment mainly occur within the Outer and Southern Bay zones of Donegal Bay. Light-bellied Brent Goose and Great Northern Diver do regularly occur within the Inner Bay zone, but usually in small numbers. Common Scoter and Sanderling occur almost entirely within the Outer Bay zone, apart from the Inner Bay Eddrim Estuary subsite in which Sanderling do regularly occur.

6.8 Light-bellied Brent Goose feeds in the intertidal and shallow subtidal zones, but can also roost in the deep subtidal zone. All the main biotopes provide suitable feeding habitat, although its distribution patterns indicate that the estuarine fine sands biotope is not used as much as the other biotopes. At many sites in Ireland, agricultural fields are now important feeding habitats for Light-bellied Brent Goose. However, at Donegal Bay, while some field feeding does occur, the majority of the birds feed in the tidal habitats (John Cromie, pers. comm.).

6.9 Common Scoter and Great Northern Diver feed and roost in subtidal waters, mainly in the deep subtidal zone. However, they may feed over habitats in the intertidal zone when these are flooded at high tide.

6.10 Sanderling feeds and roosts exclusively in the intertidal zone. Within Donegal Bay, it mainly occurs within the intertidal muddy sand to sand biotope, although the sandier parts of the estuarine fine sands biotope would also be suitable habitat. The intertidal hard substrate biotope would not be suitable for this species.

[4] Note that Figure 2 in NPWS (2011b) includes biotope mapping of the entire Donegal Bay SPA. However, only the biotope mapping for the SAC is included in Figure 6.1, as NPWS not supplied the biotope mapping for the SPA.

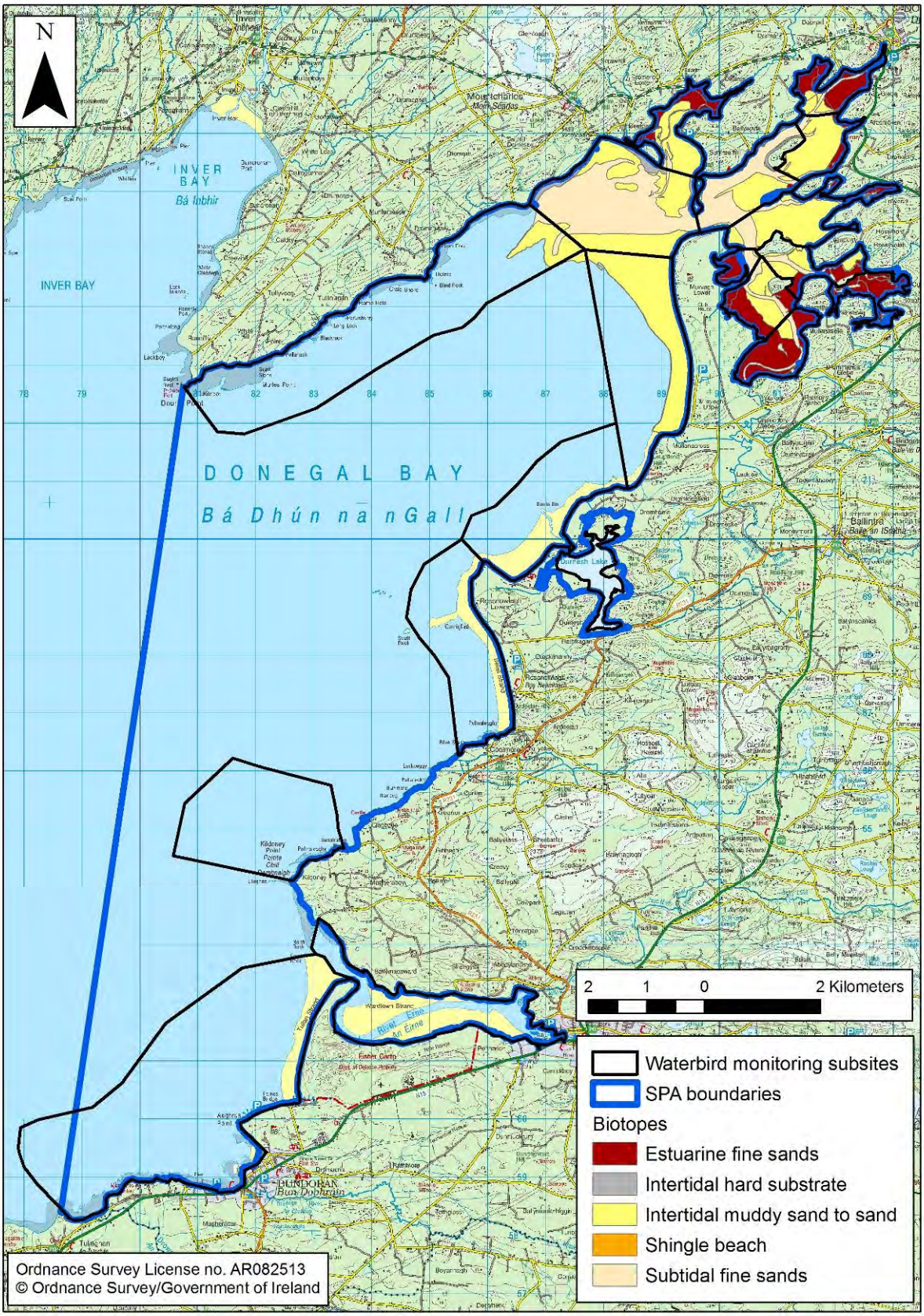

Figure 6.1 – Distribution of biotopes in relation to the waterbird monitoring subsites

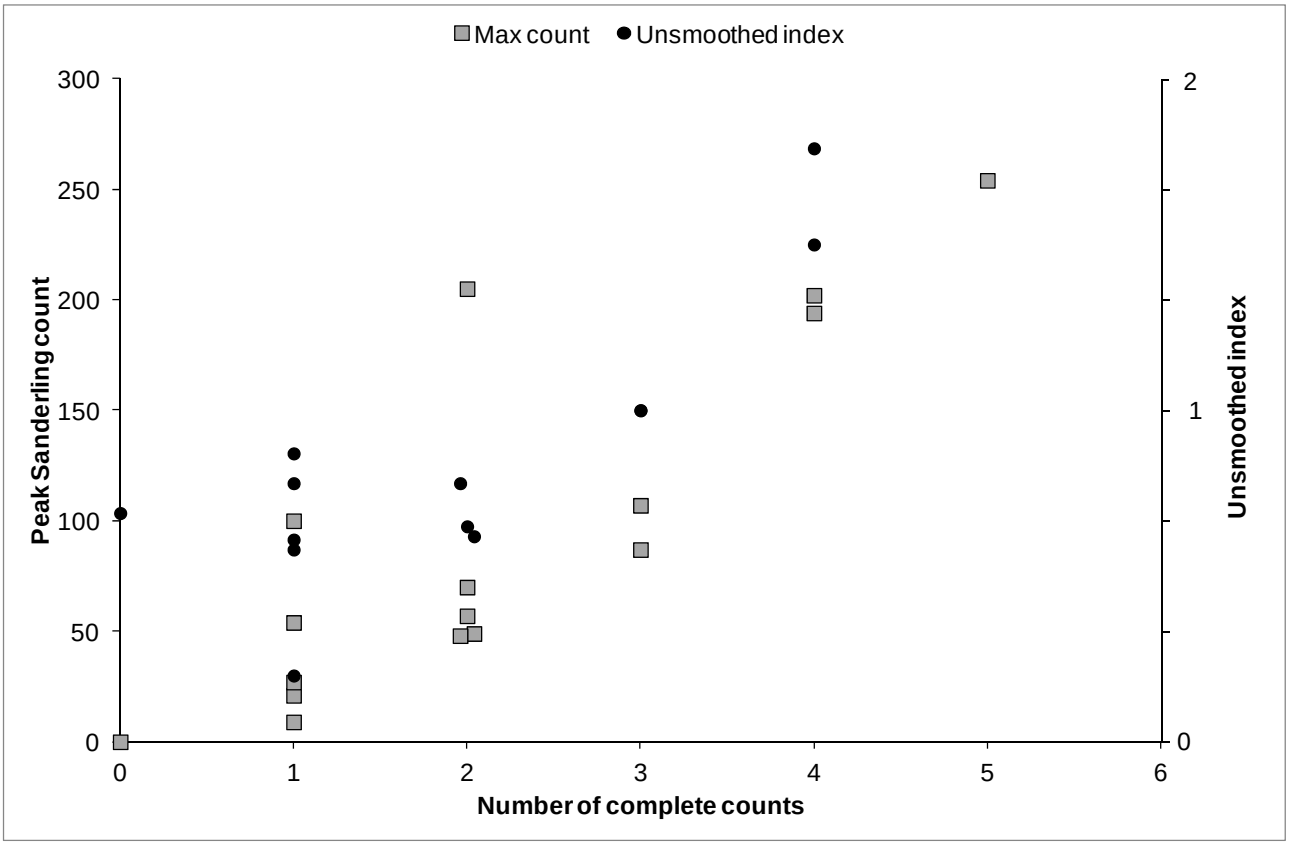

Figure 6.2 – Relationship between the number of complete counts each winter and Sanderling population estimates (as indicated by the maximum count and the unsmoothed index values) each winter in the I-WeBS dataset, 1995/96-2010/11 and 2012/13

7. Assessment of suspended oyster culture

Scope of activity

7.1 The existing and proposed suspended oyster cultivation in Donegal Bay all involves bags and trestles in the intertidal and shallow subtidal zones.

7.2 Within the Donegal Bay SPA there are currently 17 plots licensed for intertidal oyster culture and 11 applications (Figure 7.1) covering a total area of 99 ha. In addition, there are two plots with Fishery Orders, covering a total area of 30 ha.

7.3 The main area of intertidal oyster cultivation occurs in the Mountcharles subsite in the Outer Bay, where there are a large block of applications and licenses on the lower sandflats, with one application plot extending up the tidal channel into the Eddrim Estuary subsite. The exposure of these plots varies, depending upon the spring-neap tidal cycle, with all plots fully exposed and within the intertidal zone on spring low tides, but with significant areas of the plots not exposed, and remaining within the shallow subtidal zone on neap low tides.

7.4 Smaller plots occur in all of the subsites within the Inner Bay, except the Revlin Pt. subsite. There is also one isolated plot within the Doorin Pt.-Salthill Pier subsite.

7.5 Most of the plots occur within the intertidal muddy sand to sand and subtidal fine sands biotopes (Figure 7.2). The Fishery Order areas both occur mainly within the estuarine fine sands biotope. The application plot within the Doorin Pt.-Salthill Pier subsite occurs within the intertidal hard substrate biotope.

7.6 The licensed plots and the Fishery Order area in the Legacurry/Righan subsite all contain blocks of oyster trestles, with again the largest area in the Mountcharles subsite (Figure 7.3). In the Inner Bay, the main areas of trestles are along the outer edge of the sandflats in the St. Ernan's Isl. and Dungally Strand subsites.

7.7 The Fishery Order area in the Murvagh NE subsite is not, and has never been, active (Marine Institute) and is not considered further in this assessment.

7.8 The Doorin Point-Salthill and Muckros Strand subsite only contain applications, and there are no areas of trestles within these subsites.

7.9 The access routes used by tractors travelling to/from the plots are shown in Figure 7.1. The plots in the Mountcharles subsite are accessed from the beach car park at Summerhill. The plots in the Dungally Strand subsite are accessed across the intertidal from Legacurry, and the plots in the outer part of St. Ernan's Isl. subsite are accessed by crossing the tidal channel from the Dungally Strand plots. The plots in the outer part of the Legacurry subsite are accessed across the intertidal, branching off the access route to the Dungally Strand plots. The fishery order area in the Legacurry/Roughan subsites, and the plots in the Murvagh E/Mullansole subsites are mainly accessed along shoreline routes, with only short stretches crossing the intertidal. Additional access routes will presumably need to be developed if the application plots in the inner part of the St. Ernan's Isl. subsite and in the Muckros subsite are developed.

Description

7.10 The SAC AA describes this activity as follows:

> *Oyster farming within Donegal Bay takes place in the intertidal zone using the standard bag and trestle culture method typically employed across the rest of Ireland and abroad. Cultivation of the Pacific oyster (Crassostrea gigas) is carried out by growing oysters in mesh bags placed on steel trestles to keep them elevated above the seabed. Oysters are not artificially fed nor do they receive any medicinal treatments. They are filter feeders*

relying completely on the natural environment for food, and consume phytoplankton when submerged during high tide periods.

Trestles used in Donegal Bay typically measure 3m x 0.5m and stand 0.4 - 0.7m in height above the seabed, each holding 6 bags. There are variations of this. The bags are made of a plastic (HDPE) mesh and are fastened to trestles using rubber straps and hooks. The mesh size varies depending on the grade of oyster stock (4mm, 6mm, 9mm, 13mm).

The production cycle begins in Donegal Bay when 4-10mm (G3 - G7) seed is introduced from French hatcheries in the spring of each year. Hatcheries from which seed are sourced are:

- *GrainOcean*
- *France Naissin*
- *Satmar (3 French hatcheries)*
- *FranceTurbot*

Time to harvest, depending on intake size, ranges from 2.5 to 4 years. Donegal Bay is also used for the production of half grown oysters which are harvested at this size and finished in other bays both in Ireland and in France.

Only hatchery produced triploid oysters are grown in Donegal Bay. They grow well in the bay and can be harvested year round.

The majority of licenced sites are accessed by tractor and trailer. Each operator observes one or 2 dedicated access routes to the sites from their land base. At any one time there will be up to 9 tractors, 2 four-wheel drive vehicles operating across the licensed sites in inner Donegal Bay.

Upon receipt from the hatchery, seed is placed in the mesh plastic bags with mesh size and stocking density appropriate to the seed grade. Initial stocking densities are anywhere between 600 and 2000 oysters per bag. As the oysters grow stocking densities are reduced. After the first year oysters will reach an individual weight of 10-15g. At the end of year 2, upon reaching 50-60g, typical stocking densities are set at 250 – 300 per bag and this reduces to a final density of 90 - 110 oysters per bag at finishing prior to harvest, at a weight of approximately 100g each.

Grading takes place annually in early autumn for seed and between January and May for the remainder of stock. Grading and harvesting activities entails actually removing the bags from the inter-tidal zone to the various land bases. They are collected by hand, loaded onto trailers and transported offsite by tractor.

All trestle lines and blocks are labelled by their operators for site management, stock management and traceability purposes. Based upon experience, the operators utilise different areas of their sites for different oyster grades to maximise growth and minimise risks. All stocking and movement activities are recorded by date and location so that a full record of stock distribution is maintained on an ongoing basis. As appropriate, site boundaries are marked for navigational purposes.

Most of the growers use more exposed upper shore sections of their licensed sites as dedicated holding areas to allow for "hardening" of the final harvestable product ready for transport to market. As well as conditioning the oysters, this also serves to bring all harvestable stock to a single location thus minimising the amount of time spent on the other sites while harvesting to demand.

Maintenance activities on-site include shaking and turning of bags, and hand removal of fouling and seaweed to ensure maintain water flow through the bags when submerged. The bags are shaken and turned on site three – four times over the growing season which

is between May and September. Tractor movements in this instance are simply for the transport of staff to and from site. Nearshore (hardening) sites can also be accessed by foot.

Given the scale of the two larger oyster farming operations in Donegal Bay the programme of work becomes continuous over all low tide periods. However, more intensive period of activity occur during Spring (February-April) when the bags are stocked with new seed and existing stock is graded. The Summer months (May-September) are relatively quiet when bags are turned to reduce fouling and ensure even growth of oysters. During the warmer months activity is kept to an absolute minimum so as not to disturb the oysters. When the water temperatures are at their maximum, oysters may become stressed and disturbance may impact negatively on their performance. During October, activity increases to a peak in and around Christmas as harvesting and grading occurs primarily to serve holiday markets.

Potential impacts

Trestle blocks

7.11 Intertidal oyster culture using bags and trestles causes a significant physical alteration to the structure of the intertidal habitat through the placement of physical structures (oyster trestles) on the intertidal habitat.

7.12 Intertidal oyster culture may cause impacts to benthic invertebrates through sedimentation, eutrophication and compaction within the areas occupied by trestles, and this could potentially affect food resources for waterbird species. However, the SAC AA considered that the characterising species of the main biotopes affected “are not considered particularly sensitive to sedimentation, organic enrichment and compaction”.

7.13 Intertidal oyster culture may also cause impacts to waterbirds through disturbance associated with husbandry activities. This may occur both within and adjacent to the areas occupied by trestles, as well as along the access routes.

7.14 Gittings and O’Donoghue (2012) carried out a detailed study of the effects of intertidal oyster culture using trestles on the spatial distribution of waterbirds. The results of this study were used to categorise species according to their degree of positive or negative association with oyster trestles. This study found that:

- Light-bellied Brent Goose showed a variable response to oyster trestles.
- Sanderling showed a negative response to oyster trestles.

7.15 Therefore, both Light-bellied Brent Goose and Sanderling could potentially be negatively affected by suspended oyster cultivation in Donegal Bay. The evidence relating to the nature of their associations with intertidal oyster trestles is discussed in detail in the respective species assessments below.

7.16 Great Northern Diver and Common Scoter were not covered by this study as they do not feed in intertidal habitat. However, both these species could feed in areas occupied by oyster trestles when these are covered at high tide.

7.17 The study by Gittings and O’Donoghue (2012) examined the combined potential effects of habitat alteration and disturbance from husbandry activity. The sites included in the study included some with very high levels of husbandry activity. Therefore, it is not necessary to consider these components of the potential impacts separately.

Access routes

7.18 The routes used by tractors, and other vehicles, to access the trestle blocks (see Figure 7.1) could potentially cause impacts to benthic invertebrates through compaction, and this could potentially affect food resources for waterbird species that feed on benthic invertebrates. However, the areas

involved are small: assuming a 10 m wide corridor along each access route the affected areas would be around 2.6 ha within the Mountcharles/Eddrim Estuary subsites, 5.6 ha within the Dungally Strand/Legacurry subsites and 0.9 ha within the Murvagh E/Mullanasole subsites. The impact zone would be wider (but less intense) if tractors do not follow access routes consistently. However, the access routes are clearly visible on aerial photographs, indicating that there is little deviation from the routes. Any potential impacts from compaction on food resources for SCI species that feed on benthic invertebrates are considered together with the potential impact of the trestles in the assessment below.

7.19 The access routes could also potentially cause disturbance impacts to waterbird species in areas away from the trestle blocks. However, there are generally only a few vehicle movements along these routes during each low tide period, with each vehicle movement only lasting a few minutes, and tractors sometimes travelling in groups. The data from the trestle watch study indicates that during each low tide period of around six hours duration, there may be 6-12 tractor movements along access routes over intertidal habitat occupying a total of around 18-28 minutes in the Mountcharles/Eddrim Estuary subsites, and 6-12 tractor movements occupying a total of around 10-40 minutes in the Dungally Strand subsite. However, as the tractors are moving along the access routes, rather than remaining in one area, any particular area of intertidal habitat will only be potentially affected by disturbance from tractor movements for a much shorter period of time: e.g., at a speed of 20 km/hr, and assuming a disturbance distance of 200 m, any particular area would only be affected by disturbance for 36 seconds per tractor movement. Therefore, any potential disturbance impacts will be of short duration relative to the total low tide exposure period, and the cumulative total of hectare minutes affected by disturbance will be very low, and would not significantly affect the utilisation of the affected habitat by waterbirds. Therefore, this potential impact is not considered any further in this assessment.

Assessment

Definition of areas

7.20 The main area of intertidal oyster cultivation is in the Mountcharles subsite, with additional areas in various subsites in the Inner Bay.

7.21 The intertidal zone of the Mountcharles subsite north of the main tidal channel forms an ecological unit with the Eddrim Estuary that is physically discrete from other significant areas of intertidal sandflats, and these areas should be considered together in analysing waterbird distribution. The areas are collectively referred to as the Mountcharles/Eddrim Estuary area.

7.22 The intertidal zone of the Mountcharles subsite south of the main tidal channel is separated from the above areas by a 500 m wide tidal channel. This area is part of the extensive sandflats along the Murvagh peninsula and is contiguous with the intertidal zone of the Murvagh subsite. It does not form an obvious ecological unit with the Mountcharles/Eddrim Estuary area, and, for the purposes of our analyses, has not been included within the area we have defined as the Mountcharles/Eddrim Estuary area. However, it is possible that in some NPWS BWS and I-WeBS counts, birds recorded from the Mountcharles subsite occurred in this area.

Light-bellied Brent Goose

Distribution within Donegal Bay

7.23 The distribution of Light-bellied Brent Goose on the NPWS BWS counts is shown in Table 7.1. The October count was carried out before the main arrival of the geese. The flock location maps show that the records from the Mountcharles subsite were all within the Mountcharles/Eddrim Estuary area.

Table 7.1 – Distribution of Light-bellied Brent Goose in the NPWS BWS of Donegal Bay, 2009/10

Zone	Subsite	21 Oct LT	04 Nov LT	02 Dec LT	07 Feb HT	17 Feb LT
Outer Bay	Doorin Pt. - Salthill Pier			10	61	61
	Mountcharles		48	105	31	23
	Murvagh	10	94	17	30	25
	Rossnowlagh - Inishfad		24	23	57	31
	Rossnowlagh			33	11	
Inner Bay	Eddrim Estuary	12			2	
	St. Ernan's Isl.		107			
	Muckros Strand					8
	Dungally Strand				22	
	Murvagh NE					2
Southern Bay	Erne Estuary			9		
	Aughrus Pt - Bundoran			123	144	23
Total		22	273	320	358	173

7.24 In the I-WeBS counts, between 2006/07-2010/11, over 80% of the total Light-bellied Brent Goose numbers occurred in the Outer Bay and Southern Bay zones, apart from one count in October 2008 (Table 7.2). However, in 2012/13, high numbers occurred in the Inner Bay zone from December-February.

Table 7.2 – Light-bellied Brent Goose distribution by zones in I-WeBS counts of Donegal Bay, 2006/07-2010/11 and 2012/13

Winter	Month	Outer Bay	Inner Bay	Southern Bay	Total
2006/07	Nov	2	10		12
	Dec	136	16		152
	Jan	138	34	79	251
	Feb	154	7	130	291
2007/08	Dec	311	11	167	489
	Jan	218	3	161	382
2008/09	Oct		100	26	126
	Dec	150	31	37	218
	Jan	152	31	209	392
2009/10	Dec	225	26	176	427
	Jan	206	17	200	423
2010/11	Dec	162	76	148	386
	Jan	202	3	87	292
2012/13	Sep	8		2	10
	Oct	185	57		242
	Dec	70	184	15	269
	Jan	187	304	65	556
	Feb	295	216	62	573

7.25 In the Outer Bay zone, the majority of the total count usually occurred between Murvagh and Rossnowlagh (Table 7.3). In the Inner Bay zone, St. Ernan's Isl./Dungally Strand were the subsites that most frequently held significant numbers, while no Light-bellied Brent Goose were recorded in the innermost subsites (Muckros Strand and Revlin Pt.; Table 7.4).

Table 7.3 - Light-bellied Brent Goose distribution in the Outer Bay zone, and the Eddrim Estuary, in I-WeBS counts of Donegal Bay, 2006/07-2010/11 and 2012/13

Winter	Month	Doorin Pt. - Salthill Pier	Mountcharles	Eddrim Estuary	Murvagh-Rossnowlagh	Donegal Bay Total
2006/07	Nov				2	12
	Dec	**18**	16	*3*	102	152
	Jan	**49**	15	8	74	251
	Feb	53	*101*	*7*		291
2007/08	Dec	**41**		*3*	270	489
	Jan	**45**		3	173	382
2008/09	Oct					126
	Dec	85	28		37	218
	Jan	**113**	39			392
2009/10	Dec	39	40	2	146	427
	Jan	25	*33*		148	423
2010/11	Dec	12	2	11	148	386
	Jan	22	2	*3*	178	292
2012/13	Sep	5	*3*			10
	Oct	**52**	**10**	*15*	123	242
	Dec		6		64	269
	Jan	16	2	46	*169*	556
	Feb	**68**		*5*	227	573

Murvagh-Rossnowlagh represents the combined count across the Murvagh, Rossnowlagh-Inishfad and Rossnowlagh subsites. Counts in italics were at high tide, counts in bold were at low tide; all other counts were on rising or falling tides. For Murvagh-Rossnowlagh, where counts were not all carried out at the same tidal states in these subsites, the count is classified according to the tidal state in the subsite(s) with the majority of the count.

Table 7.4 - Light-bellied Brent Goose distribution in the InnerBay zone, excluding the Eddrim Estuary, in I-WeBS counts of Donegal Bay, 2006/07-2010/11 and 2012/13

Winter	Month	St. Ernan's Isl./Dungally Strand	Legacurry/ Roughan	Murvagh E/ Mullansole	Murvagh NE	Donegal Bay Total
2006/07	Nov	**9**		1		12
	Dec	*9*	*4*			152
	Jan		**26**			251
	Feb					291
2007/08	Dec				8	489
	Jan					382
2008/09	Oct	90		**10**		126
	Dec	*16*		15		218
	Jan		14	3	14	392
2009/10	Dec	*24*			15	427
	Jan	*1*	16			423
2010/11	Dec	41	9			386
	Jan					292
2012/13	Sep					10
	Oct	*42*				242
	Dec	81	56	47		269
	Jan	*170*		*57*	31	556
	Feb	27	11	32	141	573

Counts in italics were at high tide, counts in bold were at low tide; all other counts were on rising or falling tides. For combined subsites, where counts were not all carried out at the same tidal states in both subsites, the count is classified according to the tidal state in the subsite with the majority of the count.

7.26 The census counts carried out during the trestle watch survey recorded significantly lower number than the I-WeBS counts carried out during the same period, presumably due to the incomplete coverage of the Inner Bay zone (Table 6.5).

Table 7.5 - Distribution of Light-bellied Brent Goose in partial census counts of Donegal Bay, Jan-March 2013

Zone	Subsite	29-Jan	03-Feb	12-Feb	25-Feb	12-Mar
Census count						
Outer Bay (north)	Doorin Pt.-Salthill Pier			92	39	45
	Mountcharles		18		58	59
Inner Bay	Eddrim Estuary	103		55		
	St. Ernan's Isl.				7	
	Dungally Strand			43		
Outer Bay (south)	Murvagh				8	
	Rossnowlagh-Inishfad		112	169	62	
	Rossnowlagh			43	102	50
Southern Bay	Aughrus Pt.-Bundoran		75	53	104	113
Flying		55		159	35	137
Total census estimate		158	205	469	317	270
Trestle monitoring						
St. Ernan's Isl./Dungally Strand				7	3	
Eddrim Estuary/ Mountcharles		198	50	36	27	14

The total census estimate excludes birds that were considered to have been double-counted between subsites and, therefore, may not match the sum of the subsite counts. Note that the Erne Estuary and Aughrus Pt – Bundoran not covered on 29 Jan, Inner Bay not covered or only partially covered on all counts.

7.27 Overall, the data indicates that Light-bellied Brent Goose regularly occurs within the Mountcharles/Eddrim Estuary area. In the I-WeBS counts, when this area was mainly counted on rising or falling tides, the numbers within this area were generally low and usually less than 10% of the total Donegal Bay population. However, the data from the NPWS BWS counts and the trestle watch survey, suggest that larger numbers can, on occasion, occur at low tide. Across the nine low tide counts from these datasets (excluding the October 2009 count), the mean percentage within the Mountcharles/Eddrim Estuary area was 14% (s.d. 11%) (Table 7.6).

Table 7.6 – Low tide counts of Light-bellied Brent Goose in the Mountcharles/Eddrim Estuary area

Winter	Date	Mountcharles/Eddrim Estuary count	Donegal Bay total count	% within the Mouncharles/Eddrim Estuary
2009/10	04 Nov	48	273	18%
	02 Dec	105	320	33%
	17 Feb	23	173	13%
2012/13	11 Jan	0	556	0%
	29 Jan	198	573	28%
	03 Feb	50	573	3%
	12 Feb	36	573	10%
	25 Feb	57	573	4%
	12 Mar	14	270	21%

Donegal Bay total count taken from closest I-WeBS counts for the January and February 2013 data (see 0).

Association with oyster trestles

7.28 In previous work, Gittings and O'Donoghue (2012) found that Light-bellied Brent Goose showed a variable response to the presence of oyster trestles with observed numbers within the oyster trestle blocks broadly in line with predicted numbers at two sites (Dungarvan Harbour and

Waterford Harbour) but generally lower than the predicted numbers at two other sites (Ballymacoda Bay and Bannow Bay).

7.29 During the NPWS BWS low tide counts, the flock map data show that three Light-bellied Brent Goose flocks were recorded within oyster trestle blocks within the Mountcharles subsite: a flock of 52 feeding subtidally on the November count, a flock of 98 feeding intertidally (83) and subtidally (15) on the December count, and a flock of 3 feeding supratidally (presumably on trestles) on the February count. The only additional record from this subsite during these counts was of 7 birds on the November count for which the flock position was not recorded.

7.30 The results of the trestle watch study provide more detail about Light-bellied Brent Goose distribution and habitat usage in relation to the presence of oyster trestles. The key findings in relation to this assessment are presented below, while full details of the study and analyses of the results are presented in 0. Three parameters were used to analyse the occurrence of Light-bellied Brent Goose in relation to the presence of oyster trestles: the number of discrete flocks occurring within the trestle blocks relative to the total number of flocks present; the maximum number of birds occurring within the trestle blocks relative to the total number of birds present; and the total number of bird minutes spent within the trestle blocks relative to the total number of bird minutes spent in the overall area. As Light-bellied Brent Goose flocks are very mobile, the latter parameter probably gives the best indication of the relative importance of the trestle blocks. However, it should be noted that various assumptions had to be made in the calculation of the above parameters and 0 should be consulted for the full details.

7.31 Light-bellied Brent Goose were recorded within the Mountcharles trestle blocks on four of the five survey days. They were not recorded at all within the St. Ernan's Island/Dungally Strand trestle blocks, but there were only two records of flocks within the St. Ernan's Island/Dungally Strand area across all five days of the trestle watches. Most of the flock observations within the Mountcharles trestle blocks were in the western part of the trestle area broadly corresponding to the distribution of trestle blocks with high cover of green algal slime.

7.32 Relative to all the area covered by the trestle monitoring watches, Light-bellied Brent Goose activity within the trestle blocks was very low, apart from on the 25th February (Table 7.7), which was the day with the lowest overall activity. However, when the analysis is restricted to the Mountcharles/Eddrim Estuary sandflats (i.e., covering the Mountcharles trestle blocks and the area of comparable undeveloped habitat), Light-bellied Brent Goose activity within the trestle blocks was relatively high on three of the five survey days (Table 7.8). All the records within the trestle blocks were of birds feeding subtidally as the tideline advanced across the trestles on the rising tide and, within the Mountcharles/Eddrim Estuary sandflats all the records of birds feeding subtidally were within the trestle blocks. Analysis of the timing of the flock records shows that all the records of flocks within trestle blocks occurred during times when no tractors were present within the trestle blocks.

7.33 Because Light-bellied Brent Goose feed subtidally as well as intertidally, it is difficult to define the available habitat and calculate the proportion occupied by trestles. However, given the extent and distribution of trestles, the relative degree of occurrence of Light-bellied Brent Goose within trestle blocks compared to the available habitat is considered to be high relative to the extent of available habitat within the Mountcharles/Eddrim Estuary sandflats on three of the five survey days. Therefore, from the results of the trestle watch study, there is no evidence of Light-bellied Brent Goose showing an avoidance response to trestles and there may be a positive association. It is notable, that during the trestle watches the numbers of Light-bellied Brent Goose that occurred within the trestle blocks were low, and the larger flocks occurred outside the trestles. However, large flocks did occur within the trestles during the NPWS BWS counts, and given, the low overall frequency of large flocks in this area, the absence of large flocks from the trestle blocks during the trestle watches may be just due to chance.

7.34 The apparent temporal link between flock occurrences within the trestles and absence of tractors during the trestle watches is quite striking, although it is possible that this link is an artefact of both being related to the tidal state: i.e., the tractors leave and the geese arrive as the tide begins to flood the trestles. However, we do have anecdotal observations from other sites that also indicate that disturbance from aquaculture activities may limit utilisation of habitat occupied by trestles. If this is the case it would indicate that, in the absence of any aquaculture husbandry activity, Light-bellied Brent Goose flocks would occur more frequently within the trestle blocks.

7.35 Our observations indicate that Light-bellied Brent Goose within trestle blocks typically feed on green algae growing on the trestle bags. During the trestle watch survey, the cover of green algae was low, as would be expected in late winter. Higher cover would be expected in the autumn/early winter, and Light-bellied Brent Goose flocks might, therefore, be expected to occur more frequently within trestle blocks at this time. Indeed, oyster farmers that we spoke to during field work at Donegal Bay told us that the geese mainly occurred within the trestles earlier in the winter.

7.36 In conclusion, it seems likely that oyster trestles are an attractive habitat for Light-bellied Brent Goose in Donegal Bay, particularly in the autumn/early winter although disturbance from aquaculture operations may limit their utilisation of the habitat at times.

Table 7.7 - Summary of Light-bellied Brent Goose occurrence within trestles, including all areas covered in the trestle monitoring watches

Date	Numbers		Flocks		% of bird minutes within trestles
	Total	Within trestles	Total	Within trestles	
29 Jan	240	0	3	0	0%
03 Feb	123-127	9	7	1	< 1%
12 Feb	85-109	2	10	1	< 1%
25 Feb	43-50	31	7	2	58%
12 Mar	59-63	10-12	5	3	7%

Table 7.8 - Summary of Light-bellied Brent Goose occurrence within trestles, relative to total activity in the Mountcharles/Eddrim Estuary sandflats

Date	Numbers		Flocks		% of bird minutes within trestles
	Total	Within trestles	Total	Within trestles	
29 Jan	159	0	2	0	0%
03 Feb	82	9	3	1	1%
12 Feb	15	2	3	1	32%
25 Feb	31	31	5	5	100%
12 Mar	10-12	10-12	3	3	100%

Impact assessment

7.37 The impact of intertidal oyster cultivation on Light-bellied Brent Goose in Donegal Bay will depend upon the balance between a positive impact due to the attractiveness of the trestles as a feeding habitat and a negative impact due to the disturbance from aquaculture activities. The evidence we have discussed above suggests that in Donegal Bay the positive impact generally outweighs the negative impact.

7.38 Even if it was the case that the negative impact outweighed the positive impact, the overall impact would not be complete exclusion of Light-bellied Brent Goose from the trestle blocks, but rather reduced utilisation of the area occupied by the trestle blocks compared to the utilisation of this area before trestles were introduced (assuming that Light-bellied Brent Goose did use the area before the introduction of the trestles). Because the numbers of Light-bellied Brent Goose in the

areas with oyster licenses and applications are usually relatively low, and because introduction of trestles would cause at most reduced usage, rather than complete exclusion, all, or nearly all of the birds within these areas would have to usually feed within the areas occupied by the oyster licenses and applications for there to be any chance of significant displacement impacts occurring. *A priori*, this would be considered unlikely, and the results of the trestle watch show that the Light-bellied Brent Goose are very mobile and range widely across the habitat in these areas.

7.39 In conclusion, it seems likely that intertidal oyster cultivation has an overall positive impact on Light-bellied Brent Goose and, even if the overall impact was negative, it is extremely unlikely to cause significant displacement impacts.

Sanderling

Distribution within Donegal Bay

7.40 The main areas used by Sanderling in Donegal Bay have been described as the sandy shoreline west and south of the Beefpark peninsula in the Mountcharles subsite, the sandflats at the northern end of Murvagh around the boundary between the Murvagh and Mountcharles subsites, and the upper shore in the Murvagh subsites, with some also in the Rossnowlagh subsite (John Cromie, pers. comm.).

7.41 Sanderling numbers recorded in various counts of Donegal Bay show high variability (Table 7.9).

Table 7.9 – Sanderling counts in Donegal Bay

Season	Source	Sep	Oct	Nov	Dec	Jan	Feb	Mar
2006/07	I-WeBS			52	87	26	0	
2007/08	I-WeBS				48	0		
2008/09	I-WeBS	0	107		33	42		
2009/10	I-WeBS				21	57		
	BWS		109	52	271	271	130	
2010/11	I-WeBS				195	205		
2012/13	I-WeBS	72	14		31	1	254	
	This study					51	224*	38

* maximum of three counts: 210, 44 and 224

7.42 In the NPWS BWS counts (Table 7.10) Murvagh was the only subsite that held Sanderling on all the counts. NPWS (2012) notes that, within the Murvagh subsite, Sanderling "*appeared to favour foraging within an area on the lower shore in the north of the subsite, the birds positioned in roughly the same area in all four low tide counts, usually accompanied by Dunlin, Bar-tailed Godwits and Oystercatchers amongst other species, with flocks often overlapping with subsites 0A497 and 0A432*". The Erne Estuary held Sanderling on three of the five counts and the Eddrim Estuary held Sanderling on two of the five counts. No Sanderling were recorded in the Inner Bay subsites (apart from the Eddrim Estuary).

Table 7.10 – Distribution of Sanderling in the NPWS BWS of Donegal Bay, 2009/10

Subsite	21 Oct LT	04 Nov LT	02 Dec LT	07 Feb HT	17 Feb LT
Aughrus Pt - Bundoran			35		
Erne Estuary	46		160	170	
Eddrim Estuary			2	35	
Murvagh	63	51	74	66	130
Rossnowlagh		1			
Total	109	52	271	271	130

7.43 In the I-WeBS counts, most Sanderling occurred within the Outer Bay zone, with significant numbers also occurring, but less frequently in the Southern Bay zone (Table 7.11). Most counts were carried out on rising or falling tides. The distribution of birds between subsites is not very consistent across these counts. However, on most counts, the majority of birds were distributed across the subsites in the middle of the bay: Murvagh, Rossnowlagh – Inishfad and Rossnowlagh (Table 7.12). Sanderling were recorded from the Mountcharles subsite on three counts. There was only one count from the Inner Bay.

Table 7.11 – Sanderling distribution by zones in I-WeBS counts of Donegal Bay, 2006/07-2010/11 and 2012/13

Winter	Month	Southern Bay	Inner Bay	Outer Bay	Total
2006/07	Nov			52	52
	Dec	23		65	87
	Jan	22		3	26
2007/08	Dec	28		20	48
2008/09	Oct			107	107
	Dec	1		32	33
	Jan	25	9	8	42
2009/10	Dec	17		4	21
	Jan			57	57
2010/11	Dec			195	195
	Jan	48		157	205
2012/13	Sep	52		20	72
	Oct			14	14
	Dec			31	31
	Jan			1	1
	Feb			254	254

Table 7.12 – Sanderling distribution in the Outer Bay zone in I-WeBS counts of Donegal Bay, 2006/07-2010/11 and 2012/13

Winter	Month	Doorin Pt. - Salthill Pier	Mountcharles	Murvagh-Rossnowlagh	Donegal Bay total
2006/07	Nov			52	52
	Dec			65	87
	Jan			3	26
2007/08	Dec			*20*	48
2008/09	Oct			107	107
	Dec	1	*31*		33
	Jan		8		42
2009/10	Dec			4	21
	Jan			57	57
2010/11	Dec			195	195
	Jan		*2*	155	205
2012/13	Sep	**20**			72
	Oct			14	14
	Dec			31	31
	Jan			1	1
	Feb	**6**		248	254

Murvagh-Rossnowlagh represents the combined count across the Murvagh, Rossnowlagh-Inishfad and Rossnowlagh subsites. Counts in italics were at high tide, counts in bold were at low tide; all other counts were on rising or falling tides. For Murvagh-Rossnowlagh, where counts were not all carried out at the same tidal states in these subsites, the count is classified according to the tidal state in the subsite(s) with the majority of the count.

7.44 The distribution of Sanderling on the partial census counts in January-March 2013 is shown in Table 7.13. These counts did not cover the Inner Bay, while coverage of some of the more extensive outer sandflats, such as Murvagh, was probably limited. The largest Sanderling flocks were recorded in the Aughrus Pt – Bundoran subsite on the two counts when the main population

was probably counted. Combining the results of the trestle watch and census counts, Sanderling occurred in the Eddrim Estuary/Mountcharles area on four of the five count days.

Table 7.13 – Distribution of Sanderling in partial census counts of Donegal Bay, Jan-March 2013

	Subsite	11 Jan	29 Jan	03 Feb	12 Feb	25 Feb	12 Mar
Census count	Mountcharles				44		**16**
	Eddrim Estuary					**40**	**10**
	Murvagh		51	84			**12**
	Rossnowlagh					38	
	Aughrus Pt - Bundoran			126		146	
	Total		51	210	44	224	38
Trestle watch	Eddrim Estuary/ Mountcharles			**90**	**62**	**63**	
Other	Mountcharles	**52**					

Erne Estuary and Aughrus Pt – Bundoran not covered on 29 Jan, Inner Bay not covered or only partially covered on all counts. Counts in bold were at low tide; all other counts were on rising or falling tides

7.45 Overall, the data indicates that Sanderling distribution across Donegal Bay is highly variable. However, given the large month-to-month variation in total numbers recorded on counts, and the difficulty of accurately counting a small and mobile wader across such a large site, it seems likely that many of the counts miss significant numbers of Sanderling. It seems plausible that there is a total midwinter population of around 200-300 birds, in which case, only counts that record more than 200 are likely to give a good indication of patterns of Sanderling distribution.

7.46 Given the above issues, attempting to estimate mean percentages of birds in subsites would be unwise. For this assessment, the key issue is the degree to which Sanderling use subsites containing applications or licenses for intertidal oyster cultivation.

7.47 Excluding the Eddrim Estuary, Sanderling do not seem to occur within the Inner Bay. Therefore, Sanderling distribution does not overlap with any of the Inner Bay applications or licenses for intertidal oyster cultivation.

7.48 Sanderling do seem to occur with some regularity within the Eddrim Estuary/Mountcharles area. Therefore, Sanderling distribution does overlap with the applications and licenses in the Mountcharles subsite. It is difficult to assess how frequently Sanderling use this area. Due to their tidal timing, the I-WeBS counts may underestimate the frequency of occurrence within this area: the Beefpark peninsula in the Mountcharles subsite has been described as one of the main areas where Sanderling occur (John Cromie, pers. comm.). In the census counts and trestle watches, Sanderling were recorded on four of the five survey days, and were also recorded on a separate reconnaissance visit, with a mean count across these six days of 48. However, these were intensive surveys, with the area continuously watched for a period of over three hours, and the Sanderling flocks were typically only observed as being present for a duration of less than one hour (although they were generally not observed leaving the area, and may have been present for longer: e.g. in the upper part of the Eddrim Estuary, which was not visible, or obscured by topography, etc.).

7.49 Sanderling were recorded less frequently within the Eddrim Estuary/Mountcharles area in the I-WeBS and NPWS BWS counts. However, in the I-WeBS counts, these subsites were mainly counted on rising or high tides. Most of the NPWS BWS counts were low tide counts, although only one of the low tide counts exceeded 200 (i.e., can be considered likely to accurately reflect Sanderling distribution).

7.50 In conclusion, given the lack of accurate information, and following the precautionary principle, for the purposes of this assessment, we have estimated that around 25% of the Donegal Bay Sanderling population regularly occur within the Eddrim Estuary/Mountcharles area. Sanderling can also occasionally occur within the Doorin Point-Salthill Pier subsite.

Distribution within the Eddrim Estuary/Mountcharles area

7.51 The limited data that is available indicate that Sanderling flocks can occur throughout the available intertidal muddy sand to sand biotope[5] within the Mountcharles/Eddrim Estuary area. There were no observations of Sanderling flocks in the estuarine fine sands biotope, although only limited parts of the area covered by this biotope were visible from the vantage point used for the trestle watches.

7.52 It is obviously not possible to know whether Sanderling occurred within the area now occupied by trestles, prior to the introduction of the trestles. However, given the pattern of Sanderling distribution within the Mountcharles/Eddrim Estuary area, the similarity in substrate/biotope between the area now occupied by trestles and the area where Sanderling now occur, and the location of the trestle blocks between two areas where Sanderling regularly occur (the Mountcharles/Eddrim Estuary area and the Murvagh sandflats), it is reasonable to assume that Sanderling would have occurred within the area now occupied by trestles, prior to the introduction of the trestles.

Association with oyster trestles

7.53 In previous work, Gittings and O'Donoghue (2012) reported a negative association between Sanderling and intertidal oyster trestles. However, the data for Sanderling in this study was limited and the reported association was based on the position of Sanderling in ordination analyses, rather than the more detailed analyses of species distribution that were possible for some other species. Nevertheless, in the extensive study component of Gittings and O'Donoghue (2012), a total of 524 Sanderling were recorded on 14 counts across four sites and there were only two records, each of single birds, within areas of oyster trestles.

7.54 In the trestle watch study carried out for this assessment, there were ten separate observations of flock positions within the Mountcharles/Eddrim Estuary area. Sanderling were never recorded within the oyster trestle blocks and the pattern of distribution of the Sanderling flocks is suggestive of Sanderling avoiding the trestles (0). However, because of the low total number of observations of Sanderling flocks, the dataset does not have sufficient statistical power to demonstrate significant avoidance of the trestle blocks: the probability of all nine flock positions not occurring within the trestle blocks, if they were selecting habitat at random, would have been around 23%. Nevertheless, the data from this study adds to the evidence from the previous work by Gittings and O'Donoghue (2012) for Sanderling showing strong avoidance of oyster trestles. Therefore, for the purposes of this assessment, we have assumed that intertidal oyster cultivation causes complete exclusion of Sanderling from the area occupied by the trestles.

Impact assessment

7.55 The impact of intertidal oyster cultivation on Sanderling will depend upon the numbers of Sanderling that occur within the Mountcharles/Eddrim Estuary area, the distribution of Sanderling relative to the areas occupied by oyster trestles and the proportion of the available habitat that is occupied by the oyster trestles. While Sanderling also occur within the Doorin Pt.-Salthill Pier subsite, the plot in this subsite occurs within the intertidal hard substrate biotope and is, therefore, unsuitable habitat for Sanderling.

7.56 As discussed above, we have assumed that around 25% of the Donegal Bay Sanderling population regularly occur within the Eddrim Estuary/Mountcharles area.

7.57 Based on the discussion above, we have assumed for the purposes of this assessment, that the potential habitat for Sanderling within the Mountcharles/Eddrim Estuary area comprises the entire

[5] Some of the areas where Sanderling flocks occurred are classified as the subtidal fine sand biotope by NNPWS (2011b), but are treated as the intertidal muddy sand to sand biotope in this assessment (see paragraph 2.5).

area occupied by the intertidal muddy sand to sand biotope[6], and that, in the absence of intertidal oyster cultivation, Sanderling could occur randomly throughout this area.

7.58 The intertidal oyster cultivation licenses and applications occupy varying proportions of the available habitat, depending upon the state of the tide. Generally around low tide, they occupy around 25-30% of the available habitat (Figure 7.4). However, the duration of this level of exposure varies significantly with the height of the low tide: around 5 hours on a 0.3 m low tide, 3.5 hours on a 0.6 m low tide and 2 hours on a 1.2 m low tide. Based on these patterns, a duration of this level of exposure of around 3 hours would be expected on a 0.9 m low tide (the mean low tide height). The areas occupied by the intertidal oyster cultivation applications are mainly in the lower part of the intertidal zone, and were mainly exposed on the lower tides (the 0.3 m and 0.6 m low tides), where they occupied around 7-8% of the available habitat.

7.59 If Sanderling flocks occur randomly throughout this area, then during these periods of maximum exposure, we would expect Sanderling to occur within the impact zone around 25-30% of the time. In terms of habitat usage this can be considered to be equivalent to Sanderling being distributed uniformly across the available habitat with 25-30% of the birds occurring within the impact zone. Therefore, the exclusion of Sanderling by 100% utilisation of the impact zone would cause displacement of 5-7.5% of the total Donegal Bay Sanderling population.

7.60 Part of the impact zone is already occupied by oyster trestles. Therefore, it is possible that some displacement of Sanderling has already occurred, and that the overall numbers within the Mountcharles/Eddrim Estuary area have been reduced. The oyster trestles occupy around 15-20% of the available habitat, during the period of maximum exposure. If additional Sanderling were to be distributed at the same density within this area, as within the remainder of the suitable habitat within the Mountcharles/Eddrim Estuary area, then a total of around 29-31% of the total Donegal Bay Sanderling population would be expected to occur within the Mountcharles/Eddrim Estuary area. Under this scenario, the exclusion of Sanderling by 100% utilisation of the impact zone would cause displacement of around 7.5-9.5% of the total Donegal Bay Sanderling population.

Conclusions

7.61 The pattern of distribution of the Sanderling flocks recorded in the trestle watch study of this assessment is suggestive of Sanderling avoiding the trestles, although, because of the low total number of observations of Sanderling flocks, the dataset does not have sufficient statistical power to demonstrate significant avoidance of the trestle blocks. However, previous work has also reported a negative association between Sanderling and intertidal oyster trestles (although this was based on limited data), and it is reasonable to conclude from the weight of the evidence that Sanderling show more or less complete avoidance of oyster trestles.

7.62 Sanderling regularly occur within the Mountcharles/Eddrim Estuary area. The proportion of the Donegal Bay population that occur within this area at some point during the low tide period may be around 25%, although some flocks may only spend a short time within this area. Full occupation by trestles of the oyster licenses and applications within this area could potentially cause displacement of 5-10% of the Donegal Bay population, compared to the distribution that would be expected in the absence of any trestles.

[6] Including areas classified as the subtidal fine sand biotope when they are exposed by the tide (see paragraph 2.5).

Common Scoter

Distribution within Donegal Bay

7.63 The distribution of Common Scoter within Donegal Bay is discussed in detail in Section 8.

7.64 The only subsite containing intertidal oyster applications or licenses in which Common Scoter regularly occur is the Doorin Pt. - Salthill Pier subsite. In the NPWS BWS counts, they occurred within this subsite on all the counts, with low numbers on four of the counts (less than 5% of the total count) and higher numbers on one count (16% of the total count). In the I-WeBS dataset, there are seven counts for this subsite ranging from 6-41 birds. There are also two counts of four birds each from the Mountcharles subsite.

Association with oyster trestles

7.65 The nature of the association between Common Scoter and oyster trestles is not known.

Impact assessment

7.66 Common Scoter only regularly occur within one subsite containing intertidal oyster applications or licenses. They usually occur in small numbers within this subsite. This subsite contains a single application for intertidal oyster cultivation covering an area of around 5 ha.

7.67 Given the small numbers of Common Scoter that occur within this subsite, the small area occupied by the application for intertidal oyster cultivation, and the fact that scoter would only be able to use this area during the high tide period, any intertidal oyster cultivation in this plot will not cause significant displacement of Common Scoter.

Great Northern Diver

Distribution within Donegal Bay

7.68 Great Northern Diver mainly occur within the Outer Bay zone of Donegal Bay, with a mean of 86% (range 80-100%, excluding total counts of less than 50) of the total count within this zone across the I-WeBS dataset (Table 7.14). Within the Outer Bay zone, Great Northern Diver regularly occur within all the subsites, although Doorin Point-Salthill appear to be the subsite that most consistently supports large numbers (Table 7.15).

7.69 Within the two Outer Bay subsites containing intertidal oyster applications or licenses, a mean of 39% of the total Donegal Bay count occurred within the Doorin Point-Salthill Pier subsite (range 18-67%%, excluding total counts of less than 50), and a mean of 9% the total Donegal Bay count occurred within the Mountcharles subsite (range 0-18%, excluding total counts of less than 50).

Table 7.14 – Great Northern Diver distribution by zones in I-WeBS counts of Donegal Bay, 2006/07-2010/11 and 2012/13

Winter	Month	Southern Bay	Inner Bay	Outer Bay	Total	% in Outer Bay
2006/07	Nov	3	3	122	128	95%
	Dec	4	3	59	66	89%
	Jan	3	3	84	90	93%
	Feb	7	5	9	21	43%
2007/08	Dec	7		25	32	78%
	Jan	4	3	57	64	89%
2008/09	Oct		2	38	40	95%
	Dec	10	12	46	68	68%
	Jan	5	9	24	38	63%
2009/10	Dec	10	4	77	91	85%
	Jan	10	3	97	110	88%
2010/11	Dec	7	10	67	84	80%
	Jan	19	9	145	173	84%
2012/13	Oct			22	22	100%
	Dec	1	8	56	65	86%
	Jan	4	5	46	55	84%
	Feb	3	5	86	94	91%

Note: there was incomplete coverage of subsites in the Outer Bay zone in February 2007 count.

Table 7.15 – Great Northern Diver distribution in the Outer Bay zone in I-WeBS counts of Donegal Bay, 2006/07-2010/11 and 2012/13

Winter	Month	Doorin Pt. - Salthill Pier	Mountcharles	Murvagh-Rossnowlagh	Donegal Bay total
2006/07	Nov	32	3	84	128
	Dec	23	12	24	66
	Jan	51	2	31	90
	Feb	5	4		21
2007/08	Dec	9		16	32
	Jan	23	1	33	64
2008/09	Oct	23	6	9	40
	Dec	34	10	2	68
	Jan	21	3	0	38
2009/10	Dec	34	14	29	91
	Jan	34	9	54	110
2010/ 11	Dec	20	6	41	84
	Jan	31	6	108	173
2012/13	Oct	4	3	15	22
	Dec	38	11	7	65
	Jan	16		30	55
	Feb	63	12	11	94

Murvagh-Rossnowlagh represents the combined count across the Murvagh, Rossnowlagh-Inishfad and Rossnowlagh subsites. Note: the Murvagh, Rossnowlagh-Inishfad and Rossnowlagh subsites were not covered in the February 2007 count.

Association with oyster trestles

7.70 The nature of the association between Great Northern Diver and oyster trestles is not known.

Impact assessment

7.71 Great Northern Diver does not occur in significant numbers within the Inner Bay zone. Therefore, they do not show significant spatial overlap with intertidal oyster applications or licenses within the Inner Bay zone.

7.72 Great Northern Diver regularly occur within two subsites in the Outer Bay zone containing intertidal oyster applications or licenses.

7.73 The Doorin Point-Salthill Pier supported a mean of 39% of the total Donegal Bay count. This subsite contains a single application for intertidal oyster cultivation covering an area of around 5 ha.

7.74 The Mountcharles subsite supported a mean of 9% of the total Donegal Bay count. This subsite contains several application and licenses for intertidal oyster cultivation covering an area of around 60 ha.

7.75 Great Northern Diver typically occurs as individuals or in dispersed small groups and range widely across the areas in which they occur. A single bird can move several 100 m over the course of a few successive dives. In the Doorin Point-Salthill Pier subsite, the intertidal oyster cultivation plot is too small to represent a significant area of habitat for Great Northern Divers. The intertidal oyster cultivation plots in the Mountcharles subsite cover a larger area, but the overall numbers of Great Northern Diver occurring within this subsite are low.

7.76 Intertidal oyster cultivation plots will only be available for use by Great Northern Divers during the high tide period.

7.77 Taking the above factors into account, even if Great Northern Divers have a negative response to intertidal oyster cultivation, any intertidal oyster cultivation in these plots will not cause significant displacement of Great Northern Divers.

Conclusions

7.78 Oyster trestles appear to be an attractive habitat for Light-bellied Brent Goose in Donegal Bay, particularly in the autumn/early winter, although disturbance from aquaculture operations may limit their utilisation of the habitat at times. Even if it was the case that the negative impact from disturbance outweighed the positive impact, the overall impact would not be complete exclusion of Light-bellied Brent Goose from the trestle blocks, but rather reduced utilisation of the area occupied by the trestle blocks compared to the utilisation of this area before trestles were introduced. Therefore, it seems likely that intertidal oyster cultivation has an overall positive impact on Light-bellied Brent Goose and, even if the overall impact was negative, it is extremely unlikely to cause significant displacement impacts.

7.79 While the data is limited, the complete avoidance of trestles by Sanderling flocks recorded in this assessment combined with reported a negative association between Sanderling and trestles reported in previous work indicate that Sanderling show more or less complete avoidance of oyster trestles. Sanderling regularly occurs within the Mountcharles/Eddrim Estuary area. The proportion of the Donegal Bay population that occur within this area at some point during the low tide period may be around 25%, although some flocks may only spend a short time within this area. Full occupation by trestles of the oyster licenses and applications within this area could potentially cause displacement of 5-10% of the Donegal Bay population, compared to the distribution that would be expected in the absence of any trestles.

7.80 The distribution of Common Scoter and Great Northern Diver in Donegal Bay does not show significant spatial overlap with main areas of suspended oyster cultivation licenses and applications.

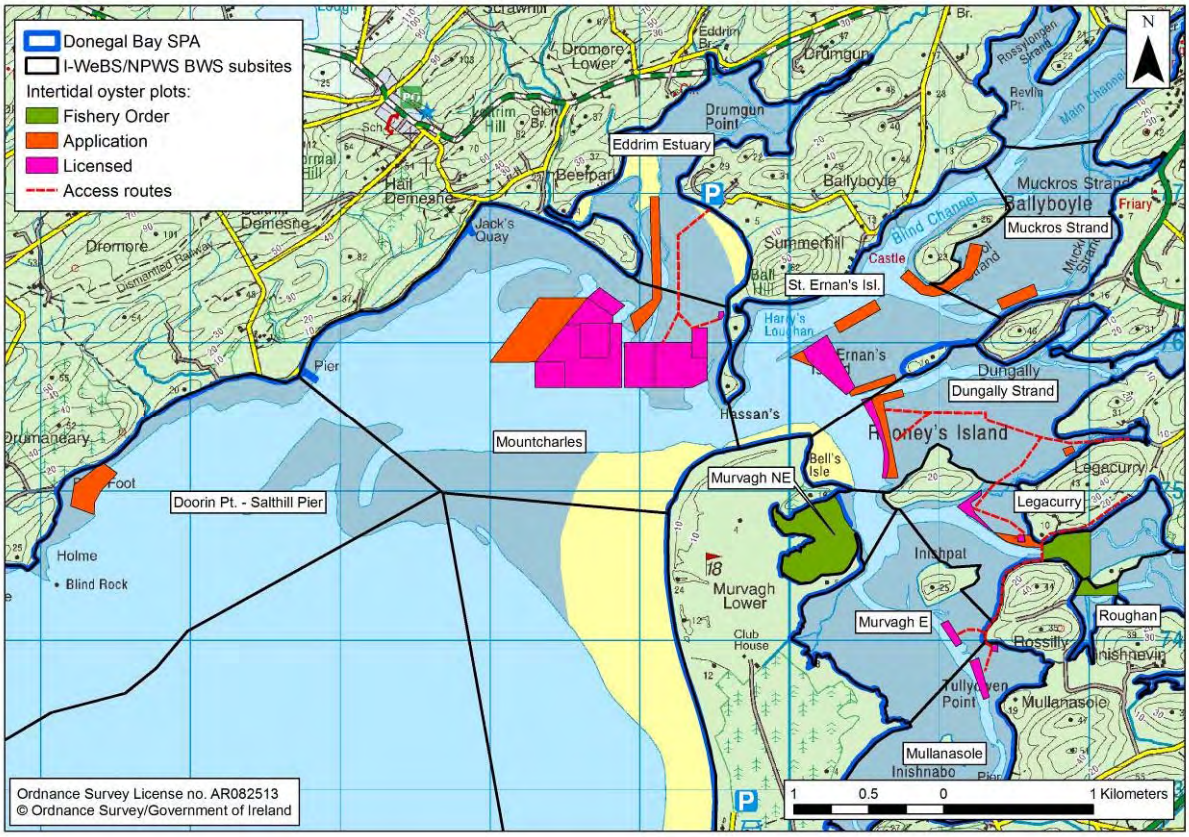

Figure 7.1 – Intertidal oyster cultivation applications and licenses

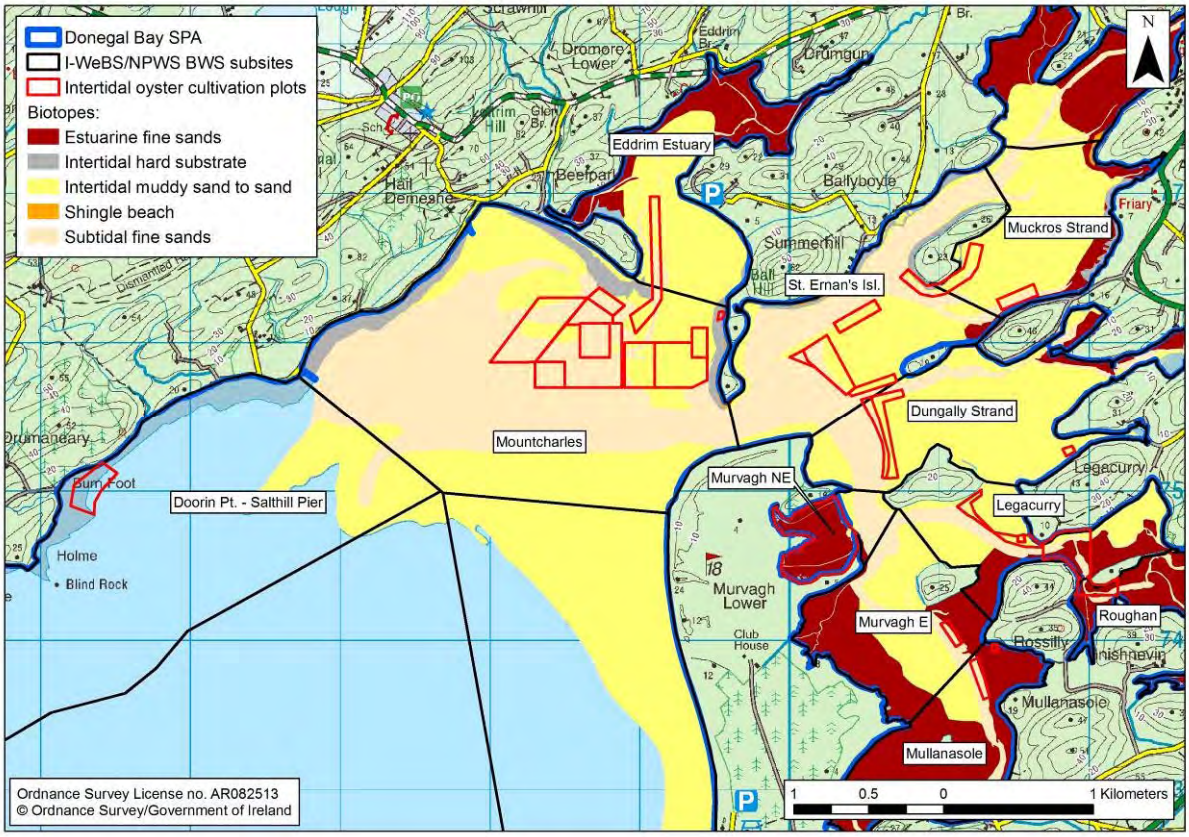

Figure 7.2 – Distribution of intertidal oyster cultivation plots in relation to biotopes

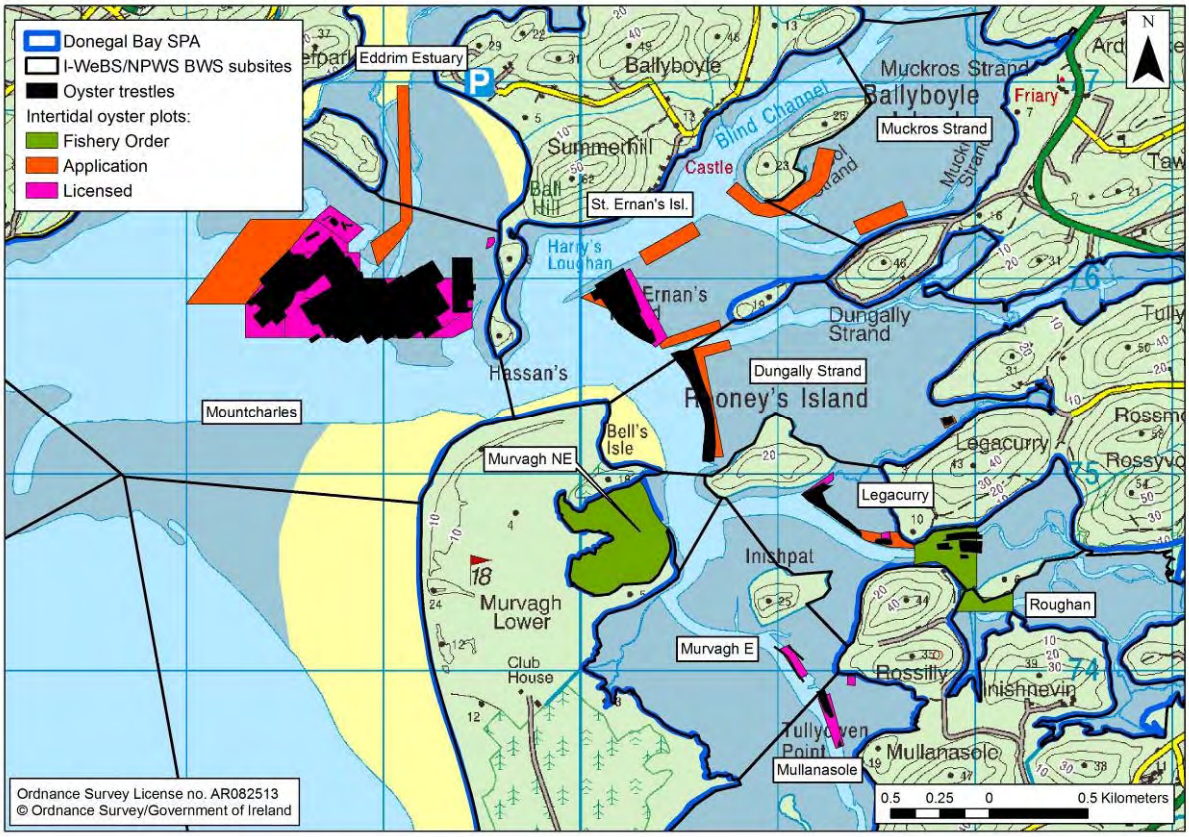

Figure 7.3 – Oyster trestles

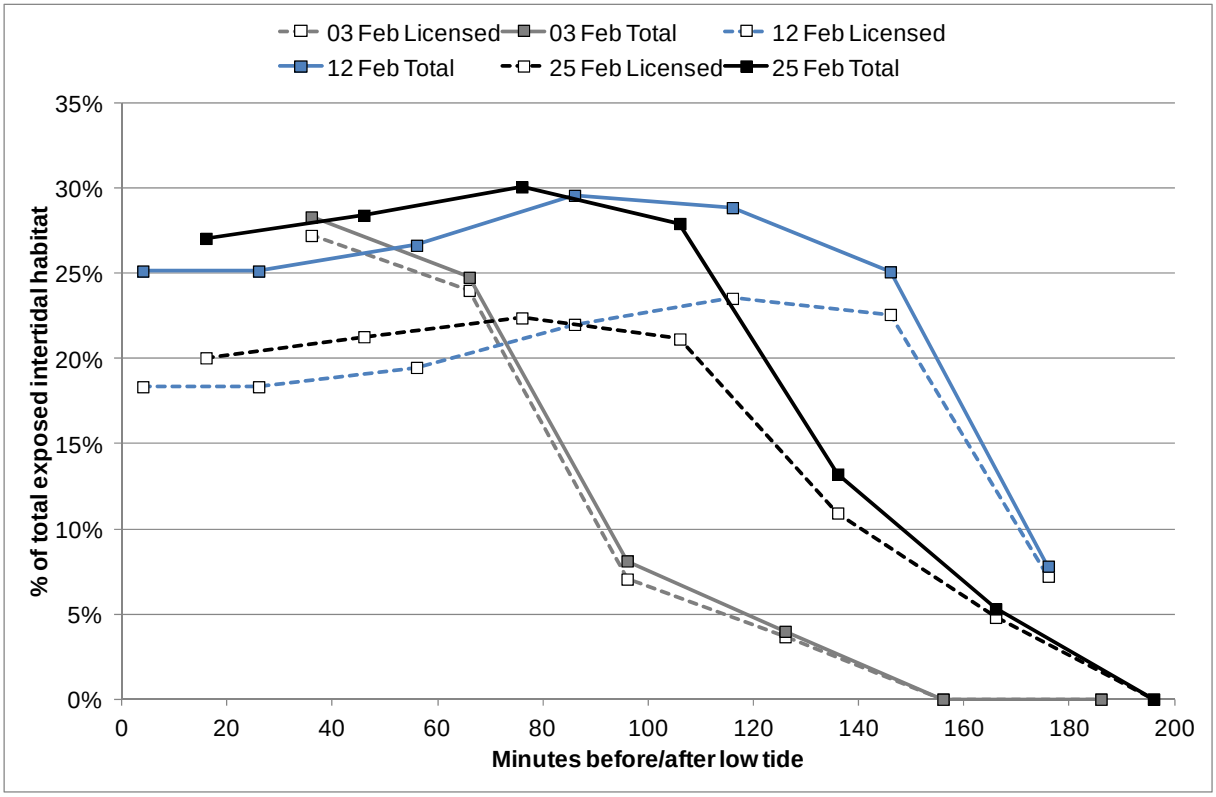

Figure 7.4 – Proportion of exposed intertidal habitat within intertidal oyster licenses and applications in the Mountcharles/Eddrim Estuary area on a 0.3 m low tide (12 Feb), a 0.6 m low tide (25 Feb) and a 1.2 m low tide (03 Feb)

8. Assessment of oyster bottom culture

Scope of activity

8.1 Within the Donegal Bay SPA there is one application for oyster bottom culture (covering 31 ha) in subtidal waters in the Doorin Point-Salthill Pier subsite (Figure 8.1).

8.2 The plot is located mainly in waters of between 2-5 m deep within the subtidal fine sands with polychaetes and bivalves community complex.

Description

8.3 The SAC AA describes this activity as follows:

> *Subtidal extensive culture of oysters involves the placement of oysters in an uncontained fashion on the seabed after a nursery phase in the intertidal zone. It is proposed that suitably sized oysters (> 15g – ½-grown) are spread within the licenced area. Oysters will be checked periodically when the progress (growth and mortality) of the oysters will be monitored and intervention will be necessary if anomalies are discovered. For example, oysters may need turning-over if excessive fouling or siltation is noted on the animals. Such intervention, as well as harvesting (when oysters are approximately 100g, will be carried out using oyster dredges deployed from boats. The dredges are typically 1.5m wide and have contact with the substrate via a flat blade. Harvest is expected 24-36 months after initial seeding. This may be shorter depending upon the size of the seed and the production capabilities of the area in question. This culture method is carried out in an uncontained fashion whereby oysters are spread on the seabed and left to grow to market size for 18-24 months.*

8.4 The location of the area that will be used for the nursery phase have not been specified. However, we assume that this will take place within one of the intertidal oyster cultivation plots. Therefore, this component of the activity is covered under the assessment of intertidal oyster cultivation (see Section 7) and is not considered further.

Potential impacts

Potential impacts on habitat structure and prey resources

8.5 The SAC AA states that:

> *Uncontained sub-tidal oyster culture will lead to change in community structure and function through the addition, at high % cover, of an epi-benthic species (living on the seabed) to an infaunal sedimentary community.*
>
> *The activities associated with this culture practice (dredging of the seabed) are considered disturbing which can lead to removal and/or destruction of infaunal species and changes to sediment composition. In addition, the location of large numbers of a single epifaunal species onto what is, in essence, an infaunal dominated system will likely result in a change to the habitat.*

8.6 It is considered unlikely that increases in oyster density (even to 10's per m^2) would impact negatively on fishes. In fact, it is possible that fish production/abundance would increase. The oysters, along with shell 'hash', provides a low relief habitat that will increase general heterogeneity in overall structure and which has been shown to increase diversity and abundance of fish species. However, it should be noted that these conclusions relate to work conducted on a different oyster species, *Crassostrea virginica* in the US (Francis O'Beirn, Marine Institute, pers. comm. See also Lenhert and Allen, 2002; Scyphers, *et. al.*, 2011; Tolley and Volety, 2005).

Potential impacts from habitat alteration on SCI species

8.7 The potential impacts on habitat structure and prey resources will only potentially affect SCI species that make significant use of subtidal waters as a feeding habitat. Common Scoter, Great Northern Diver and Light-bellied Brent Goose all feed in subtidal waters. However, Light-bellied Brent Goose only feed in shallow waters (e.g., just below the tideline) and the water depth within the oyster bottom culture plot (2-5 m) is too deep for it to be suitable feeding habitat for this species (Clausen, 2000). Therefore, Common Scoter and Great Northern Diver are the only SCI species that could potentially be affected.

8.8 Common Scoter feed mainly on molluscs, as well as other benthic invertebrates. However, oysters do not appear to have been recorded in their diets. The Common Eider, another molluscan feeding duck, has been recorded feeding on oysters. However, Scheiffarth *et al*. (2007) find it "*difficult to imagine how they could succeed in tearing a Pacific Oyster loose from the substrate and subsequently swallow it*". Furthermore, they consider it "*unlikely that Common Eiders take mussels attached to oysters*" so the species "*obviously loses foraging opportunities when mussel beds turn into oyster beds*". The Common Eider is a larger duck than the Common Scoter, so the latter species is presumably even more unlikely to be able to take oysters. Therefore, this species could be affected by oyster bottom culture causing reduced suitability of existing mussel beds. In addition, the impacts on the subtidal habitat from bottom culture of oysters described in the SAC AA may also have negative impacts on other Common Scoter prey species. In particular several bivalve species (potential prey for Common Scoter) in the subtidal biotope are described as sensitive to organic enrichment.

8.9 Great Northern Diver is a mainly fish-eating species. As bottom oyster culture is considered unlikely to negatively affect fish populations (see above), potential negative impacts from habitat alteration due to bottom oyster culture to Great Northern Diver are considered unlikely and are not discussed further.

Potential disturbance impacts on SCI species

8.10 The relaying of the oysters and the stock movements during ongrowing has the potential to cause disturbance impacts to SCI species that use subtidal waters. These include Common Scoter, and Great Northern Diver. In addition, while Light-bellied Brent Goose are unlikely to make significant use of the oyster bottom culture plot for feeding, they can roost in deeper waters, so could also be affected.

8.11 However, these activities will only occur for short periods of time, and will only affect limited areas of habitat at any one time, so any disturbance impacts will be of short duration and will not affect the availability of resources in this area.

8.12 Therefore, there are no potentially significant disturbance impacts that are likely to arise from the ongrowing of oysters in subtidal waters.

Assessment

Common Scoter

Distribution within Donegal Bay

8.13 Common Scoter mainly occur in the middle section of Donegal Bay across the Murvagh, Rossnowlagh and Rossnowlagh-Inishfad subsites. In the NPWS BWS counts, a mean of 91% (range 78-99%) of the total count occurred within these subsites (Table 8.1). In I-WeBS counts between 2006/07 and 2010/11, a mean of 96% (range 77-100%, excluding total counts of less than 100) the total count occurred within these subsites (Table 8.2). In 2012/13, total counts were very low and birds were absent or present in very low numbers in these subsites on some of the counts.

8.14 The flock locations recorded in the NPWS BWS survey indicate that in Donegal Bay Common Scoter mainly occur within water of less than 10 m depth (Figure 8.2).

8.15 The oyster bottom culture plot is located in the Doorin Point-Salthill Pier subsite. In the NPWS BWS counts, they occurred within this subsite on all the counts, with low numbers on four of the counts (less than 5% of the total count) and higher numbers on one count (16% of the total count), giving a mean occurrence across all the counts of 5%. In the I-WeBS dataset, there are seven counts for this subsite ranging from 6-41 birds. There are also two counts of four birds each from the Mountcharles subsite.

8.16 It should be noted that the I-WeBS counts of Donegal Bay were not considered to produce consistent data for Common Scoter (NPWS, 2012b), as is typical for this species (Crowe, 2005), due to the difficulty of counting this species from land-based vantage points. Therefore, the I-WeBS dataset may not produce a very precise indication of Common Scoter distribution by subsites, particularly for those subsites (such as the Doorin Point-Salthill Pier subsite) in which relatively small numbers occur.

Table 8.1 – Distribution of Common Scoter in the NPWS BWS of Donegal Bay, 2009/10

Subsite	21 Oct LT	04 Nov LT	02 Dec LT	07 Feb HT	17 Feb LT
Doorin Pt. - Salthill Pier	55	30	22	2	395
Murvagh	740	1110	1394	1400	1600
Rossnowlagh - Inishfad	34		176	228	399
Rossnowlagh	158		37	296	104
Aughrus Pt - Bundoran	205			13	36
Total	1192	1140	1629	1939	2534

Table 8.2 – Common Scoter distribution in I-WeBS counts of Donegal Bay, 2006/07-2010/11 and 2012/13

Winter	Month	Doorin Pt. - Salthill Pier	Mountcharles	Murvagh-Rossnowlagh	Aughrus Pt - Bundoran	Total
2006/07	Nov		3	651	16	670
	Dec	12		569	60	641
	Jan	3		295	11	309
	Feb	8			57	65
2007/08	Dec			496		496
	Jan			402	103	525*
2008/09	Oct			318		318
	Dec			505		505
2009/10	Dec	41		1427		1468
	Jan	20		2307		2327
2010/11	Dec	30	4	1685	1	1720
	Jan	6		1785		1791
2012/13	Sep	12		45		57
	Oct	6		115		121
	Dec			0	134	134
	Jan		4	5	126	135
	Feb	7		3	1	11

* also includes a count of 20 in the Creevy Pier - Kildoney Point subsite

Murvagh-Rossnowlagh represents the combined count across the Murvagh, Rossnowlagh-Inishfad and Rossnowlagh subsites. Note, the Murvagh, Rossnowlagh-Inishfad and Rossnowlagh subsites were not covered in the February 2006 count.

Distribution within the Doorin Point-Salthill Pier subsite

8.17 The flock locations recorded in the NPWS BWS survey were mainly well below the oyster bottom culture plot, around 1 km out from the shoreline on the southern side of the Murvagh Spit (Figure 8.3). It is necessary to be cautious in the interpretation of the locations of distant flocks recorded from shore-based vantage points. However, at least for the December count, the original field map indicates that a sandbar was exposed at the tip of the Murvagh Spit, so the flock positions recorded below the spit on this count were clearly outside the oyster bottom culture plot. As the same counter carried out all the counts of this subsite, it is likely that the recording of flock positions was consistent across the counts. Therefore, the flock positions recorded in the NPWS BWS survey indicate that, at least during that winter, at low tide, Common Scoter flocks did not regularly occur within the oyster bottom culture plot.

Impact assessment

8.18 Common Scoter typically occurs in small numbers within the Doorin Point-Salthill Pier subsite. However, the precise importance of the subsite is difficult to gauge to the limitations of the I-WeBS dataset, and it is possible that it could hold 5% or more of the Donegal Bay population.

8.19 The recorded information on Common Scoter flock locations from the NPWS BWS survey indicate that scoter flocks do not regularly occur within the oyster bottom culture plot.

8.20 Even if the flock locations recorded by the NPWS BWS are atypical, the oyster bottom culture plot occupies around 10% of the total area of subtidal habitat of less than 10 m depth within the Doorin Point-Salthill Pier subsite. Therefore, if scoter were dispersed throughout the suitable subtidal

habitat within the subsite, only a fraction of a percent of the total Donegal Bay population would be likely to occur within the oyster bottom culture plot.

8.21 The oyster bottom culture plot would only be likely to support significant numbers of scoter if it has some concentrated food resource, such as a mussel bed. However, if this was the case then scoter flocks should have been recorded within the plot during the NPWS BWS survey.

8.22 In conclusion, the oyster bottom culture plot does not appear to support significant numbers of Common Scoter. Therefore, oyster bottom culture in this plot will not cause significant displacement of Common Scoter

Conclusions

8.23 No potentially significant impacts from the proposed oyster bottom culture have been identified in this assessment.

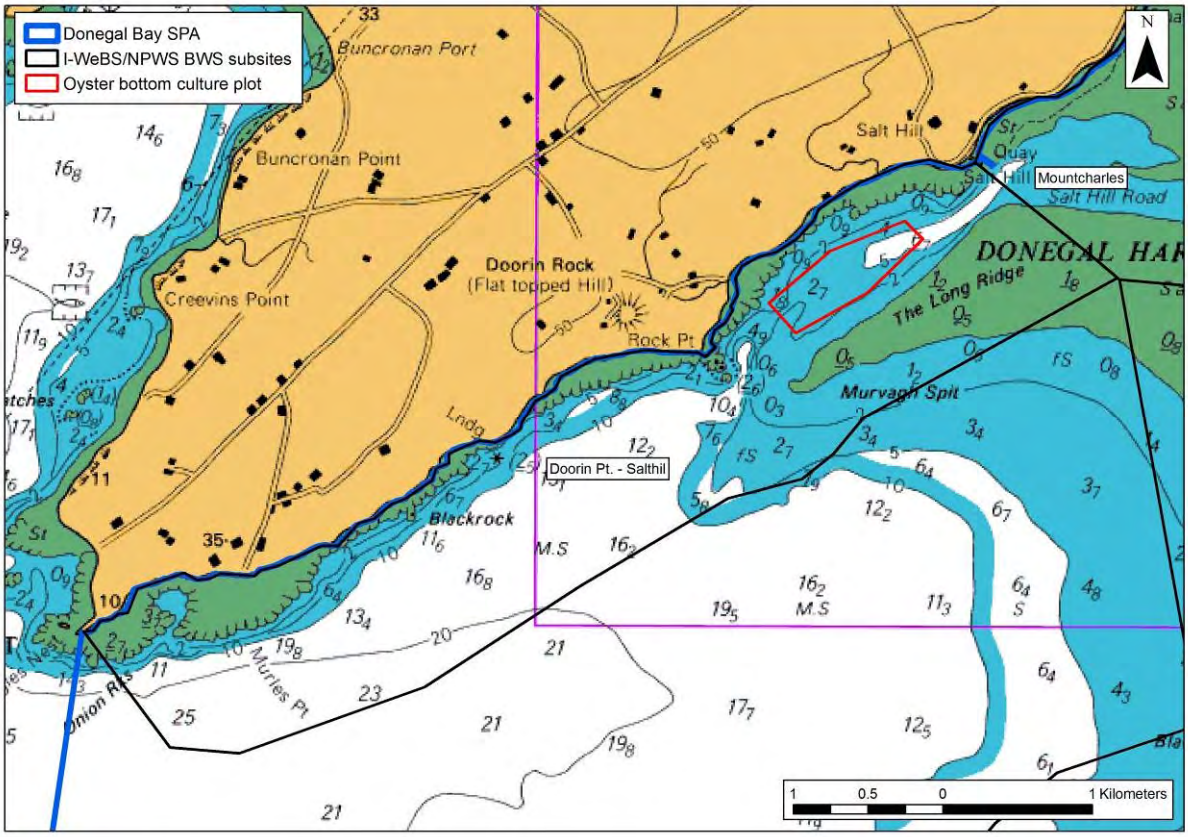

Figure 8.1 – Location of the oyster bottom culture plot

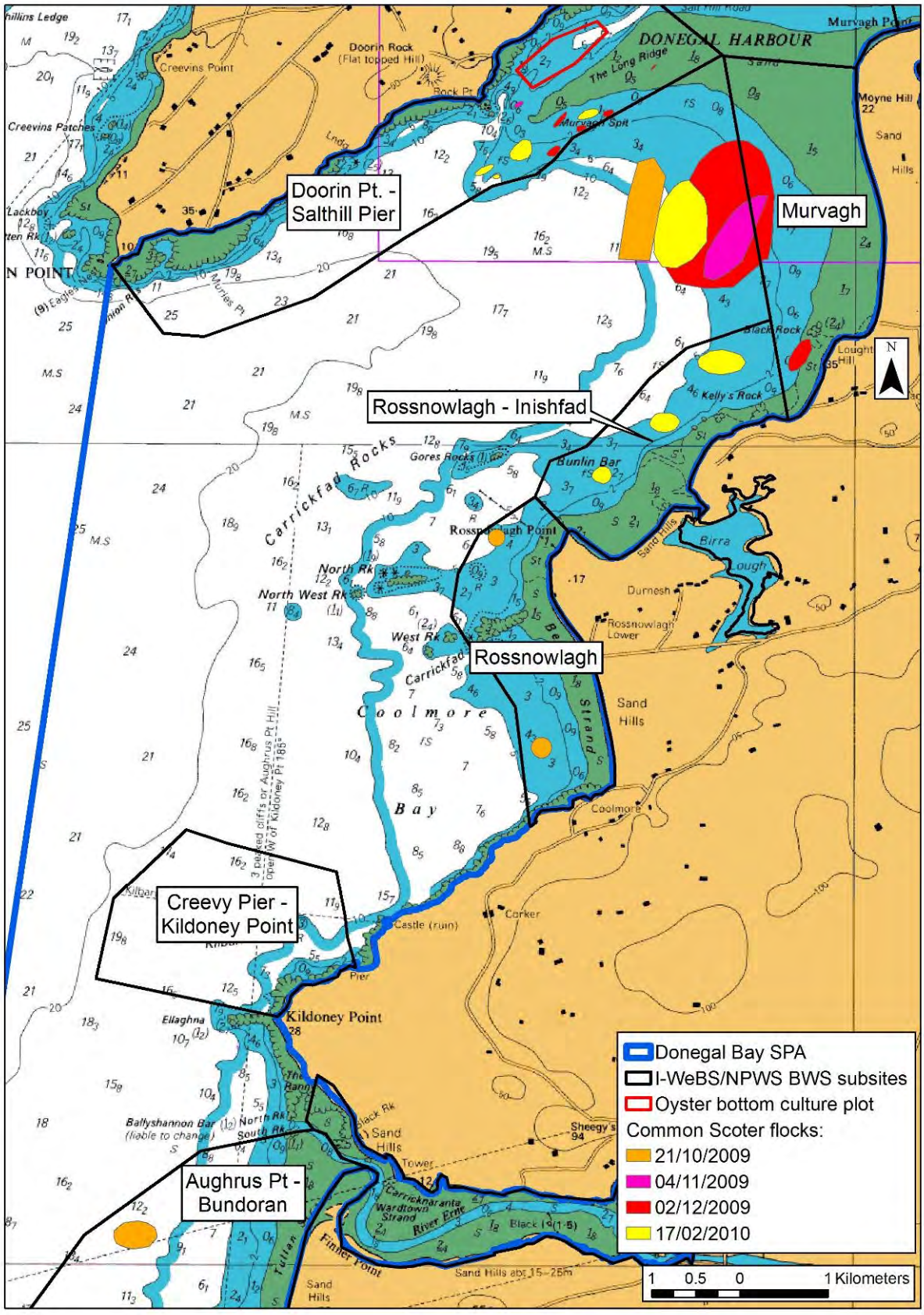

Figure 8.2 - Location of Common Scoter flocks across Donegal Bay, recorded during the NPWS BWS survey

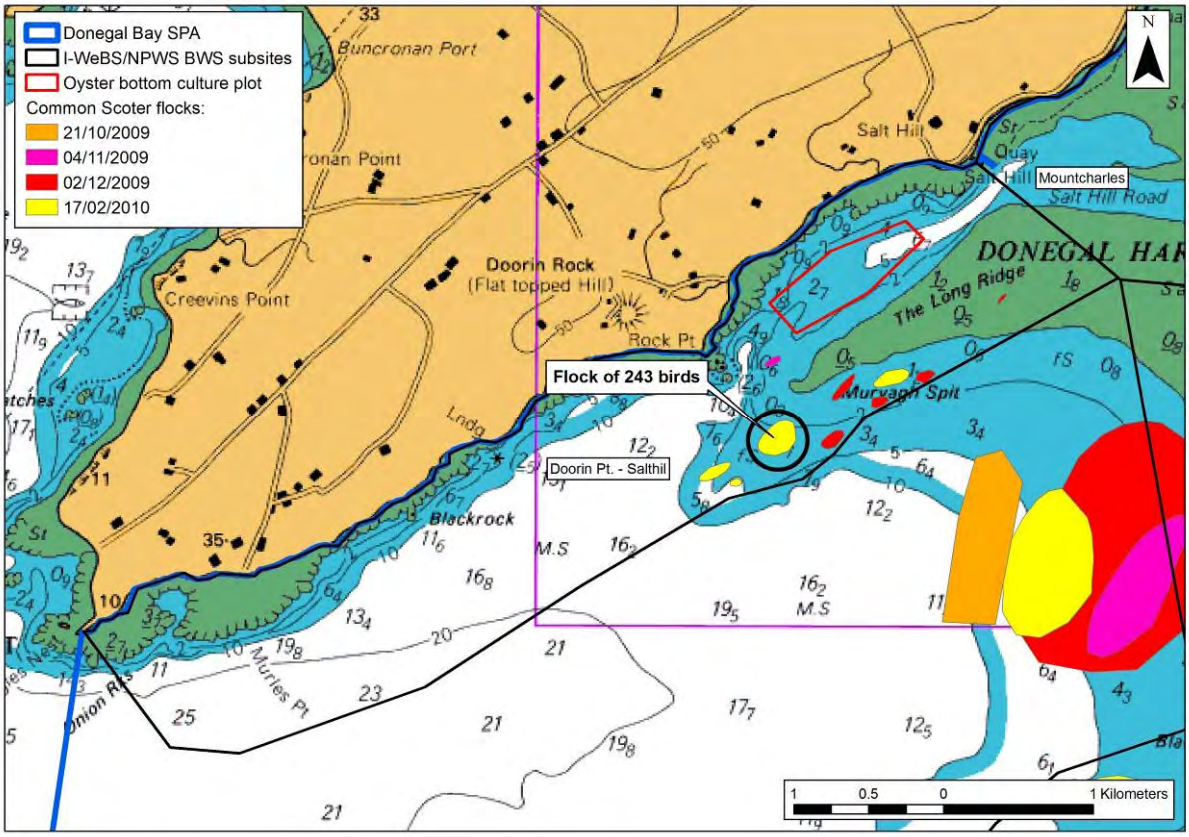

Figure 8.3 – Location of Common Scoter flocks within the Doorin Pt. – Salthill Pier subsite, recorded during the NPWS BWS survey

9. Intertidal culture of sea urchins

Scope of activity

9.1 There is one application for intertidal farming of sea urchins in a plot located at the western end of the Doorin Pt.-Salthill Pier subsite, covering an area of 6.8 ha. (T12/428A). The plot is located within the intertidal zone, in the intertidal hard substrate biotope.

Description

9.2 Historically, sea urchins were hand collected by scuba divers working from small boats. There was no minimum catch limit; specimens were sorted on deck with quality specimens retained and others thrown back. The fishing season traditionally ran from October to February. Sea urchins are extremely vulnerable to overfishing especially when spawning stock is also being removed. While in the 1970's over 500 tonnes of sea urchin were produced in Ireland annually; the industry saw a significant decline in production since the 1990's.

9.3 The current application is for the farming of sea urchin at a 6.8 ha. site immediately east of Doorin Point (the site held a trial licence between 1999 and 2002). The species to be farmed is likely to be *Paracentrotus lividus* or purple sea urchin. Broodstock conditioning, hatchery and early nursery ongrowing is done in onshore facilities; the first such commercial hatchery was developed in Dunmanus Bay, Co. Cork during the 1990's (Watson and Stokes, na) and it is from here that juveniles are likely to be sourced for Donegal. In tandem with the production of juveniles was the application for aquaculture licences to ongrow these juveniles in intertidal and subtidal pools. It is for the latter process that the current licence application at Doorin Point refers. Juvenile urchins are ready to go to sea after one year at a size of 15mm; however, at this site they are more likely to be put out at 20mm to maximise survival. Urchins planted out in intertidal and subtidal rockpools reach market size in 4 years. This extensive system of farming mimics natural conditions with planted urchins feeding on naturally growing algal frequenting intertidal and shallow subtidal waters.

Potential impacts

9.4 The licence application block is predominantly located within the intertidal zone, in the intertidal hard substrate biotope. No physical structures are to be placed on the foreshore and no vehicular access tracks are envisaged. Unlike with oyster cultivation where ongoing maintenance of bags etc. is required no such pattern of regular maintenance operations is required for sea urchins which are effectively left to there own devices once planted. Furthermore, no habitat alteration or programmes of intensive predator control are envisaged. The first stock planted would take 4 years to reach maturity; thereafter harvesting of stock for market would be annual and would most likely occur between December and March. Densities at which sea urchins are planted may be somewhat higher than would be normal to allow for losses; however, excessively high densities would merely deplete available algal food resources and as such are not desirable. The main food species is likely to be *Laminara* brown algals; most of which will be washed onto the application plat during high seas.

Assessment

Light-bellied Brent Goose

9.5 The distribution of Light-bellied Brent Goose on the NPWS BWS counts is shown in Table 6.1-6.4. While large numbers of Brent Geese occur in the Outer Bay the majority usually occurred between Murvagh and Rossknowlagh (Table 6.3); though counts of up to 113 have been recorded in the Doorin Pt.-Salthill Pier subsite within which the licence application is located. Intertidal hard

substrate biotope which characterises the application site offers suitable feeding / roosting habitat for Light-bellied Brent Goose, though generally at a low density spread out along the shoreline where they feed on intertidal and shallow subtidal algae. The predicted levels of disturbance are unlikely to affect patterns of site usage by Light-bellied Brent Goose (see discussion of disturbance with respect to culturing oyster on trestles). The main risk is localised loss of food due to overgrazing of algae by locally elevated populations of sea urchin. The area of available intertidal habitat within the application block is ca. 3.1% of that within the Doorin Pt.-Salthill Pier subsite. Even allowing for the unlikely worst case scenario in which there is a collapse in algal stocks within the licence block due to overgrazing by sea urchin this is not likely to have a negative impact on brent geese within this subsite or the wider Donegal Bay SPA due to the small area occupied by the application.

Sanderling

9.6 Areas of intertidal hard substrate such as those located within the application block are not favoured by Sanderling which instead favour open sand shores (Summers *et al*., 2002). Sanderling were not recorded in any number or with any degree of regularity in the Doorin Pt.-Salthill Pier subsite in any of the surveys discussed above, favouring instead sandflats such as those around the northern side of Murvagh. Given the small numbers of Sanderling that occur within this subsite and the small area occupied by the application, any intertidal farming of sea urchin in this plot will not cause significant impacts or displacement of Sanderling.

Common Scoter

9.7 The distribution of Common Scoter within Donegal Bay is discussed in detail in Section 7.

9.8 In the NPWS BWS counts, Common Scoter occurred within Doorin Pt.-Salthill Pier subsite on all the counts, with low numbers on four of the counts (less than 5% of the total count) and higher numbers on one count (16% of the total count). In the I-WeBS dataset, there are seven counts for this subsite ranging from 6-41 birds.

9.9 Common Scoter usually occur in small numbers within this subsite. This subsite contains a single application for sea urchin farming covering an area of around 6.8 ha. Given the small numbers of Common Scoter that occur within this subsite, the small area occupied by the application for intertidal sea urchin farming, and the fact that scoter would only be able to use this area during the high tide period, any intertidal sea urchin farming in this plot will not cause significant displacement of Common Scoter.

Great Northern Diver

9.10 Great Northern Diver mainly occur within the Outer Bay zone of Donegal Bay, with a mean of 86% (range 80-100%, excluding total counts of less than 50) of the total count within this zone across the I-WeBS dataset (see Table 6.14). Within the Outer Bay zone, Great Northern Diver regularly occur within all the subsites, although Doorin Point-Salthill appear to be the subsite that most consistently supports large numbers (see Table 6.15).

9.11 A mean of 39% of the total Donegal Bay count occurred within the Doorin Point-Salthill Pier subsite (range 18-67%%, excluding total counts of less than 50).

9.12 Great Northern Diver typically occurs as individuals or in dispersed small groups and range widely across the areas in which they occur. A single bird can move several 100 m over the course of a few successive dives. Unlike cultivation of oysters on trestles no physical structures and associated habitat loss is likely with the proposed extensive system of farming sea urchin. Even assuming a worse case scenario in which divers might be excluded from this area the application plot is too small to represent a significant area of habitat loss for Great Northern Divers in Donegal Bay.

9.13 It should also be noted that intertidal sea urchin farming plots will only be available for use by Great Northern Divers during the high tide period.

9.14 Taking the above factors into account any sea urchin farming in these plots will not cause significant displacement of Great Northern Divers.

Conclusions

9.15 Taking the above factors into account any sea urchin farming in these plots will not cause significant displacement of Light-bellied Brent Geese, Sanderling, Common Scoter or Great Northern Divers.

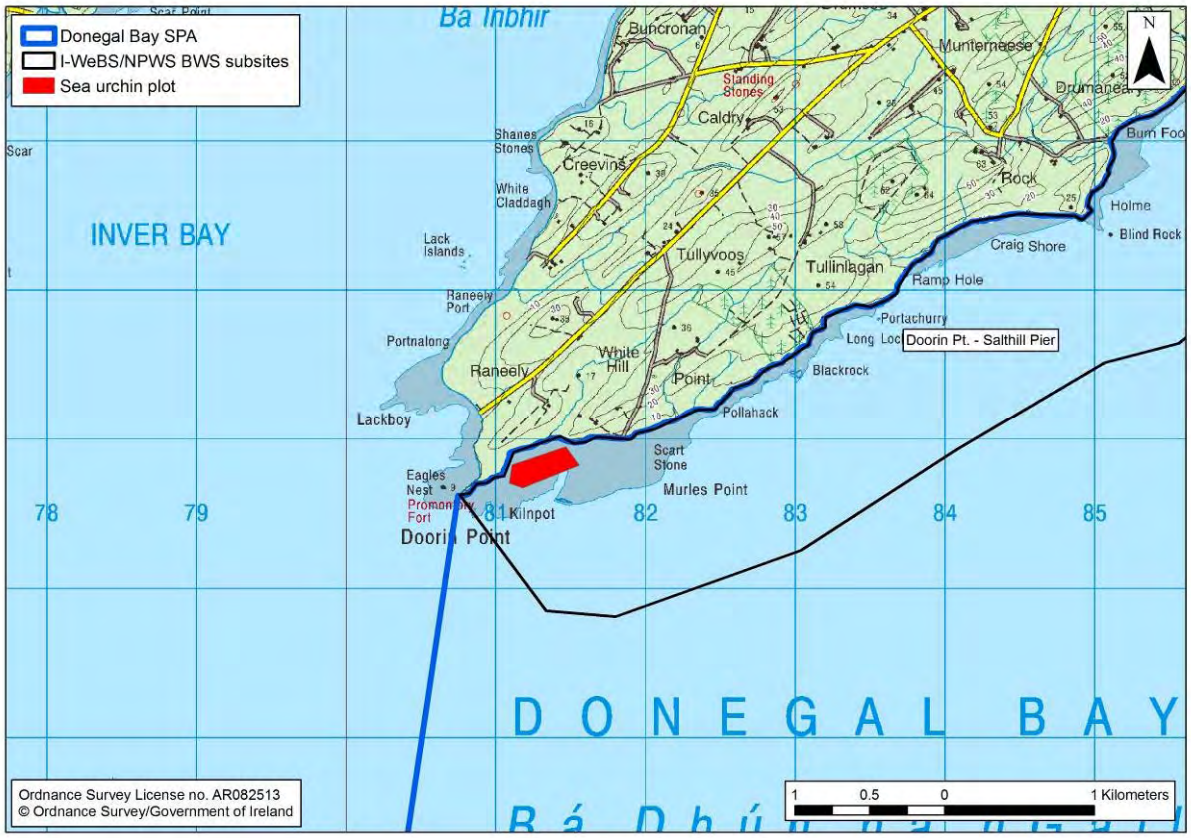

Figure 9.1 – Location of application plot for intertidal sea urchin cultivation

10. Fisheries

Scope of activity

10.1 There are also a number of Fisheries within Donegal Bay, largely outside of and west of the SPA. Fishery data in the SAC and SPA and in the sea area east of St. Johns Point and Mullaghmore indicates that this is mainly comprised of punts fishing for sprat, salmon, shrimp, lobster and crab. These small vessels change activity seasonally and even monthly. Approximately 27 of these small (<8m) vessels in total use waters around Donegal Bay east of St. Johns and Mullaghmore. In addition, larger vessels target sprat and to a lesser extent herring in autumn in Inver Bay (pelagic trawls) and bottom otter trawls target mixed demersal and *Nephrops* in Inver Bay and south west to Inishmurray. There is a draft net fishery for salmon in Inver Bay estuary. There is very little activity in the SPA and none in the SAC with most of the fisheries activity being in waters west of the SAC and SPA. Description

10.2 Fisheries in Donegal Bay (see distribution maps in Annex I SAC assessment) can be broken down as follows: -

1. Pelagic trawl and encircling nets for sprat and herring
   - Sprat (*Sprattus sprattus*); Mainly in Inver Bay. Includes VMS vessels using pelagic trawls and <15m vessels out of Killybegs. Up to 20 punts using ring nets and other encircling nets. Autumn fishery running from September to November.
   - Herring (*Clupea harengus);* Fishery at St. Johns Point between December and January using pelagic trawls. All vessels carry VMS.

2. Line fishing
   - Mackerel (*Scomber scombrus*); a mackerel fishery operates from St. Johns Point to Inver Bay using small punts.
   - Squid; a squid fishery again operates from punts in waters from St. Johns Point to Inver Bay between August and September. Fishing occurs in the morning and evening.

3. Atlantic Salmon (*Salmo salar*); There are 10 draft net licences in this area. Fishing occurs from mid May to 1st August in the estuary of the Inny River and into Inver Bay, along the shore.

4. Pots
   - Lobster (*Homarus gammarus*) / Edible crab (*Cancer pagurus*); – potting for lobster and crabs peaks during the summer months. There is some trammel netting (bait fishing) associated with this fishery mainly by the smaller vessels with less gear. Vessels with more gear tend to purchase frozen bait. Landings / activity tends to be as follows: - From St. Johns to Doorin Pt. there are up to 20 punts, all part time; there is NO activity east of Doorin Pt.; 7 punts / half deckers operate from Mullaghmore to Creevy – effort is mainly 200 pots per vessel, with some of the larger vessels (maybe 1-2 vessels) operating 350-400 pots.
   - Pink Shrimp (Common Prawn) (*Palaemon serratus*); – potting for shrimp operates in a well defined season between August and May (mainly between September and December); up to 20 punts (the same vessels as in lobster and sprat fishery above) operate between St. John's Point and Inver Bay. The volume of gear used is unknown
   - Nephrops (*Nephrops norvegicus*); - potting for Nephrops (Norway lobster or Dublin Bay prawn) takes place between St. Johns Point to Inver Bay. The level of activity tends to be low and episodic. No further information on the fishery, volume of gear used etc. is available.

5. Demersal; - there is also a mixed / *Nephrops* demersal fishery operated by both VMS vessels and <15m trawlers operating out of Killybegs, Co. Donegal. Tracks run from i) St. Johns Point to Inver Bay and ii) southwest from St. Johns Point to Inishmurray.

Potential impacts

10.3 As all activities occur in offshore subtidal waters there is no impact predicted on intertidal shores used by either Sanderling or Light-bellied Brent Geese.

10.4 Both Common Scoter and Great Northern Diver feed in flooded intertidal waters and in subtidal wasters; Common Scoter on bivalves, Great Northern Diver on fish and crabs. As there is potential for impact on the latter two species these are considered further below; see also Table 9.1.

Table 9.1 – Potential for Impact on Common Scoter and Great Northern Diver associated with fisheries in Donegal Bay

Fishery	Target	Season	Temporal Overlap*	Spatial Overlap
Pelagic	Sprat	Sept – Nov	Partial temporal overlap early in autumn / winter only	Mainly in Inver Bay to the west; some fishery effort within the SPA.
	Herring	Dec - Jan	Limited temporal overlap in mid-winter	Fishery at St. Johns Point; some fishery effort possible within the SPA.
Line	Mackerel	Late summer / early Autumn	Partial temporal overlap early in autumn	Main fishery is St. Johns Point to Inver Bay, though mackerel fishing likely to occur within the Bay
	Squid	Aug - Sept	Partial temporal overlap early in early autumn only	Mainly from St. Johns Point to Inver Bay
Draft nets	Atlantic Salmon	Mid-May to 1st August	No overlap	n/a
Potting (with associate trammel netting)	Lobster / Crab	Peaks in summer months	No overlap	n/a
	Pink Shrimp	Aug – May (mainly Sept – Dec)	Partial temporal overlap early in autumn / winter only	Mainly from St. Johns Point to Inver Bay
	Nephrops	Summer-Autumn	Partial overlap	Mainly from St. Johns Point to Inver Bay
Demersal	Mixed / *Nephrops*	All year	Ovelap	i) St. Johns Point to Inver Bay and ii) Southwest from St. Johns Point to Inishmurray.

* Note: All SCI species are winter visitors to Donegal Bay; largely between September and April.

Risk Assessment

Pelagic

10.5 There are two pelagic fisheries in the environs of Donegal Bay, sprat (*Sprattus sprattus*) and herring (*Clupea harrengus*). Sprat is a species which comes inshore during the winter period. The sprat fishery closest to Donegal SPA is that in Inver Bay. The fishing fleet is a combination of >15m vessels (which carry VMS) using pelagic trawls and <15m vessels out of Killybegs. The smaller vessels include up to 20 punts using ring nets and other encircling nets. The fishery is predominantly an autumn fishery running from September to November.

10.6 There are no herring spawning beds in Donegal Bay; main spawning areas are west Donegal and along the north Mayo coast (MI 2012). Large aggregations of herring are unlikely to occur in inner Donegal Bay therefore although herring do occur throughout the Bay.

10.7 The fishery being considered here is primarily a sprat fishery which occurs around St. Johns Point between December and January using pelagic trawls; vessels >15m carry VMS. A number of punts are involved in the fishery.

10.8 The fisheries are not within an area used by any of the intertidal SCI species for which the bay is listed; i.e. Sanderling or Light-bellied Brent Geese.

10.9 We have no data on numbers or spatial distribution of Common Scoter, if any, around St. Johns Point or of interchange between this area and Donegal Bay; however, the diet of Common Scoter is overwhelmingly dominated by bivalves (Fox, 2003, BWPi, 2004 and Kaiser et al. 2005); pelagic fishing for sprat or herring will not affect bivalve food availability for this species nor does it occur within Donegal Bay SPA.

10.10 Unlike the other diver species, Great Northern Divers occur frequently in exposed, deep coastal and marine waters. However, onshore winds will bring these divers into shallower waters. Great Northern Divers are primarily fish eaters although a variety of other prey items can be taken including molluscs and crustaceans. Crab seems to be commonly taken in Irish waters (pers obs). We have no data on numbers or spatial distribution of Great Northern Divers, if any, around St. Johns Point or of interchange between this area and Donegal Bay; however, Great Northern Diver are likely to occur in suitable habitat through coastal areas north of Donegal Bay.

10.11 Some disturbance from fishing vessels may occur to birds outside the SPA. There is a low risk of by-catch of Great Northern Diver in pelagic trawls. Common Scoter are unlikely to attend close to fishing vessels. The pelagic fishery also removes potential prey, sprat and herring, from Inner Donegal Bay. Herring biomass in Area VI south is depleted and ICES recommends a re-building plan. ICES and MI (2012) recommend reduced catch of sprat as stock status is uncertain. Both species are subject to MSY 2015 objectives. Continued low biomass of Herring and uncontrolled exploitation of sprat may reduce the suitability of the Donegal SPA for Great Northern Diver. The SPA population is small and fish biomass required to sustain the population represents a small proportion of the available pelagic fish biomass even with current fishing effort. The risk to great northern diver posed by the pelagic fishery is low.

Line

10.12 There are two relatively small scale and intermittent line fisheries; i) mackerel (*Scomber scombrus*) and ii) Squid (*mixed species, including Loligo forbesi*).

10.13 Mackerel can be caught throughout Donegal Bay in late summer and early autumn. The mackerel fishery under consideration operates from St. Johns Point to Inver Bay using small punts and is entirely outside Donegal Bay SPA. The squid fishery again operates from punts in waters from St. Johns Point to Inver Bay between August and September. Fishing occurs in the morning and evening using a technique known as "jigging"; i.e. it relies on the use of lures to capture squid,

with the attractiveness of the lures being enhanced by moving the lures up and down in the water column.

10.14 The fisheries occur entirely outside Donegal Bay SPA; do not overlap with intertidal habitats (used by Sanderling and Light-bellied Brent Geese); and while in subtidal waters are timed and of a scale and proposed frequency that should not impact species such as Common Scoter or Great Northern Diver

Draft Nets

10.15 Draft netting occurs from mid-May to 1st August. The proposed fishery does not occur within Donegal SPA, nor is it within areas of intertidal habitat used by either Sanderling or Light-bellied Brent Geese from Donegal SPA. Furthermore, there is minimal to no temporal overlap between the fishery and the seasonal occurrence within Donegal Bay of Sanderling, Light-bellied Brent Geese and Great Northern Diver. While, Common Scoter numbers may begin to build up at wintering sites in mid summer (returning males) there is no data available for Donegal Bay for seasonal patterns of occurrence or for distribution of scoter in the Outer Bay and adjoining waters (i.e. areas which cannot be adequately covered by IWeBS). However, as noted draft netting does not occur within the areas of Donegal SPA known from either the IWeBS winter counts or the 2009 / 2010 NPWS Baseline waterbird survey to be favoured by Common Scoter.

10.16 Taking the above factors into account draft fishing for Atlantic Salmon in the estuary of the Inny River and into Inver Bay will not cause significant displacement of Common Scoter or Great Northern Divers.

Potting (Lobster / Crab)

10.17 The target species are Brown / Edible crab (*Cancer pagurus*), Velvet crab (*Necora puber*) and Lobster (*Homarus gammarus*).

10.18 Brown crab is abundant throughout the northeast Atlantic on mixed coarse grounds, mud and sand from shallow sublittoral to about 200 metres. Velvet crab favours rocky bottoms from the shoreline to a depth of about 65 metres. Adult lobster prefer hard substrates such as reef or mixed reef and sediment, and live in holes or crevices, emerging at night to feed; they can live at depths of 0–150 metres, but normally favour waters less than 50 m deep.

10.19 The fishery would use baited soft eye side entrance pots (creels) set in strings. Pots are baited with frozen fish blocks. Potting for lobster and crabs peaks during the summer months. There is some trammel netting (bait fishing) associated with this fishery mainly by the smaller vessels with less gear. Vessels with more gear tend to purchase frozen bait. Landings / activity tends to be as follows: - from St. Johns to Doorin Pt. there are up to 20 punts, all part time; there is no activity east of Doorin Pt.; 7 punts / half deckers operate from Mullaghmore to Creevy – effort is mainly 200 pots per vessel, with some of the larger vessels (maybe 1-2 vessels) operating 350-400 pots per vessel. The offshore areas in which it is proposed to pot for crab and lobster are not covered by either the IWeBS winter counts or the 2009 / 2010 NPWS Baseline waterbird survey, so the following comments are based upon known habitat / behavioural preferences of the SCI species listed for Donegal Bay.

10.20 The proposed fishery is not within an area used by any of the intertidal SCI species for which the bay is listed; i.e. Sanderling or Light-bellied Brent Geese.

10.21 The only other SCI species which forage in the benthic zone of offshore / marine subtidal waters, which could be impacted by crab and lobster potting, are Common Scoter and Great Northern Diver. The diet of Common Scoters presented in Fox (2003), BWPi (2004) and Kaiser et al. (2005) indicates that it is overwhelmingly dominated by bivalves (88% or greater of the diet composition in the eight studies reviewed by Kaiser et al., 2005). While crabs, fish and gastropods can be taken these don't appear to be significant elements of the diet (Kaiser et al., 2006).

10.22 To the best of our knowledge there is no evidence of accidental capture of these species diving birds in crab and lobster pots (creels) and the scale of proposed potting is not likely to affect the prey availability for either species. There is a low risk of capture of great northern diver and Common Scoter in trammel nets used in the SPA in association with the crab and lobster fishery. These nets are left unattended increasing the likelihood of spatial overlap with birds.

Potting (Pink Shrimp)

10.23 The target species is Pink shrimp (*Palaemon serratus*); also known as the common prawn). Individuals hide in rocky crevices at depths of up to 40 metres; the population is highly seasonal, with a pronounced peak in autumn. This species is an important food resource for a range of fish species. Baited shrimp pots will be set in strings; mesh size 10mm. Small fish and other small crustaceans are captured and brought on deck. Non target species are graded out on deck and discarded live. Small shrimp are usually graded on board and discarded live. As for lobster and crab fishing the gear is static. Potting for shrimp operates in a well defined season between August and May (mainly between September and December); up to 20 punts (the same vessels as in lobster and sprat fishery above) operate between St. John's Point and Inver Bay. The volume of gear used is unknown.

10.24 The proposed activity is therefore largely external to the SPA. As above, the offshore areas in which it is proposed to pot for pink shrimp are not covered by either the IWeBS winter counts or the 2009 / 2010 NPWS Baseline waterbird survey, so the following comments are based upon known habitat / behavioural preferences of the SCI species listed for Donegal Bay.

10.25 The proposed fishery is not within an area used by any of the intertidal SCI species for which the bay is listed; i.e. Sanderling or Light-bellied Brent Geese.

10.26 The only other SCI species which forage in the benthic zone of offshore / marine subtidal waters, which could be impacted by Pink shrimp potting, are Common Scoter and Great Northern Diver. The assessment is as above for lobster / crab; To the best of our knowledge there is no evidence of accidental capture of these species diving birds in crab and lobster pots (creels) and the scale of proposed potting is not likely to affect the prey availability for either species.

Potting (*Nephrops*)

10.27 *Nephrops norvegicus* (Norway lobster or Dublin Bay Prawn) is the most important commercial crustacean in Europe. In Donegal it is targeted by potting and demersal trawling (see below). Adults favour muddy sediments in which they dig 20-30cm deep burrows; they are both a scavenger and an active predator. Potting for Nephrops takes place between St. Johns Point and Inver Bay and is therefore outside Donegal Bay SPA. The level of activity tends to be low and episodic. No further information on the fishery, volume of gear used etc. is available. As above, the offshore areas in which it is proposed to pot for pink shrimp are not covered by either the IWeBS winter counts or the 2009 / 2010 NPWS Baseline waterbird survey, so the following comments are based upon known habitat / behavioural preferences of the SCI species listed for Donegal Bay.

10.28 The proposed fishery is not within an area used by any of the intertidal SCI species for which the bay is listed; i.e. Sanderling or Light-bellied Brent Geese.

10.29 The only other SCI species which forage in the benthic zone of offshore / marine subtidal waters, which could be impacted by Nephrops potting, are Common Scoter and Great Northern Diver. The assessment is as above for lobster / crab and Pink Shrimp; to the best of our knowledge there is no evidence of accidental capture of these species diving birds in pots (creels) and the scale of proposed potting is not likely to affect the prey availability for either species or cause disturbance to foraging birds.

Demersal (Mixed / *Nephrops*)

10.30 Demersal fisheries in Donegal Bay are mixed fisheries targeting primarily cod (*Gadus morhua*), whiting (*Merlangius merlangius*), haddock (*Melanogrammus aeglefinus*), pollack (*Pollachius pollachius*), plaice (*Pleuronectus platessa*), monkfish (*Lophius piscatorius*), black sole (*Solea solea*), lemon sole (*Microstomus kitt*) and Turbot (*Scopthalmus maximus*) (Donegal County Council, 2002). The Donegal fishery is also targeting *Nephrops* and uses bottom trawls.

10.31 This mixed / Nephrops demersal fishery operates from .15m vessels (carrying VMS) and from <15m trawlers - operating out of Killybegs, Co. Donegal. Tracks run from i) St. Johns Point to Inver Bay and ii) southwest from St. Johns Point to Inishmurray. In both cases these tracks are outside Donegal Bay SPA and will not impact upon SCI species for which the SPA has been designated.

Conclusions

10.32 Trammel netting poses a low risk, due to the possibility of capture in nets, to Great Northern Diver and Common Scoter. This gear is used in the SPA in association with the crab and lobster fishery and is left unattended.

10.33 Continued low biomass of herring and uncontrolled fishing for sprat may reduce the suitability of Donegal Bay SPA for Great Northern Diver. There is also a low risk of capture of Great Northern Diver in pelagic trawls. However, the risk to the SPA population is regarded as low as the species is not a specialised feeder on pelagic fish.

10.34 Consequence, likelihood and concluding risk scores for the SCIs are in Table 9.2.

Table 9.2 – Concluding risk scores for fisheries effects on SCI species in Donegal Bay SPA

	Bottom trawling		Pelagic trawling		Line fishing		Potting		Trammel netting		Draft netting	
Consequence	Prey reduction	By-catch	Prey reduction	By-catch	Prey reduction	By-catch	Prey reduction	By-catch	Prey reduction	By-catch	Prey reduction	By-catch
A003 Great Northern Diver *Gavia immer* (wintering)	1	1	1	1	0	0	0	0	0	1	0	1
A046 Light-bellied Brent Goose *Branta bernicla hrota* (wintering)	0	0	0	0	0	0	0	0	0	0	0	0
A065 Common Scoter *Melanitta nigra* (wintering)	1	1	0	0	0	0	0	0	0	1	0	1
A144 Sanderling *Calidris alba* (wintering)	0	0	0	0	0	0	0	0	0	0	0	0
Likelihood												
A003 Great Northern Diver *Gavia immer* (wintering)	2	1	2	1	1	1	1	1	2	1	2	1
A046 Light-bellied Brent Goose *Branta bernicla hrota* (wintering)	0	0	0	0	0	0	0	0	0	0	0	0
A065 Common Scoter *Melanitta nigra* (wintering)	2	1	0	1	0	0	0	0	0	1	0	1
A144 Sanderling *Calidris alba* (wintering)	0	0	0	0	0	0	0	0	0	0	0	0
Risk												
A003 Great Northern Diver *Gavia immer* (wintering)	2	1	2	1	0	0	0	0	0	1	0	1
A046 Light-bellied Brent Goose *Branta bernicla hrota* (wintering)	0	0	0	0	0	0	0	0	0	0	0	0
A065 Common Scoter *Melanitta nigra* (wintering)	2	1	0	1	0	0	0	0	0	1	0	1
A144 Sanderling *Calidris alba* (wintering)	0	0	0	0	0	0	0	0	0	0	0	0

11. Assessment of cumulative impacts

Assessment of cumulative impacts of aquaculture projects and plans and fishing activities

11.1 This section assesses whether the combined effects of the three aquaculture activities and fisheries covered in this assessment could have significant impacts on the SCI species.

Light-bellied Brent Goose

11.2 There is potential for the combined effects of suspended oyster cultivation and intertidal sea urchin cultivation to cause cumulative impacts on this species. However, the likely magnitude of any potential impact from the sea urchin culture is so small that it would not significantly increase any negative impacts that might arise from suspended oyster cultivation (and suspended oyster cultivation is not considered likely to cause significant negative impacts).

Common Scoter

11.3 There is potential for the combined effects of all three activities to cause cumulative impacts on this species. However, the likely magnitudes of any potential impact from suspended oyster culture and sea urchin culture are so small that they would not significantly increase any negative impacts that might arise from oyster bottom cultivation (and oyster bottom cultivation is not considered likely to cause significant negative impacts).

Sanderling

11.4 No potential impacts from oyster bottom culture and intertidal sea urchin culture have been identified. Therefore, there are no potential cumulative impacts to consider from the combined effects of the three aquaculture activities covered in this assessment.

Assessment of the cumulative impacts of aquaculture and fishing activities in combination with other activities within the SPA

Activities

Beach recreation

11.5 There are several popular beach recreation areas within the Outer Bay and Southern Bay zones, including the beaches at Murvagh and Rossnowlagh and the Bundoran area (NPWS, 2012b). High levels of recreation activity occur on these beaches, although this is weather dependent. In addition to pedestrian activities, there is vehicular access to these Balhill Strand (within the Rossnowlagh subsite). Beach recreational activities, in addition to walking, include shore angling, surfing, dog exercising, horse riding and quad and trail bikes.

11.6 There is much more limited recreational activity in the Mountcharles/Eddrim Estuary area, mainly along the sandy spit around the Beefpark peninsula. During the trestle watches, occasional walkers and dogs were noted along this beach on each survey day.

11.7 There is presumably little recreational activity in the Inner Bay, due to the lack of accessible suitable beaches.

11.8 Beach recreation could cause negative impacts to waterbird species that use intertidal habitats within the Outer Bay and Southern Bay zones. The only SCI species that this would apply to are Light-bellied Brent Goose and Sanderling.

Hand collection of shellfish

11.9 During the NPWS BWS counts, shellfish gathering activity was recorded in five subsites: Doorin Pt.-Salthill Quay, Mountcharles, Eddrim Estuary, Rossnowlagh – Inishfad and Rossnowlagh[7]. It occurred most frequently in the Doorin Pt.-Salthill Quay, occurring on all four low tide counts in this subsite.

11.10 During the trestle watch survey, shellfish gathering activity was noted in the Doorin Pt.-Salthill Quay and/or Mountcharles subsites on four out of the five survey dates. Shellfish gathering activity presumably also occurs in other areas of rocky shoreline within the Donegal Bay SPA.

11.11 Shellfish gathering could cause negative impacts to waterbird species that use the intertidal hard substrate biotope. The only SCI species that this would apply to is Light-bellied Brent Goose.

Bait digging

11.12 During the NPWS BWS counts, bait digging was in three subsites: Muckros Strand and Roughan in the Inner Bay and Rossnowlagh in the Outer Bay[8], but was only recorded on a single count in each subsite. It was not recorded during the trestle watch study, although the muddier habitats in the Inner Bay, where bait digging is most likely to occur, were largely not covered during this study.

11.13 Bait digging could cause negative impacts to waterbird species that use muddier intertidal habitats. The sandier habitats favoured by Sanderling are unlikely to be affected by bait digging, but Light-bellied Brent Goose, which can use muddier intertidal habitats, could be affected. However, the level of bait digging activity appears to be low, so, overall, this activity is unlikely to have significant impacts.

Boat traffic

11.14 There is no detailed information on boat traffic within the SPA. Various commercial fishing activities occur in the outer part of Donegal Bay, with fishing boats coming from Killybegs. Given the absence of an active fishing port within the Inner Donegal Bay there is presumably unlikely to be high levels of inshore boat activity, although activities such as lobster potting may occur in inshore areas, and leisure and charter fishing boats launch from quays in Donegal Town and Mountshannon (NPWS, 2012b). However, during the NPWS BWS counts, boat activity was only noted in one subsite on one count date (a fishing boat in the outer part of the Doorin Pt.-Salthill Quay subsite), indicating that the overall level of boat activity is low.

11.15 Kayakers were noted on one of the survey days during the trestle watch study, causing disturbance to Light-bellied Brent Goose in the Mountcharles subsite. However, it seems unlikely that levels of kayaking activity are high enough to cause significant levels of disturbance impacts. Jet skiing and wind surfing also occur off the main beach recreation areas, although these activities were not noted during either the NPWS BWS counts or the trestle watch study, and, presumably, mainly occur during the summer.

11.16 Overall, it seems that the level of boat activity in inshore areas during the winter period is low and unlikely to cause significant impacts to waterbirds. It is possible that there could be some overlap between high levels of jet skiing and wind surfing activity in the late summer/autumn and the arrival of significant numbers of waterbirds.

Effluent discharge

11.17 Organic and nutrient inputs to estuaries increase productivity and may increase food resources for waterbirds. Adverse impacts to waterbirds may be caused by declines in organic and nutrient

[7] NPWS (2012b) state that shellfish gathering was recorded in four subsites, but this activity is recorded in five subsites in the raw dataset supplied by NPWS.
[8] NPWS (2012b) state that bait digging was recorded in seven subsites, but this activity is only recorded in three subsites in the raw dataset supplied by NPWS.

inputs, although there is no hard evidence to date of this happening (Burton *et al*., 2003). Therefore, effluent discharges to Donegal Bay are unlikely to cause adverse impacts to waterbirds.

Light-bellied Brent Goose

11.18 There is potential for the combined effects of suspended oyster cultivation and beach recreation and/or shellfish gathering to cause cumulative impacts on this species.

11.19 Beach recreation is likely to cause disturbance impacts to Light-bellied Brent Goose, particularly in the Rossnowlagh-Inishfad and Rossnowlagh subsites, where they feed in rocky shoreline areas close to foci of recreational activity.

11.20 Shellfish gathering is likely to cause disturbance impacts to Light-bellied Brent Goose, particularly in the Doorin Pt.-Salthill Quay and/or Mountcharles subsites.

11.21 If suspended oyster cultivation has an overall negative effect on Light-bellied Brent Goose, it is possible that the effects of beach recreation and/or shellfish gathering could, in combination with suspended oyster cultivation, cause a significantly greater impact than the impact of suspended oyster cultivation by itself. However, it seems likely that suspended oyster cultivation in Donegal Bay has an overall positive impact on Light-bellied Brent Goose.

Sanderling

11.22 There is potential for the combined effects of suspended oyster cultivation and beach recreation to cause cumulative impacts on this species.

11.23 Beach recreation may cause disturbance impacts to Sanderling, particularly around the high tide period when they are concentrated into smaller areas of habitat, close to the upper shore where most recreational activity occurs. However, small waders are generally less sensitive to disturbance impacts than larger waterbirds such as Light-bellied Brent Goose

11.24 There have been several studies of the impacts of recreational disturbance of wader distribution in sandy beaches. This type of disturbance may affect the foraging behaviour of waders: e.g. Thomas et al. (2003) found that that the number and activity of people significantly reduced the amount of time spent foraging by Sanderling on sandy beaches in California. However, several studies have found no evidence that recreational disturbance affects the spatial distribution of waders on sandy beaches (Colwell and Sundeen, 2000; Lafferty, 2001; Yasué, 2006; Neuman et al., 2008), while Trulio and Sokale (2008) found no effect on intertidal mudflats from trail use around San Francisco Bay. Several of these papers include Sanderling among the species assemblages. In particular, Neuman et al., (2008) specifically report a lack of any effect of recreational disturbance on Sanderling distribution in Monterey Bay.

11.25 Therefore, given the amount of evidence from the scientific literature, it seems unlikely that recreational disturbance is having significant impacts on the spatial distribution of Sanderling in Donegal Bay.

Conclusions

11.26 If suspended oyster cultivation has an overall negative effect on Light-bellied Brent Goose, it is possible that the effects of beach recreation and/or shellfish gathering could, in combination with suspended oyster cultivation, cause a significantly greater impact than the impact of suspended oyster cultivation by itself. However, it seems likely that suspended oyster cultivation in Donegal Bay has an overall positive impact on Light-bellied Brent Goose.

11.27 No other potentially significant cumulative impacts have been identified in this assessment.

12. References

Burton, N. H. K., Jones, T. E., Austin, G. E., Watt, G. A. & Rehfisch, M. M. (2003). Effects of reductions in organic and nutrient loading on bird populations in estuaries and coastal waters of England and Wales: Phase 2 report. English Nature Research Report No. 586. English Nature, Peterborough.

Clausen, P. (2000). Modelling water level influence on habitat choice and food availability for Zostera feeding brent geese *Branta bernicla* in non-tidal areas. *Wildlife Biology*, 6(2), 75–87.

Colwell, M. A., & Sundeen, K. D. (2000). Shorebird distributions on ocean beaches of Northern California. *Journal of Field Ornithology*, 71(1), 1–15.

Crowe, O. (2005). Ireland's wetlands and their waterbirds: status and distribution. Newcastle, Co. Wicklow: BirdWatch Ireland.

Cummins, S and Crowe, O. (2010). *Collection of baseline waterbird data for Irish coastal Special Protection Areas 2: Trawbreaga Bay, Lough Swilly, Donegal Bay, Blacksod & Broadhaven, Inner Galway Bay and Wexford Harbour & Slobs*. Unpublished report commissioned by the National Parks and Wildlife Service, and prepared by BirdWatch Ireland.

Donegal County Council (2002). *Donegal Bay Water Quality Management Plan*, April 2002.

Durell, S. E. A. le V. dit, Stillman, R., Triplet, P., Aulert, C., Ditbiot, D., Bouchet, A., Duhamel, S., *et al*. (2005). Modelling the efficacy of proposed mitigation areas for shorebirds: a case study on the Seine estuary, France. *Biological Conservation*, 123(1), 67–77.

EC (2012). *Common methodology for assessing the impact of fisheries on marine Natura 2000*. Service Contract No. 070307/2010/578174/SER/B. DGEnv Brussels.

Fletcher, W. J. (2005). The application of qualitative risk assessment methodology to prioritise issues for fisheries management. *ICES Journal of Marine Science*. 62: 1576-1587.

Fox, A.D. (2003). Diet and habitat use of scoters *Melanitta* in the Western Palearctic – a brief overview. *Wildfowl* 54: 163-182.

Gill, J., Norris, K., & Sutherland, W. J. (2001). Why behavioural responses may not reflect the population consequences of human disturbance. *Biological Conservation*, 97(2), 265–268.

Gittings, T. & O'Donoghue, P. D. (2012). *The effects of intertidal oyster culture on the spatial distribution of waterbirds*. Report prepared for the Marine Institute. Atkins, Cork.

Hale, W. G. (1974). Aerial counting of waders. *Ibis* 116:412. (cited by Prater, 1979).

Holstein Consultancy (2011a). Oyster farming in Donegal Bay: Appropriate assessment. Principals: Donegal Oceandeep Oysters Ltd. / Donegal Oysters Ltd.. Unpublished report.

Holstein Consultancy (2011b). Oyster farming in Donegal Bay: Appropriate assessment. Principal: Sea Breeze. Unpublished report.

Kaiser, M.J., Galanidi, M., Showler, D.A., Elliott, A.J., Caldow, R.W.G., Rees, E.I.S., Stillman, R.A., and Sutherland, W.J. (2006). Distribution and behaviour of Common Scoter Melanitta nigra relative to prey resources and environmental parameters. *Ibis*148: 110-128.

Lafferty, K. D. (2001). Disturbance to wintering western snowy plovers. Biological Conservation, 101(3), 315–325.

Lehnert, R. L., & Allen, D. M. (2002). Nekton use of subtidal oyster shell habitat in a southeastern U. S. estuary. *Estuaries*, 25(5), 1015–1024.

Marine Institute (2013). *A Risk Assessment Framework for Fisheries in Natura 2000 sites in Ireland.*

Neuman, K. K., Henkel, L. A., & Page, G. W. (2008). Shorebird use of sandy beaches in central California. Waterbirds: *The International Journal of Waterbird Biology*, 31(1), 115–121.

NPWS (2011a). Conservation Objectives for Durnesh Lough SPA [004145]. Generic Version 4.0. Department of Arts, Heritage & the Gaeltacht.

NPWS (2011b). Donegal Bay (Murvagh) SAC (site code: 0133). Conservation objectives supporting document- marine habitats and species. Version 1.

NPWS (2012a). Conservation Objectives: Donegal Bay SPA [004151]. Version 1.0. National Parks and Wildlife Service, Department of Arts, Heritage and the Gaeltacht.

NPWS (2012b). Donegal Bay Special Protection Area (Site Code 4151). Conservation Objectives Supporting Document. Version 1.

Prater, A. J. (1979). Trends in accuracy of counting birds. *Bird Study*, 26, 198-200.

Rappoldt, C., Kersten, M. & Smit, C. (1985). Errors in large-scale shorebird counts. *Ardea*, 73, 13-24.

Scheiffarth, G., Ens, B., & Schmidt, A. (2007). What will happen to birds when Pacific oysters take over the mussel beds in the Wadden Sea? *Wadden Sea Newsletter*, 1, 10–14.

Scyphers, S. B., Powers, S. P., Heck Jr, K. L., & Byron, D. (2011). Oyster reefs as natural breakwaters mitigate shoreline loss and facilitate fisheries. *PLoS ONE*, 6(8), e22396.

Stillman, R. A., & Goss-Custard, J. D. (2010). Individual-based ecology of coastal birds. *Biological Reviews*, 85(3), 413–434.

Stillman, R. A., West, A. D., Goss-Custard, J. D., McGrorty, S., Frost, N. J., Morrisey, D. J., Kenny, A. J. & Drewitt, A. L. (2005). Predicting site quality for shorebird communities: a case study on the Humber estuary, UK. *Marine Ecology Progress Series*, 305, 203-217.

Summers, R.W., Underhill, L.G. and Simpson, A. (2002). Habitat preferences of waders (Charadrii) on the coast of the Orkney Islands: Twelve species of wader were surveyed on 494 coastal sections, revealing features in addition to substratum

Thomas, K., Kvitek, R. G., & Bretz, C. (2003). Effects of human activity on the foraging behaviour of Sanderlings Calidris alba. *Biological Conservation*, 109(1), 67–71.

Tolley, S. G., & Volety, A. K. (2005). The role of oysters in habitat use of oyster reefs by resident fishes and decapod crustaceans. *Journal of Shellfish Research*, 24(4), 1007–1012.

Trulio, L. A., Sokale, J. (2008). Foraging shorebird response to trail use around San Francisco Bay. *The Journal of Wildlife Management*, 72(8), 1775-1780.

West, A. D., Yates, M. G., McGrorty, S., & Stillman, R. A. (2007). Predicting site quality for shorebird communities: A case study on the Wash embayment, UK. *Ecological Modelling*, 202(3-4), 527–539.

Yasué, M. (2006). Environmental factors and spatial scale influence shorebirds' responses to human disturbance. *Biological Conservation*, 128(1), 47–54.

Appendix A - Species codes and scientific names of bird species mentioned in the text

A.1.1 The following table lists the BTO species codes and the scientific names of the bird species mentioned in the text. The nomenclature follows Cramp and Simmons (2004).

Name	Scientific name
Common Eider	*Somateria mollissima*
Common Scoter	*Melanitta nigra*
Great Northern Diver	*Gavia immer*
Light-bellied Brent Goose	*Branta bernicla hrota*
Sanderling	*Calidris alba*
Black-tailed Godwit	*Limosa limosa*
Oystercatcher	*Haematopus ostralegus*
Dunlin	*Calidris alpina*
Curlew	*Numenius arquata*
Grey Plover	*Pluvialis squatarola*
Bar-tailed Godwit	*Limosa lapponica*
Redshank	*Tringa totanus*
Ringed Plover	*Charadrius hiaticula*
Knot	*Calidris canutus*
Whooper Swan	*Cygnus cygnus*
Greenland White-fronted Goose	*Anser albifrons*

Appendix B
Trestle watch study

B.1 Introduction

B.1.1 This Appendix provides details of the methods and results of the study that was carried out on Light-bellied Brent Goose and Sanderling distribution and habitat usage in the main areas occupied by intertidal oyster trestles between January-March 2013. The discussion and interpretation of the results is included in the main text of this assessment.

B.1.2 The study was designed Tom Gittings designed the trestle watch study and carried out by Mike Trewby (bird surveys) and Eamonn Delaney (trestle condition survey). The data analysis and report writing was done by Tom Gittings. Paul O'Donoghue assisted with project design, document preparation and undertook document review. Data entry was carried out by Eamonn Delaney.

Context and rationale

B.1.3 Light-bellied Brent Goose and Sanderling are Special Conservation Interests (SCIs) of the Donegal Bay SPA. Previous work (Gittings and O'Donoghue, 2012) has shown that Sanderling have a negative response to oyster trestles, while the response of Brent Geese varied between sites with neutral/positive responses in some sites and negative responses in other sites. Analysis of the low tide count data from the National Parks and Wildlife Service Baseline Waterbird Survey (NPWS BWS) of Donegal Bay indicated that there may be significant overlap between the distribution of these species and the intertidal oyster culture plots. Therefore, there is potential for significant impacts from intertidal oyster cultivation on the spatial distribution of Brent Geese and Sanderling. The NPWS BWS only included four low tide counts in a single winter, and very low numbers of Light-bellied Brent Goose were present on one of these counts. Therefore, further data was required to assess the low tide usage of the subsites containing intertidal oyster culture plots. Also, because the response of Light-bellied Brent Goose to oyster trestles appears to vary between sites, site-specific data was required for Donegal Bay on the distribution of Light-bellied Brent Goose in relation to the distribution of oyster trestles.

Objectives

B.1.4 The objectives of this study were to:

- to obtain data on the low tide numbers of Light-bellied Brent Goose and Sanderling in the Donegal Bay subsites with significant areas of licenses and/or applications for intertidal oyster cultivation;
- to examine the distribution Light-bellied Brent Goose and Sanderling within these subsites in relation to the distribution of oyster trestles; and
- to assess the proportion of the overall Donegal Bay Light-bellied Brent Goose population that occurs within these subsites.

B.2 Methods

Survey design

B.2.1 The survey involved two components:

- Monitoring of the main areas of oyster trestles across half a low tide period.
- A census of Light-bellied Brent Goose and Sanderling across the Outer and Southern Bay zones of the Donegal Bay on the rising/falling tide.

B.2.2 In addition, a survey of the condition of the trestles was carried out to assess the potential habitat quality for Light-bellied Brent Goose (which may feed on green algae on the trestles).

Monitoring of the main areas of oyster trestles

B.2.3 The main area of oyster trestles occurs in the Mountcharles subsite (OA497) to the west of Hassan's (Figure B.1). A secondary area of oyster trestles occurs to the east of Hassan's in the St. Ernan's Isl. and Dungally Strand subsites (OA418 and OA424). Small areas of oyster trestles occur elsewhere in the Inner Bay zone.

B.2.4 The configuration and positions of the trestle blocks means that walking along the edge of the trestles, which is the survey method we have used in other sites, would not have been an effective survey method here. Instead the monitoring was carried out from a vantage point on Hassan's (Figure B.1).

B.2.5 Hassan's is a small peninsula that separates the Mountcharles and St. Ernan's Isl. subsites. The northernmost of the two small hills on this peninsula provide good vantage points for surveying these oyster trestle areas. Around two-thirds of the oyster trestle area in the Mountcharles subsite is fully visible from this vantage point and there are also good views over the oyster trestle areas in the St. Ernan's Island and Dungally Strand subsites. It was possible to detect any Brent Geese within the trestle areas, and any Sanderling within the nearer two-thirds or so of the trestles, from this vantage point. There was potential for any Sanderling in the outer third or so of the trestle blocks to escape detection, as the lanes between the trestle blocks in that area were not fully visible, although any such flocks would probably have been detected moving into/out of the blocks. The vantage point also provided extensive views over most of the Mountcharles, Eddrim Estuary (0A429), St. Ernan's Isl. and Dungally Strand subsites, and the northern end of the Murvagh subsite (0A479), although the visibility, particularly for detecting Sanderling, was considered to be poor for the western third of the Mountcharles subsite (Figure B.1).

B.2.6 Our work elsewhere has indicated that, at least in some sites, Light-bellied Brent Goose mainly use oyster trestle areas during the period in which the tide is flooding, or receding across the trestles. Therefore, this element of the survey involved monitoring these oyster trestle areas from the vantage points on Hassan's across half a low tide period: i.e., from the time that the trestles start to become exposed on the receding tide to low tide, or from low tide to the time that the trestles are fully covered on the flooding tide. The surveyor chose which period to cover on each day, depending on factors like the timing of the low tide and the requirements for the other aspects of the survey.

B.2.7 During the monitoring period, the surveyor continually scanned the survey area and recorded any Light-bellied Brent Goose or Sanderling detected. For each detection, the surveyor recorded the following information:

- the location of the bird(s);
- the subsite in which they occurred;
- the habitat in which they occurred;
- the time of the initial detection;

- the time of the final detection;
- the number of birds; and
- their activity (feeding or roosting/other).

B.2.8 The location of the bird(s) was recorded by sketching their position on a map. Movements were recorded by arrows.

B.2.9 The habitats were recorded as either: subtidal within oyster trestles; subtidal outside oyster trestles; mud/sandflat within oyster trestles; mud/sandflat outside oyster trestles; or rocky shoreline (see Figure B.1). Additional notes were often made about the nature of the habitat. Birds in lanes between trestle blocks were recorded within the appropriate within oyster trestles category.

B.2.10 The activity of the bird(s) was recorded by periodic scan counts.

B.2.11 The position of the tideline in the study area was sketched at 30 minute intervals.

B.2.12 At low tide (at the beginning or end of the monitoring period, depending upon the timing), if required, the vantage points at Jack's Quay and Salt Hill Pier (Figure B.2) were visited to scan for Sanderling that may not have been visible from the Hassan's vantage point.

Census of Light-bellied Brent Goose and Sanderling across the Outer and Southern Bay

B.2.13 The aim of this component of the survey was to obtain a total count of the Light-bellied Brent Goose population in Donegal Bay. Sanderling were also counted, but, given, the potential difficulty of detecting Sanderling at long ranges, and the time constraints, it was anticipated that it would not be possible to fully census their numbers.

B.2.14 Prior to the study, analysis of the available recent I-WeBS data indicated that Light-bellied Brent Goose and Sanderling mainly occur in Outer and Southern Bay zones: in recent I-WeBS counts (2006/07-2010/11) means of 86% (Brent Geese) and 98% (Sanderling) of the total counts occurred in these zones. Therefore, the survey focused on these areas.

B.2.15 The survey involved visiting all the vantage points used in the NPWS BWS survey for the Outer and Southern Bay zones. These vantage points are all directly accessible by road. However, for the Rossnowlagh-Inishfad subsite (OA480), it was necessary to walk south along the beach from the vantage point to view the outflow from Durnesh Lake.

B.2.16 At each vantage point, any Light-bellied Brent Goose and Sanderling present were counted, their activity (feeding or roosting/other recorded), their position(s) mapped, and the habitats used recorded (using the same classification as in the monitoring work).

Trestle survey

B.2.17 A survey of the habitat condition of the trestles was carried out on 13th March 2013. This survey covered all the trestles within the Mountcharles, St. Ernan's Isl. and Dungally Strand subsites. Each block of trestles was walked, and for each individual row of trestles within the blocks, the following parameters were recorded:

- the percentage cover of brown seaweed;
- the percentage cover of green seaweed;
- the presence of trestle bags and their condition; and
- the presence of any green slime/hue on the trestle bags.

Count dates and timing

B.2.18 Five counts were carried out between 29th January and 12th March 2013. In addition, data recorded on a reconnaissance visit on the 11th and 12th January 2013 have also been included in some of the analyses.

B.2.19 The survey days covered a range of tidal conditions from low spring tides on 12th February and 12th March to moderate neap tides on 29th January and 3rd February (Table B.1).

B.2.20 On each day, the trestle monitoring covered a period of approximately three hours before/after low tide (Table B.1).

B.2.21 The Outer Bay zone and the main subsites within the Southern Bay zone were fully covered on all the census counts, except on the first survey day, while generally the only coverage of the Inner Bay was of the subsites surveyed during the trestle monitoring period (Table B.2). On 25th Fenruary, the surveyor noted that movement of Light-bellied Brent Goose within and between Doorin Pt.-Salthill Pier, Mountcharles, Dungally Strand and Murvagh made accurate surveying difficult.

Table B.1 - Details of low tides and survey periods

Date	Salthill Pier	Killybegs		Trestle monitoring period	Census period
	Low tide time	Low tide time	Low tide height (m)		
11 Jan	11:20	11:13	0.5	09:00-11:45	
12 Jan	12:04	12:01	0.4	08:40-12:00	
29 Jan	13:09	13:11	0.6*	10:10-13:09	13:00-17:15
03 Feb	16:46	16:32	1.2	13:40-16:46	08:00-14:20
12 Feb	13:04	13:06	0.3	13:00-16:15	09:00-16:40
25 Feb	11:44	11:40	0.6	11:40-15:02	07:04-12:05
12 Mar	12:08	12:07	0.3	12:00-15:10	07:08-12:00

* the actual extent of exposure of intertidal habitat at full low tide was similar to that recorded on 03 Feb

Table B.2 – Coverage achieved during the census counts

Date	Zone	Coverage
29 Jan	Outer Bay	Incomplete coverage of Rossnowlagh-Inishfad (mouth of Durnesh Lough was covered)
	Inner Bay	Not covered
	Southern Bay	Not covered
03 Feb	Outer Bay	
	Inner Bay	
	Southern Bay	
12 Feb	Outer Bay	Complete
	Inner Bay	Eddrim Estuary, St. Ernan's Isl., Dungally Strand and Muckros Strand covered
	Southern Bay	Erne Estuary and Aughrus Pt-Bundoran covered
25 Feb	Outer Bay	Complete
	Inner Bay	Not covered
	Southern Bay	Erne Estuary and Aughrus Pt-Bundoran covered
12 Mar	Outer Bay	Complete
	Inner Bay	Eddrim Estuary, St. Ernan's Isl. and Dungally Strand covered
	Southern Bay	Erne Estuary and Aughrus Pt-Bundoran covered

B.2.22 Weather conditions were quite variable across the survey days, with conditions generally good during the reconnaissance visit and on the final three survey days (Table B.3). However, conditions were quite poor on the first survey day (29th January). On the second survey day (3rd February) there was a period of poor visibility during the middle of the trestle monitoring period when low cloud and light misty rain obscured the more distant areas, although the trestles were still visible.

Table B.3 – Weather conditions

Date	Wind	Rain	Visibility	Notes
11 Jan	light	none	excellent	
12 Jan	light	none	excellent	
29 Jan	E-ENE 3/4-5/6	passing light showers	moderate-difficult	
03 Feb	W3-5	mainly dry	mainly good-moderate	poor visibility for c. 40 mins in middle of period due to low cloud and light misty rain (but trestles still visible)
12 Feb	ESE0-2	none	good-moderate	slight misty haze
25 Feb	SSE2	none	good-excellent	
12 Mar	NW2-4	occasional light showers	excellent-moderate	visibility mostly excellent but deteriorating during showers,and limited during sunny periods when looking south from towards Murvagh

Data processing and analysis

B.2.23 All count data was entered into Excel spreadsheets and the flock locations and tideline positions were digitised as ArcMap shapefiles.

Definition of areas

B.2.24 For both Light-bellied Brent Goose and Sanderling, the analyses of their distribution patterns and activity in relation to the presence of oyster trestles focus on the trestles within the Mountcharles subsite. The intertidal zone of the Mountcharles subsite north of the main tidal channel forms an ecological unit with the Eddrim Estuary that is physically discrete from other significant areas of intertidal sandflats, and these areas should be considered together in analysing waterbird distribution. The areas are collectively referred to as the Mountcharles/Eddrim Estuary area (Figure B.1).

B.2.25 The intertidal zone of the Mountcharles subsite south of the main tidal channel is separated from the above areas by a 500 m wide tidal channel. This area is part of the extensive sandflats along the Murvagh peninsula and is contiguous with the intertidal zone of the Murvagh subsite. It does not form an obvious ecological unit with the Mountcharles/Eddrim Estuary area, and, for the purposes of our analyses, has not been included within the area we have defined as the Mountcharles/Eddrim Estuary area.

B.2.26 The upper part of the Eddrim Estuary was not visible during the trestle watches (Figure B.1) and has, therefore, been excluded from calculations of areas of exposed intertidal habitat (see paragraph B.2.29).

B.2.27 For the purposes of the data analysis, the trestle monitoring area was divided into three habitat zones (Figure B.1) based on the NPWS biotope map (NPWS, 2011b): sandflats (the intertidal muddy sand to sand and subtidal fine sands biotopes, except for a narrow band of “dry” sandy beach around the Beefpark peninsula); rocky shoreline (the intertidal hard substrate and shingle beach biotopes) and mudflats (the estuarine fine sands biotope).

Tideline analysis

B.2.28 We used the tideline positions mapped during each trestle monitoring period to clip the subsite polygons to produce polygons representing the exposed areas at 30 minute intervals in each subsite during each trestle monitoring period. This analysis was only carried out for the Eddrim Estuary/Mountcharles area. Where the tideline mapping did not cover the entire subsite, we interpolated the tideline position by reference to comparable tidelines on other survey days and/or the general topography of the coastline.

B.2.29 We used the polygons of exposed intertidal area to calculate the total area of intertidal habitat exposed at each time period, sub-divided by trestle occupancy (within or outside trestle blocks), aquaculture licensing status (within or outside aquaculture licenses or applications for licenses), and habitat zone (sandflats, rocky shoreline, or mudflats). We then calculated the proportion of exposed intertidal habitat within intertidal oyster licenses and applications in the Mountcharles/Eddrim Estuary area during each time period.

Light-bellied Brent Goose flock analysis

B.2.30 In order to analyse Light-bellied Brent Goose activity during the trestle monitoring periods, we assigned each unique flock a sequential flock number (e.g., flock 1, flock 2, etc.) when it first appeared and then tracked its recorded movements and activity across the monitoring period until it was last recorded. Where a flock split into groups, we assigned each group a sequential subscript (e.g., flock 1A, flock 1B, etc.) and tracked the groups separately. When two distinct flocks merged, we tracked the flocks together (e.g., flocks 1 and 2). If they subsequently separated, we assigned the separate groups to the original flocks based on, as far as possible, the similarities between the numbers of birds in the original flocks before they merged and the numbers in the groups that split from the merged flock. We acknowledge that this is a somewhat arbitrary procedure, but the purpose of this analysis is to analyse the overall pattern of bird activity, rather than follow individual birds and, for this purpose, the procedure is appropriate. Where it was possible that birds in a flock may have been subsequently double-counted in another flock earlier or later in the monitoring period, we recorded the number of birds possibly double-counted. We did not analyse movements of flocks that were recorded overflying the study area, or flocks outside the Mountcharles, Eddrim Estuary, St. Ernan's Isl. and Dungally Strand subsites.

B.2.31 We used the results of the above analyses to compile a database of Light-bellied Brent Goose observations by flock number, recording for each observation the position of the flock, the total number of birds, the number of birds possibly double-counted, the habitat type (sandflats, rocky shoreline, or mudflats), the tidal zone (intertidal or subtidal), the activity (feeding, loafing, swimming, or flying), and the times of initial and final detections. The latter data was used to calculate bird-minutes for each observation (i.e., the number of birds multiplied by the duration of the observation). When there were gaps in the observation record, but the flock had clearly remained in the same place, we added in an inferred record to cover that gap. For these inferred records, we only included data on tidal zone and activity when these had not changed between the observations either side of the inferred record. Therefore, for each flock we had a continuous record (observed and inferred) of its activity from the initial to the final detections.

B.2.32 We used this database of Light-bellied Brent Goose observations to analyse their activity, using three parameters: the number of unique flocks, the maximum count and the total number of bird minutes.

Sanderling flock analysis

B.2.33 Only six Sanderling flocks were recorded during the trestle monitoring periods. Therefore, to increase the sample size for our analyses, we have included Sanderling flocks recorded within the trestle monitoring area during the reconnaissance visit and during the census counts (when these were carried out during the low tide period).

B.2.34 Each separate Sanderling flock position recorded has been treated as an independent observation for the purposes of analysing their association with oyster trestles. On 12th March, the Sanderling flock recorded moving across the sandflats from Jack's Quay was treated as a single flock position as the birds were gradually moving while feeding: i.e., the movement did not represent the distinct selection of a new foraging area. Apart from this, there were no confirmed observations in our dataset of the same Sanderling flock being recorded in two separate locations during the same monitoring period.

B.2.35 To analyse Sanderling distribution in relation to the presence of trestles we calculated the areas of exposed intertidal habitat within the visible part of the Mountcharles/Eddrim Estuary sandflat zone at the time of the initial detection of each flock. To do this, we used the areas of exposed intertidal habitat derived from the polygons of tidal exposure, which represented 30 minute intervals. Taking the exposed areas (A_1 and A_2) for the time periods (T_1 and T_2) either side of the initial detection of the flock, where $A_1 < A_2$, $|T_1-T_2|= 30$ minutes, and T_2 is closer to low tide, we used the following formula to calculate the exposed area (A_i) at the time of the initial detection (T_i): $A_i = A_1 +(A_2-A_1)*(T_1 –T_i)/30$. We calculated the exposed areas for both the area within the trestle blocks (A_{iT}) and the entire sandflat zone (A_{iS}). The probability of a flock, which is selecting habitat at random within the sandflat zone, occurring outside the trestle blocks is then given by $P = 1-(A_{iT}/A_{iS})$, and the probability of n flock locations occurring outside the trestle blocks is given by P^n.

B.2.36 It should be noted that there was potentially reduced detectability of Sanderling flocks in the outer third or so of the trestle blocks (paragraph B.2.5). However, there was also potentially reduced detectability of Sanderling flocks in the outer third or so of the Mountcharles subsite (paragraph B.2.5). These reduced detectability factors were assumed to approximately balance out, so no corrections were made for reduced detectability in the above calculations.

B.3 Results

Tideline mapping

B.3.1 The results of the tideline mapping are shown in Figure B.3-5.[9]

B.3.2 On 29th January and 3rd February, the tideline at low tide only just reached below the southern edge of the trestles and did not reach below the western edge of the trestles, and only a narrow band of intertidal habitat was exposed along the shore west of Beefpark. The tide on 29th January should have been much lower, according to the predicted tidal data. On 12th February, on a low spring tide, around 200 m of intertidal habitat was exposed below the southern edge of the trestles and 400 m of intertidal habitat was exposed below the western edge of the trestles at low tide. A wide band of intertidal habitat was also exposed along the northern shore west of Beefpark out to Salt Hill Pier.

B.3.3 The pattern of tidal exposure in relation to the area occupied by intertidal oyster licenses and applications in the Mountcharles/Eddrim Estuary area is shown for three representative low tides: a 0.3 m low tide on 12th February, a 0.6 m low tide on 25th February and a 1.2 m low tide on 3rd February (Figure B.).

Trestle condition

B.3.4 Brown seaweeds were present in all but one on the trestle blocks, with mean cover ranging from 5-39% (Table B.4). Green seaweed cover was less frequent: it was only present in nine of the trestle blocks, and one in one block in the Mountcharles subsite, where it did occur cover was usually 1% or less (maximum of 5%). However, a very thin algal layer attached to the mesh of the bags, variously described as a green hue or slime, was quite frequent, especially in the Dungally Strand block and a group of blocks in the western part of the Mountcharles trestle area (Figure B.). Most trestle blocks had some degree of occupancy by trestle bags.

[9] Note: there were some errors in the initial digitisation of these tidelines. These have been corrected for the calculations of intertidal areas, etc., but have not been updated in Figure B.3-Figure B.. However, notwithstanding these errors, these latter figures give a reasonable illustration of the general pattern of exposure.

Table B.4 – Summary of the results of the trestle condition survey

Block	Number of rows	Brown seaweed	Green seaweed	Slime	Bag occupancy (% of rows)		
		mean % cover	% of rows	% of rows	None	Partial	Full
Dungally Strand							
1	35	19%	29%	51%	3%	40%	57%
St. Ernan's Isl.							
1	2	10%	0%	0%	0%	50%	50%
2	3	7%	0%	0%	0%	33%	67%
3	4	6%	25%	0%	0%	25%	75%
4	7	9%	29%	0%	14%	57%	29%
5	4	10%	25%	25%	0%	25%	75%
6	5	5%	20%	0%	0%	20%	80%
7	3	10%	0%	0%	0%	0%	100%
8	2	10%	0%	0%	0%	50%	50%
9	6	22%	33%	33%	0%	33%	67%
10	6	30%	17%	0%	0%	100%	0%
11	1	15%	0%	0%	100%	0%	0%
12	1	0%	0%	0%	100%	0%	0%
13	9	23%	67%	0%	11%	11%	78%
14	11	17%	0%	0%	18%	55%	27%
Mouncharles							
1	46	39%	0%	9%	24%	39%	37%
2	7	29%	0%	0%	29%	14%	57%
3	46	21%	2%	4%	17%	13%	70%
4	18	6%	0%	6%	11%	6%	83%
5	28	26%	0%	4%	7%	21%	71%
6	36	20%	0%	8%	22%	17%	61%
7	21	23%	0%	38%	14%	10%	76%
8	16	16%	0%	0%	19%	25%	56%
9	10	12%	0%	10%	10%	20%	70%
10	20	26%	0%	40%	35%	15%	50%
11	7	36%	0%	43%	43%	14%	43%
12	10	14%	0%	60%	30%	10%	60%
13	6	10%	0%	33%	50%	17%	33%
14	14	24%	0%	57%	7%	36%	57%
15	2	8%	0%	0%	50%	0%	50%
16	14	27%	0%	14%	14%	29%	57%
17	2	33%	0%	0%	0%	100%	0%
18	7	14%	0%	71%	0%	43%	57%

Aquaculture husbandry activity

B.3.5 Aquaculture activity was recorded on each survey day, except 3rd February, with 3-6 tractors in the Mountcharles subsite, and 1-4 tractors in the St. Ernan's Isl./Dungally Strand subsite (Table B.5). The tractors were not always active throughout the entire low tide period, and the data indicate that there may be generally a higher level of activity during the first half of the low tide period.

Table B.5 – Aquaculture husbandry activity

Date	Survey period	Mountcharles	St. Ernan's Island/Dungally Strand
11/12 Jan	before LT	3 tractors active throughout period	4 tractors active from 1 hour before low tide
29 Jan	before LT	4 tractors	1 tractor
03 Feb	before LT	none	none
12 Feb	after LT	6 tractors active for first 1.25-1.75 hours of trestle watch	3 tractors active for 0.75-1.5 hours of trestle watch; one tractor active for last 0.5 hours of trestle watch
25 Feb	after LT	5 tractors active during first half of low tide period; left around low tide and no activity during trestle watch	2 tractors left at low tide, presumably active during first half of low tide period; one tractor active for one hour during trestle watch
12 Mar	after LT	5 tractors active for first two hours of trestle watch	3 tractors active for first hour of trestle watch

B.3.6 We calculated the total duration of tractor movements across access routes as follows. We assumed a tractor speed of around 20 km/hr, based on the approximate time observed for a tractor travelling out to the Dungally Strand trestles on 12th January. A tractor travelling at this speed would take three minutes to reach the trestles in the Mountcharles subsite and five minutes in the St. Ernan's Isl./Dungally Strand subsites. For the final three survey days, we then used the data recorded on the timings of tractor movements to calculate the total duration of tractor movements during the monitoring period, and doubled this duration to allow for the other half of the low tide period (apart from tractors that were observed entering and leaving the area during the monitoring period). For the reconnaissance visit, and the first survey day, when we did not record the timings of tractor movements, we assumed that no tractor movements overlapped and that each tractor made one movement on and one movement off.

B.3.7 The results of these calculations indicate that across a low tide period of around six hours, there would be around 18-28 minutes of tractor movements along the access route to/from the Mountcharles trestles, and 10-40 minutes of tractor movements along the access route to/from the St. Ernans Island/Dungally Strand trestles (Table B.).

Table B.6 – Estimated duration of tractor movements across access routes during the low tide period

Date	Survey period	Mountcharles	St. Ernans Island/Dungally Strand
11/12 Jan	before LT	18 min	40 min
29 Jan	before LT	20 min	10 min
03 Feb	before LT	0 min	0 min
12 Feb	after LT	18 min	40 min
25 Feb	after LT	28 min	25 min
12 Mar	after LT	22 min	30 min

Light-bellied Brent Goose

Trestle monitoring

B.3.8 The following is based on our analyses of flock movements, and the assumptions made in carrying out the analyses should be borne in mind (see paragraphs B.2.30-B.2.32).

B.3.9 Light-bellied Brent Goose were recorded during the trestle monitoring periods on all five of the survey days, with 3-10 flock observations and 59-240 birds observed during each monitoring period (Table B.). Bird activity was high during the first survey day and low on the fourth survey day (Table B.). Most activity occurred in the Mountcharles/Eddrim Estuary and Murvagh sandflats (Table B.). There were no observations of flocks within the mudflats zone. Details of all the flock observations are summarised in Table B. and Figure B.-Figure B..

Table B.7 – Summary of total Light-bellied Brent Goose numbers and activity recorded during the trestle monitoring periods

Date	Minimum total	Maximum total	Number of flocks	Bird minutes/min
29 Jan	240	240	3	68
03 Feb	123	127	7	29
12 Feb	85	109	10	31
25 Feb	43	50	7	17
12 Mar	59	63	5	29

Table B.8 – Summary of Light-bellied Brent Goose activity (% of total bird minutes) in the various areas covered by the trestle monitoring watches

Date	Sandflats			Rocky shorelines	
	Mountcharles/ Eddrim Estuary	Murvagh	St. Ernan's/ Dungally	Beefpark	Hassan's
29 Jan	84%	13%	3%	0%	0%
03 Feb	65%	35%	0%	0%	0%
12 Feb	0%	68%	32%	0%	0%
25 Feb	58%	36%	0%	0%	6%
12 Mar	7%	90%	0%	2%	1%

Total bird minutes used for calculations excludes times spent flying

Table B.9 – Light-bellied Brent Goose flocks recorded during the trestle monitoring periods

Flock number	Max count	Initial detection (min ± LT)	Total duration (min)	Possible double-count	Within trestles	Notes
29-Jan						
4	136	-114	80			Foraging intertidally in upper part of Eddrim Estuary in one large flock; 2 birds flew off around Beefpark; main flock then split into two distinct parties, one (A) of 67 birds walking west up Warren Channel, the other (B) of 64 birds remaining in the area where they were initially recorded; 34 birds flew south to northern end of Murvagh at 12:06; 76 birds still present in Eddrim Estuary until 12:35
5	67	-69	35			Foraging intertidally in upper part of St. Ernan's Isl. sandflats for 6 mins; flew west, splitting into 2 groups, one group (A) heading to Murvagh, the other to Jack's Quay; A settled briefly on shore at Jack's Quay, not observed departing, but not seen subsequently; B joined flocks 5 and 6 on Murvagh; departure not observed, viewing conditions difficult, presumably drifted south
6	37	-61	27			Loafing and foraging at northern end of Murvagh; joined by flock 5; departure not observed, viewing conditions difficult, presumably drifted south
03-Feb						
1	2	-167	7	2		Loafing at northern end of Murvagh; not observed departing but could have been obscured by rocks
2	2	-167	14	2		Swimming at northern end of Murvagh; not observed departing, may have joined flock 4
3	23	-163	17			Feeding on intertidal in Eddrim Estuary, area not visible after 14:20 due to low cloud passing over; not present when visibility improved at 15:10 but may have moved into the upper part of the Eddrim Estuary; assumed to be the same birds flying with flock 5 out of Eddrim Estuary at 15:41
4	21	-152	6			Swimming at northern end of Murvagh; 5 birds flew north to join flock 3 at 14:17; area not visible after 14:20 due to low cloud passing over; none present when visibility improved at 15:10
5	50	-65	65			Seen briefly flying north out of St. Ernan's Isl. subsite, presumed to have landed in upper part of Eddrim Estuary; presumed the same flock flying out of Edrim Estuary, with flock 3, circling over trestles and then continuing north to Jack's Quay; presumed to have been present in Jack's Quay area for c. 45 minutes before flushed by kayakers and presumed to have moved to northern end of Murvagh
6	9	-62	4		yes	Flew out of St. Ernan's Isl. subsite and landed briefly within trestles (only tops exposed); birds were lost from view but were assumed to leave the area within c. 2 mins of arriving

Flock number	Max count	Initial detection (min ± LT)	Total duration (min)	Possible double-count	Within trestles	Notes
7	20	-39	39			Foraging intertidally and subtidally at northern end of Murvagh; possibly same birds as flock 4, but long gap between observations
12-Feb						
1	12	+17	64			Flock detected flying from southern tip of Hassan's and joining flock 2 on the south side of the channel where they foraged intertidally and subtidally
2	34	+17	78			Foraging intertidally and subtidally at northern end of Murvagh; numbers decreasing towards end of observation; only departure observed was of flock of 23, which flew east to bay on north-eastern side of Murvagh and then later (15:00) flew off towards inner part of St. Ernan's Isl. subsite
3	24	+24	134			Foraging intertidally in southern part of Dungally Strand subsite; numbers fluctuated from 7-24 across duration of observation period
4	3	+99	1			Observed briefly swimming at northern end of Murvagh
5	3	+103	1			Observed briefly on intertidal at Jack's Quay
6	2	+111	3		yes	Observed briefly swimming within trestles, then flew to northern end of Murvagh
7	8	+132	74	8		Foraging intertidally and subtidally at northern end of Murvagh; may have been part of flock 2
8	9	+137	1	9		Flock detected flying east from southern tip of Hassan's
9	10	+179	1	3		Observed briefly on intertidal at Jack's Quay; may have included birds from flock 3
10	4	+179	2	4		Foraging on rocky shore on western side of Hassan's
25-Feb						
1	7	+34	164		yes	Initially in subtidal habitat on eastern side of Hassans; moved to Murvagh, joining flock 2; moved back to eastern side of Hassans; joined another flock flying into Inner Bay from Salt Hill (also joined by flock 2), but circled back and landed in trestles; remained within trestles foraging in subtidal habitat (apart from a short period loafing)
2	24	+41	157		yes	Initially foraging in channel off the southern tip of Hassan's; joined by flock 1 and moved to intertidal at northern end of Murvagh, where also joined by flock 3, then flock reduced by 14 with departures not detected; joined another flock flying into Inner Bay from Salt Hill (also joined by flock 1), but circled back and landed in trestles; remained within trestles foraging in subtidal habitat (apart from a short period loafing)
3	2	+77	14			Flew in from west and joined flock 2 on intertidal habitat at the northern tip of Hassan's; assumed to have departed during the period when birds were leaving flock 2

Flock number	Max count	Initial detection (min ± LT)	Total duration (min)	Possible double-count	Within trestles	Notes
4	8	+149	49	8		First detected within trestles; remained within trestles, mainly foraging in subtidal habitat, apart from 2 birds that departed at 14:57
5	4	+180	13	3		First detected within trestles, may have included birds from flocks 1 and/or 2; 2 flew off south
6	2	+196	2	2		First detected within trestles, may have included birds from flockspreviously recorded within trestles
7	3	+196	2	2		Foraging in subtidal habitat on the eastern side of Hassan's
12-Mar						
1	49	-8	124			Initially foraging in channel off the northern end of Murvagh; moved on to the intertidal at the northern end of Murvagh; gradually dispersing with numbers reducing throughout observation period, 15 birds tracked to further south on Murvagh, the rest not accounted for
2	4	+118	64		yes	Flew in from Inner Bay to trestles in Mountcharles; moved to rocky shoreline of Beefpark and then back to trestles; foraged subtidally until near the end of the observation period; departure not detected
3	6	+153	30		yes	Flew in from Salt Hill to rocky shoreline of Beefpark; moved in to trestles, joining flock 2, and foraged here until near the end of the observation period; departure not detected
4	2	+160	29	2	yes	Arrival not detected; foraged with flocks 2 and 3 within trestles; moved to rocky shoreline on eastern side of Hassan's
5	2	+156	33	2		Arrival not detected; foraged subtidally over rocky shoreline on eastern side of Hassan's

See paragraphs B.2.30-B.2.32 for details of the flock analysis methods and the assumptions made. Note: flocks 1-3 on 29th January were recorded before the start of the monitoring period and are not included in this table, or in the analysis of Light-bellied Brent Goose activity.

B.3.10 Light-bellied Brent Goose were recorded within the Mountcharles trestle blocks on four of the five survey days, but were not recorded at all within the St. Ernan's Isl./Dungally Strand trestle blocks.

B.3.11 Most of the flock observations within the Mountcharles trestle blocks were in the western part of the trestle area (Figure B.-Figure B.) broadly corresponding to the distribution of trestle blocks with high cover of green algal slime (Figure B.).

B.3.12 Relative to all the area covered by the trestle monitoring watches, Light-bellied Brent Goose activity within the trestle blocks was very low, apart from on the 25th February (Table B.), which was the day with the lowest overall activity (Table B.). However, when the analysis is restricted to the Mountcharles/Eddrim Estuary sandflats, Light-bellied Brent Goose activity within the trestle blocks was relatively high on three of the five survey days (Table B.). Including the St. Ernan's Isl./Dungally Strand sandflats reduces the relative level of Light-bellied Brent Goose activity within the trestle blocks on one of these survey days (Table B.).

Table B.10 – Summary of Light-bellied Brent Goose occurrence within trestles, including all areas covered in the trestle monitoring watches

Date	Numbers		Flocks		% of bird minutes within trestles
	Total	Within trestles	Total	Within trestles	
29 Jan	240	0	3	0	0%
03 Feb	123-127	9	7	1	< 1%
12 Feb	85-109	2	10	1	< 1%
25 Feb	43-50	31	7	2	58%
12 Mar	59-63	10-12	5	3	7%

Table B.11 – Summary of Light-bellied Brent Goose occurrence within trestles, relative to total activity in the Mountcharles/Eddrim Estuary sandflats

Date	Numbers		Flocks		% of bird minutes within trestles
	Total	Within trestles	Total	Within trestles	
29 Jan	159	0	2	0	0%
03 Feb	82	9	3	1	1%
12 Feb	15	2	3	1	32%
25 Feb	31	31	5	5	100%
12 Mar	10-12	10-12	3	3	100%

Table B.12 – Summary of Light-bellied Brent Goose occurrence within trestles ,relative to total activity in the Mountcharles/Eddrim Estuary and St. Ernan's Island/Dungally Strand sandflats

Date	Numbers		Flocks		% of bird minutes within trestles
	Total	Within trestles	Total	Within trestles	
29 Jan	203	0	2	0	0%
03 Feb	82	9	3	1	1%
12 Feb	39	2	4	1	< 1%
25 Feb	31	31	5	5	100%
12 Mar	10-12	10-12	3	3	100%

B.3.13 All observations of Light-bellied Brent Goose within the trestle blocks were of birds swimming/foraging in subtidal habitat as the tideline passed through the trestle blocks, and, within the Mountcharles/Eddrim Estuary area, all the record of birds swimming in the sandflats zone were within the trestle blocks. On the three survey days with aquaculture husbandry activity and Light-bellied Brent Goose flock occurrences within the Mountcharles trestle blocks, the goose flocks did not arrive until after the departure of the last tractor (Table B.).

Table B.13 – Timing of tractor departures and Light-bellied Brent Goose arrival in the Mountcharles trestle blocks

Date	Departure of last tractor (min ± LT)	Arrival of first goose flock (min ± LT)
03 Feb	no tractors	-60
12 Feb	+98	+111
25 Feb	+06	+94
12 Mar	+115	+119

Census

B.3.14 The distribution of Light-bellied Brent Goose recorded on the census counts is shown in Table B.. The total census count ranged from 158-469. Most birds tended to occur in the southern part of the bay (Rossnowlagh-Inishfad, Rossnowlagh and Aughrus Pt.-Bundoran). Detailed information on the distribution and habitat usage of the flocks within each subsite was collected, but is not analysed here.

Table B.14 – Distribution of Light-bellied Brent Goose recorded in the census counts

Zone	Subsite	29-Jan	03-Feb	12-Feb	25-Feb	12-Mar
Outer Bay (north)	Doorin Pt.-Salthill Pier			92	39	45
	Mountcharles		18		58	59
Inner Bay	Eddrim Estuary	103		55		
	St. Ernan's Isl.				7	
	Dungally Strand			43		
Outer Bay (south)	Murvagh				8	
	Rossnowlagh-Inishfad		112	169	62	
	Rossnowlagh			43	102	50
Southern Bay	Aughrus Pt.-Bundoran		75	53	104	113
Flying		55		159	35	137
Total census estimate		**158**	**205**	**469**	**317**	**270**

The total census estimate excludes birds that were considered to have been double-counted between subsites and, therefore, may not match the sum of the subsite counts. Note that the Erne Estuary and Aughrus Pt – Bundoran were not covered on 29th January, and the Inner Bay was not covered or only partially covered on all counts

Sanderling

Trestle monitoring area

B.3.15 Sanderlings were recorded on the trestle watch on three of the five survey days, and were also recorded within the trestle monitoring area during the reconnaissance visit on 11th January, and on the census count on 12th March (Table B.).

B.3.16 All flock positions recorded were within the sandflats zone, mainly in the Mountcharles and, Eddrim Estuary subsites, with one flock on the boundary between the Mountcharles and Murvagh subsites (Figure B.11). No Sanderling were recorded in the inner part of the study area east of Hassan's. Flocks were recorded in the sandflats below Jack's Quay, along the tidal channel immediately west and north of the trestles, and in the Eddrim Estuary. There was only a single record of a flock on the Murvagh side. There were no observations of Sanderling within the trestle blocks. The flocks were very mobile, typically only remaining in the same area for a relatively short period.

Table B.1 – Observations of Sanderling during the low tide period within the trestle monitoring area

Date	Subsite	Flock	Number	Notes	Time of initial detection (min ± LT)	Duration
11 Jan	0A497	1	52	Feeding on sandflats on north side of tidal channel to west of trestles, on/close to tideline	-52	40[1]
03 Feb	0A479	1	84	Moving along sandbar following falling tide	-186	40[2]
	0A497	2	6	Foraging 25 m east of trestles; flew off	-130	12
12 Feb	0A497	1	44	Foraging on sandflats near Jack's Quay. Recorded during the census count so flock not tracked after initial detection	-113	-
	0A497	2	16	Flew around Beefpark peninsula and started feeding just to the north of the trestles	+166	12
	0A429/ 497	3	46	Flew from side of Beefpark peninsula and started feeding along boundary between subsites	+188	3[1]
25 Feb	0A429	1	40	Foraging	+30	21
	0A497	2	18	Seen briefly feeding, then presumably the same flock seen flying around the Beefpark peninsula and into the inner part of the Eddrim Estuary	+69	1
	0A429	3	5	Flying north into subsite	+75	-
	0A429	4	34	Foraging	+112	65
12 Mar	0A429	1	10	Foraging. Recorded during the census count so flock not tracked after initial detection	-107	-
	0A497	2	16	Initially picked up off Jack's Quay, and observed moving towards Salt Hill Pier while foraging. Recorded during the census count so flock not tracked after initial detection	-98	-

[1] observation period terminated while birds still present

[2] lost due to deteriorating visibility

B.3.17 There were ten separate observations of Sanderling flock positions in the Mountcharles/Eddrim Estuary area. We analysed the probability of all ten of these observations being outside the trestle blocks by calculating the area of suitable intertidal habitat that was outside the trestle blocks at the time of each observation as a proportion of the total area of visible intertidal habitat. These values range from 76%-96% (mean 83%). If the Sanderling flocks were selecting habitat randomly, and each observation was independent, the probability of none of the flocks occurring within the trestle blocks is the product of these values, and equals 18%. Therefore, these observations do not prove that the Sanderling flocks were avoiding the trestle blocks. However, this reflects the low number of observations: given the above values, around 18 observations would be needed for the probability to be less than 5%.

Census counts

B.3.18 The observations of Sanderling flocks during the census counts are shown in Table B.1 and the overall distribution of Sanderling recorded during the census counts is summarised in Table B.. Apart from the Mountcharles/Eddrim Estuary area, flocks also occurred in the Murvagh and Aughrus Pt.-Bundoran subsites. In the latter subsite, there were two observations of large flocks foraging on seaweed-covered bedrock around the high tide period. All of the other observations were on sandy beaches or sandflats.

Table B.16 - Observations of Sanderling during the census counts

Date	Subsite	Flock	Number	Time of initial detection (min ± LT)	Notes
29-Jan	0A479	1	38	+155	Foraging on upper sandflats towards northern end of subsite; very tightly bunched, so possible underestimate of numbers
	0A479	2	13	+177	Foraging on upper sandflats towards southern end of subsite; possible double count of bird in flock 1
03-Feb	0A468	1	16	+223*	Foraging on sand at Bundoran Bridge; assumed to have joined flock 2
	0A468	2	126	-253*	Foraging on seaweed-covered bedrock at Rougey Strand
	0A479	3	84	-186	At northern end of subsite. Initially roosting, then started foraging along tideline, moving across sand bar following the falling tide. Flushed when disturbed by walkers with dogs, but returned to this area. Recorded as flock 1 in trestle monitoring.
12-Feb	0A497	1	44	-113	Foraging on sandflats near Jack's Quay. Recorded as flock 1 in the trestle monitoring analysis
25-Feb	0A468	1	146	-264	Roosting on sandy beach at Rougey Strand, then moved to seaweed covered bedrock and started to feed
	0A468	2	38	-243	Foraging on seaweed covered bedrock at Bundoran Bridge. Possible double count with flock 1
	0A429	3	40	+30	Foraging on sandflats in the inner Eddrim Estuary. Recorded as flock 1 in the trestle monitoring analysis
12-Mar	0A479	1	12	-134	Foraging on the upper sandflats in the middle part of the subsite. Observed leaving the area, probably due to increasing disturbance from dog walkers, and may have been counted again as flocks 2 and/or 3.
	0A429	1	10	-97	Foraging on sandflats in the Inner Eddrim Estuary; possibly same birds as recorded on Murvagh Strand. Recorded as flock 1 in the trestle monitoring analysis
	0A497	2	16	-88	Initially picked up off Jack’s Quay, and observed moving towards Salt Hill Pier while foraging; possibly same birds as recorded on Murvagh Strand. Recorded as flock 2 in the trestle monitoring analysis

* these times are relative to the night-time low tide (04:17), rather than the day-time low tide (which was 16:46 on this date) used for all the other times in this table

Table B.17 – Distribution of Sanderling recorded in the census counts

	Subsite	11 Jan	29 Jan	03 Feb	12 Feb	25 Feb	12 Mar
Census count	Mountcharles				**44**		**16**
	Eddrim Estuary					**40**	**10**
	Murvagh		51	84			**12**
	Rossnowlagh					38	
	Aughrus Pt - Bundoran			126		146	
	Total		51	210	44	224	38
Trestle watch	Eddrim Estuary/ Mountcharles			**90**	**62**	**63**	
Other	Mountcharles	**52**					

Erne Estuary and Aughrus Pt – Bundoran not covered on 29 Jan, Inner Bay not covered or only partially covered on all counts. Counts in bold were at low tide; all other counts were on rising or falling tides

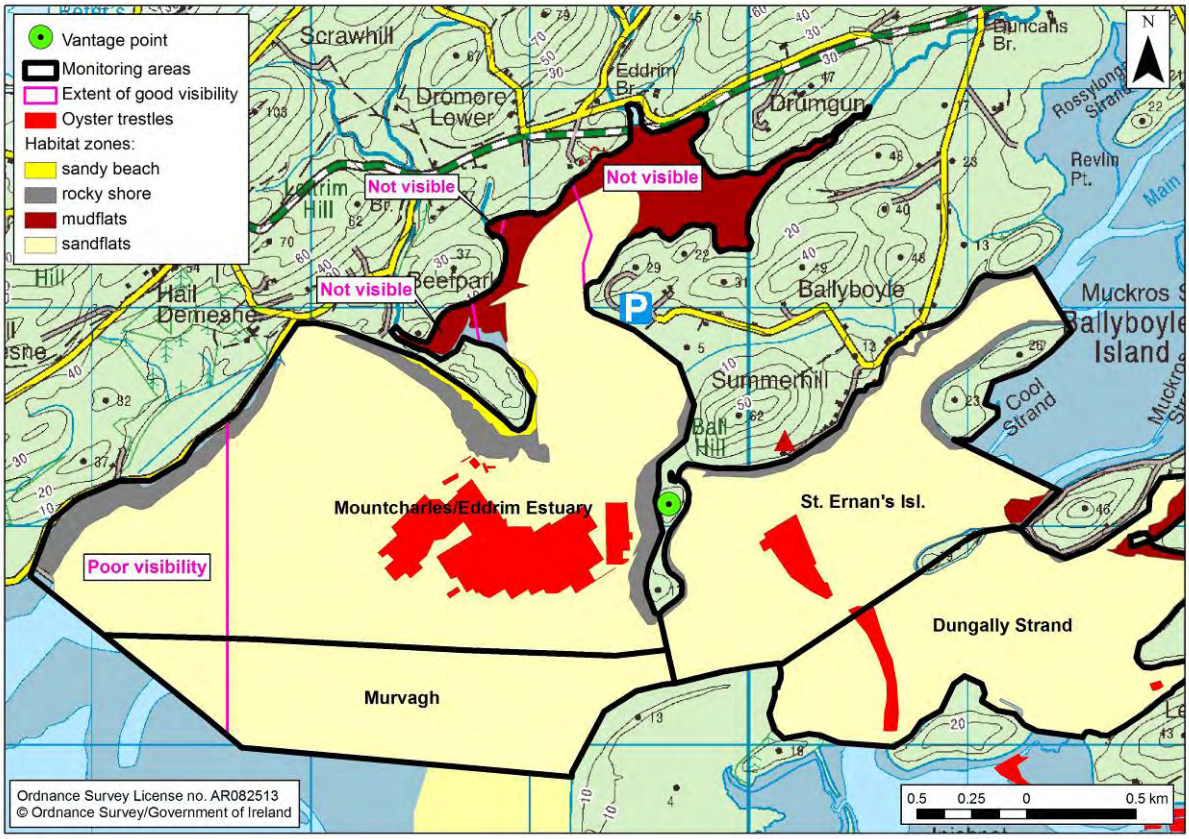

Figure B.1 – Subdivisions and habitat zones in the trestle monitoring area

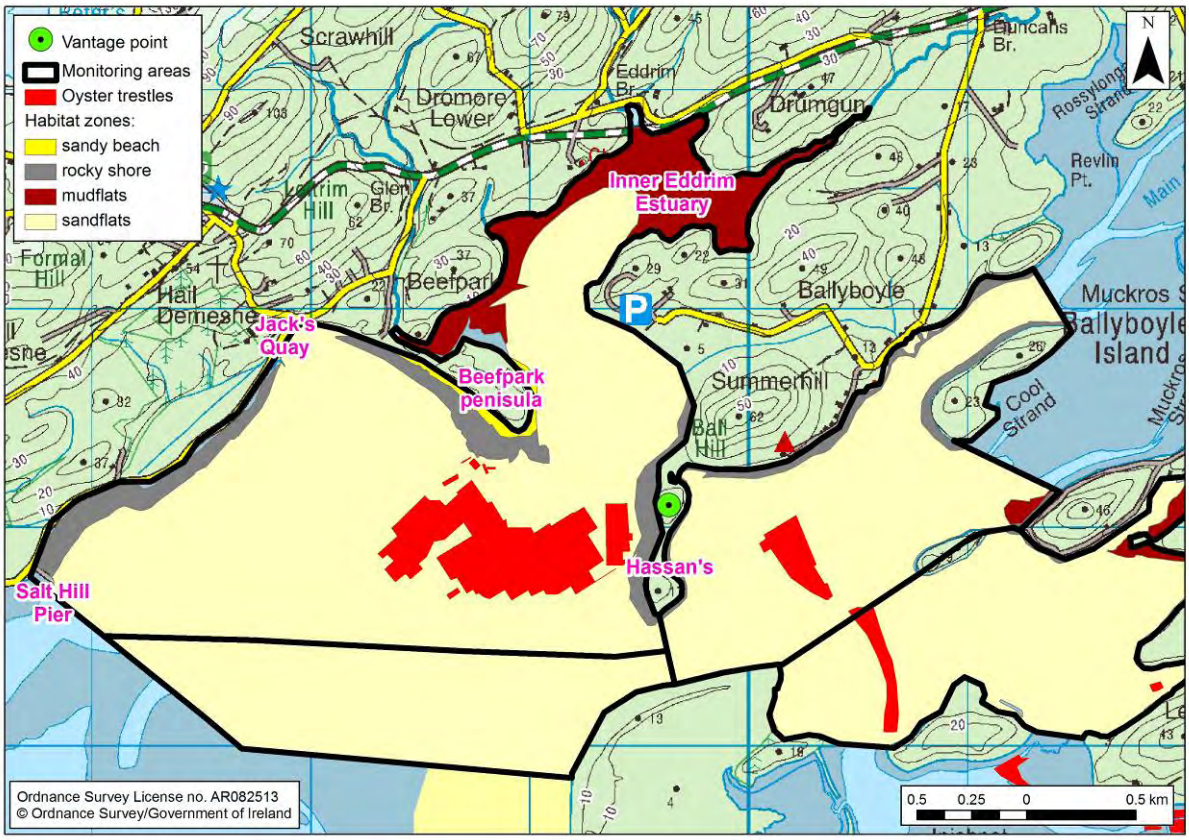

Figure B.2 – Key locations in the trestle monitoring area

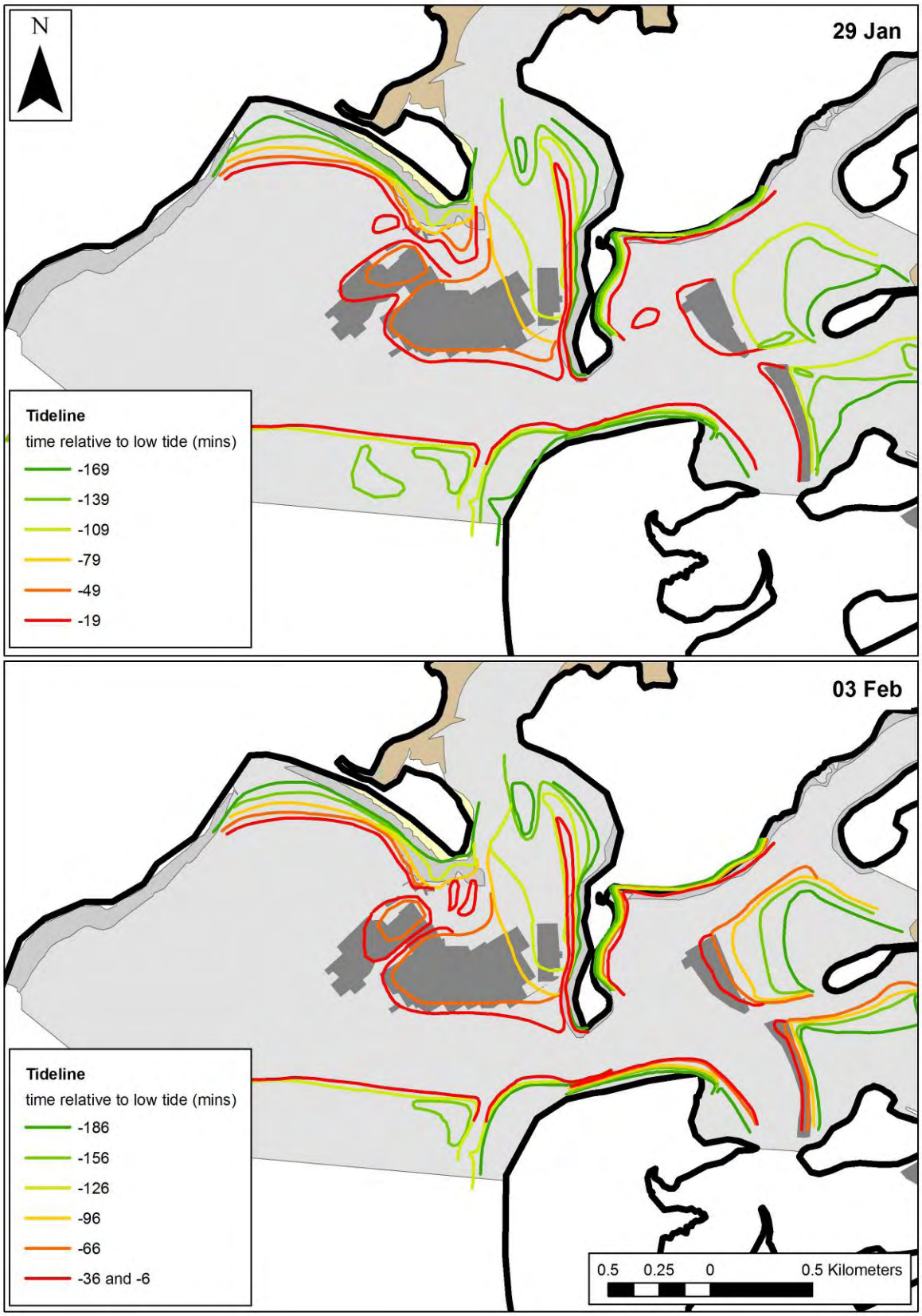

Figure B.3 - Tidelines mapped during the trestle watches on 29th January and 3rd February 2013

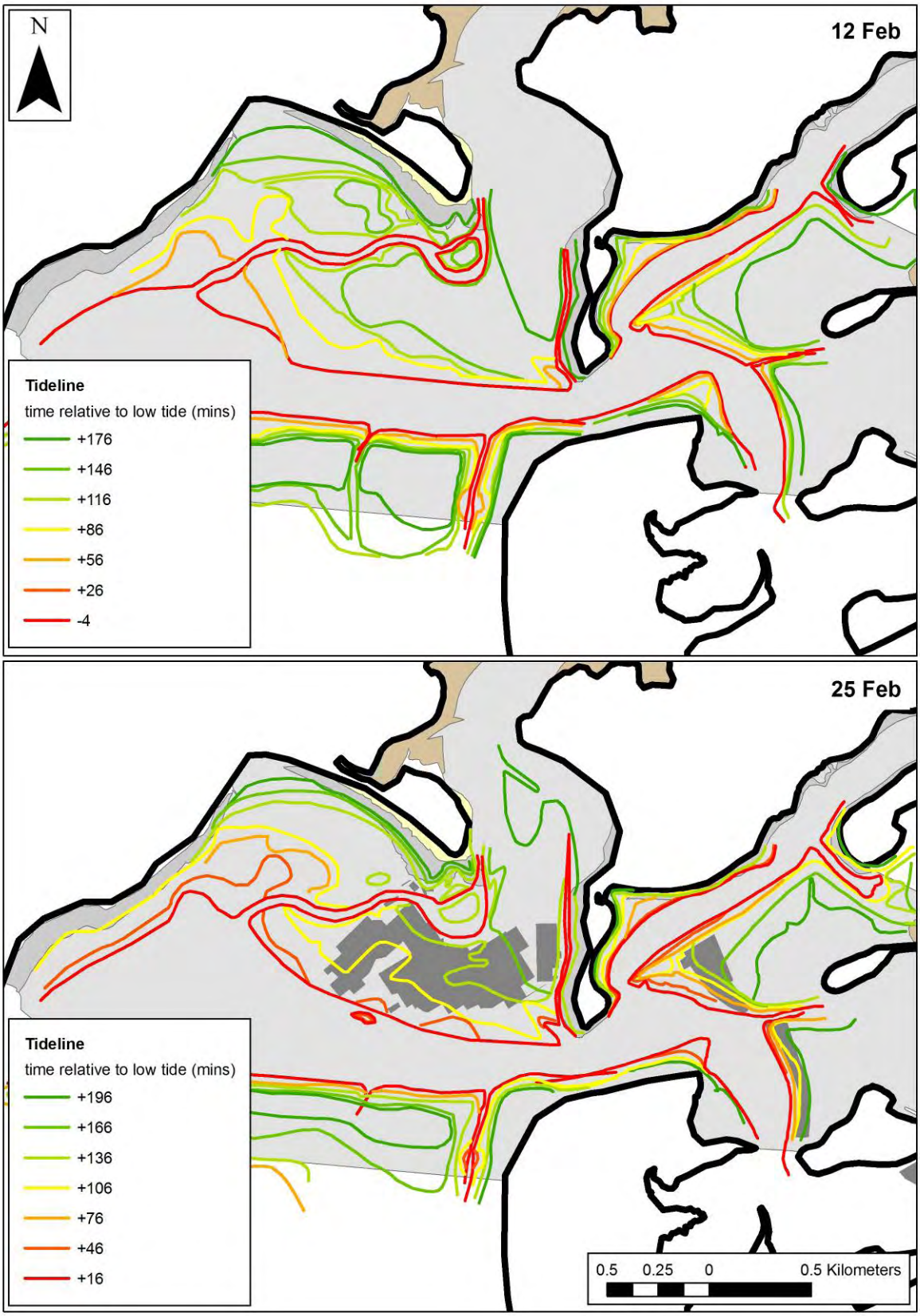

Figure B.4 - Tidelines mapped during the trestle watches on 12th and 25th February 2013

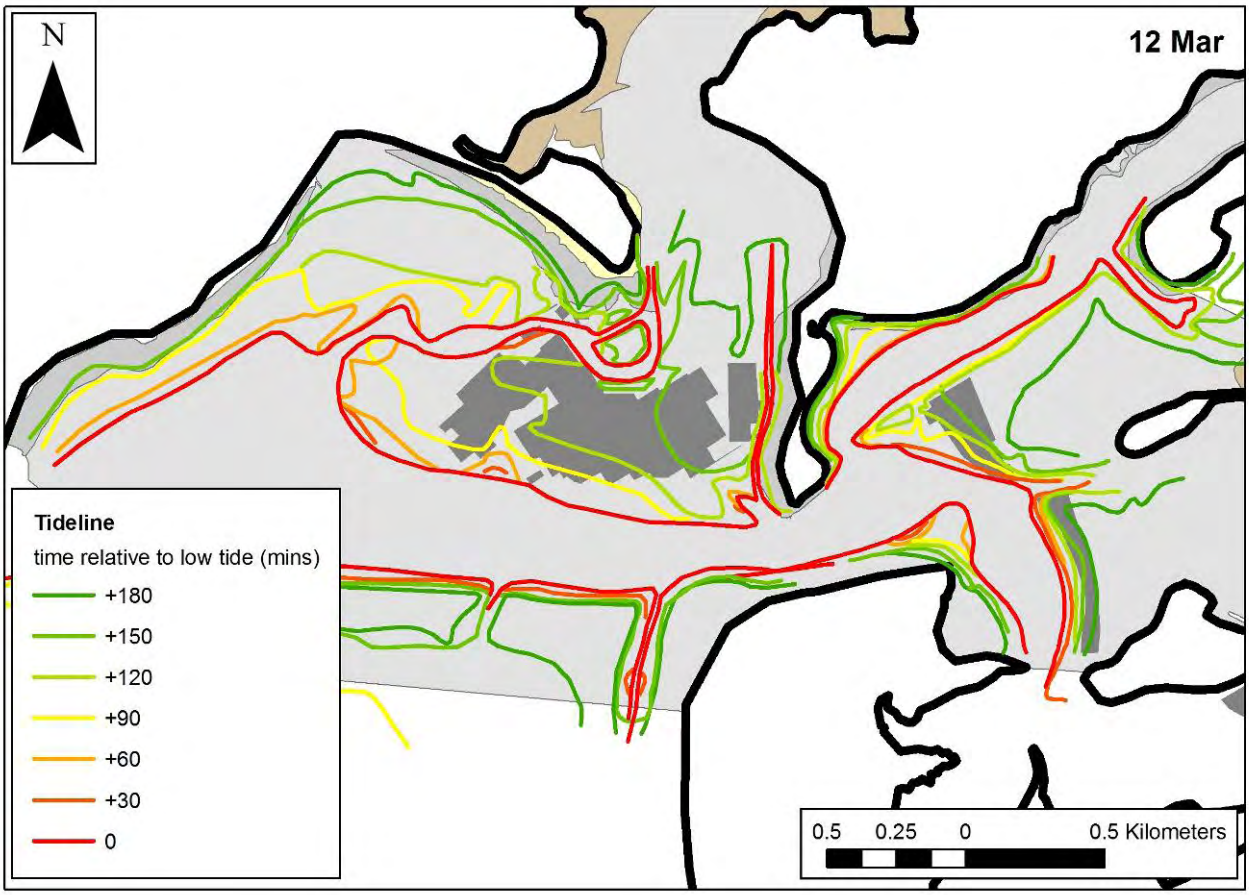

Figure B.5 – Tidelines mapped during the trestle watch on 12th March 2013

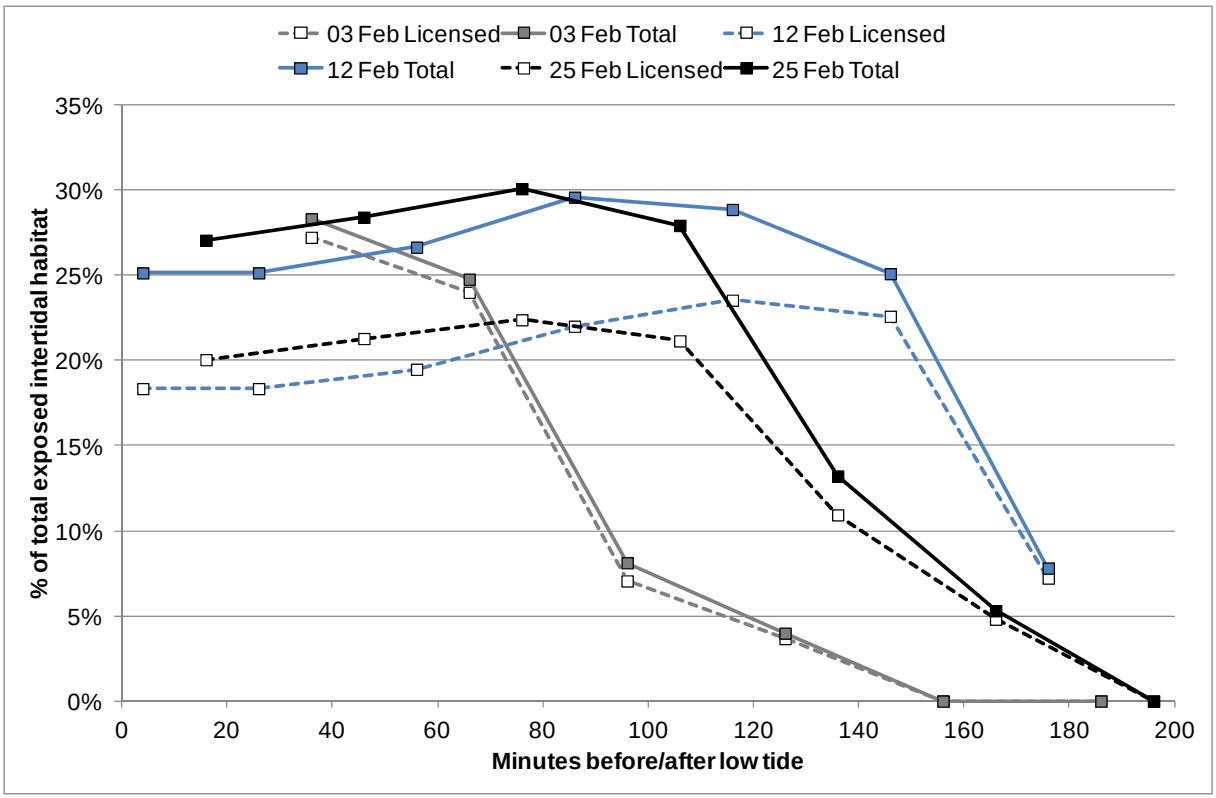

Figure B.6 - Proportion of exposed intertidal habitat within intertidal oyster licenses and applications in the Mountcharles/Eddrim Estuary area on a 0.3 m low tide (12 Feb), a 0.6 m low tide (25 Feb) and a 1.2 m low tide (03 Feb)

Figure B.7 – Trestle blocks with high cover of green algal slime

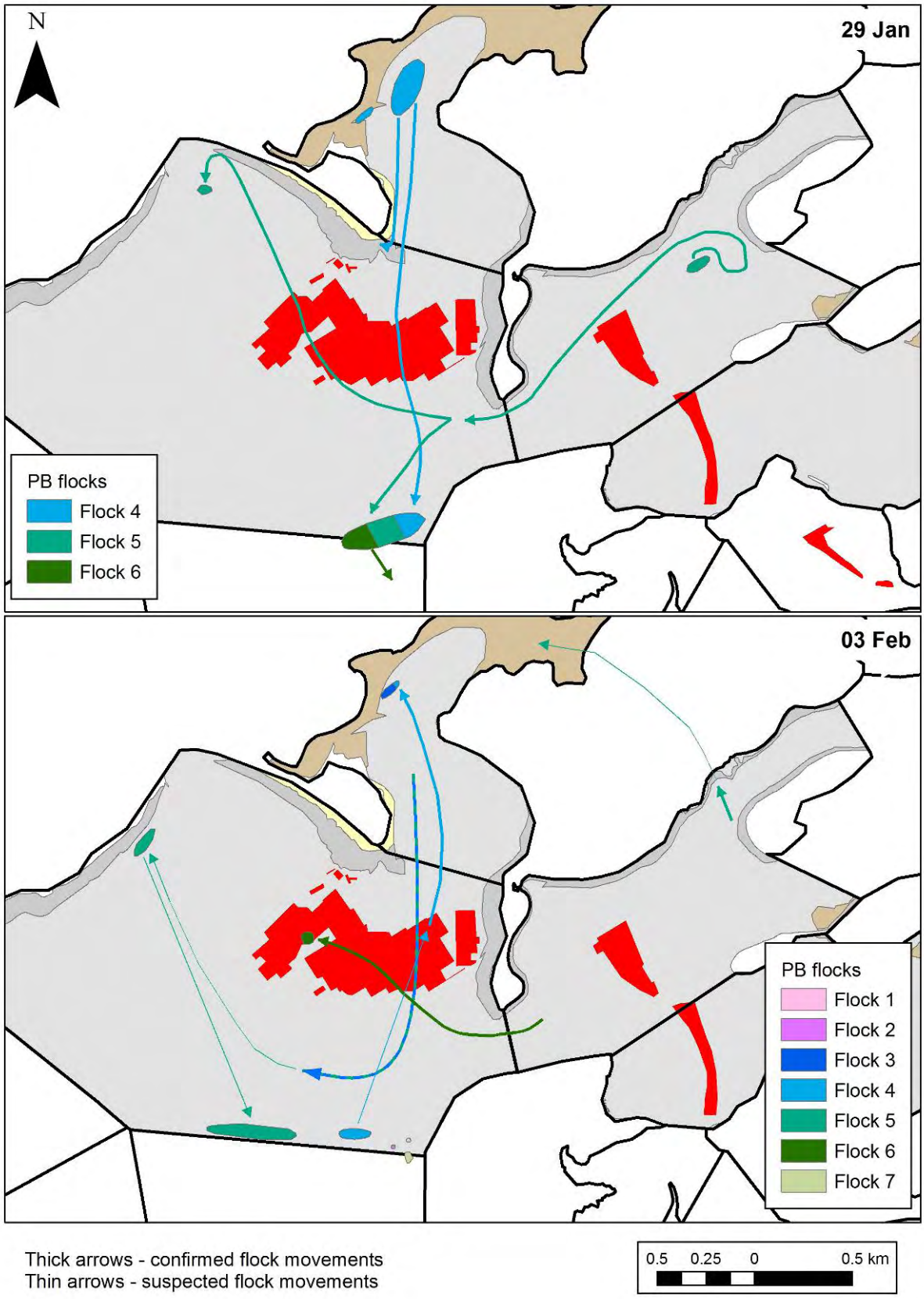

Figure B.8 – Light-bellied Brent Goose flocks recorded during the trestle monitoring on 29th January and 12th February (excluding overflying flocks)

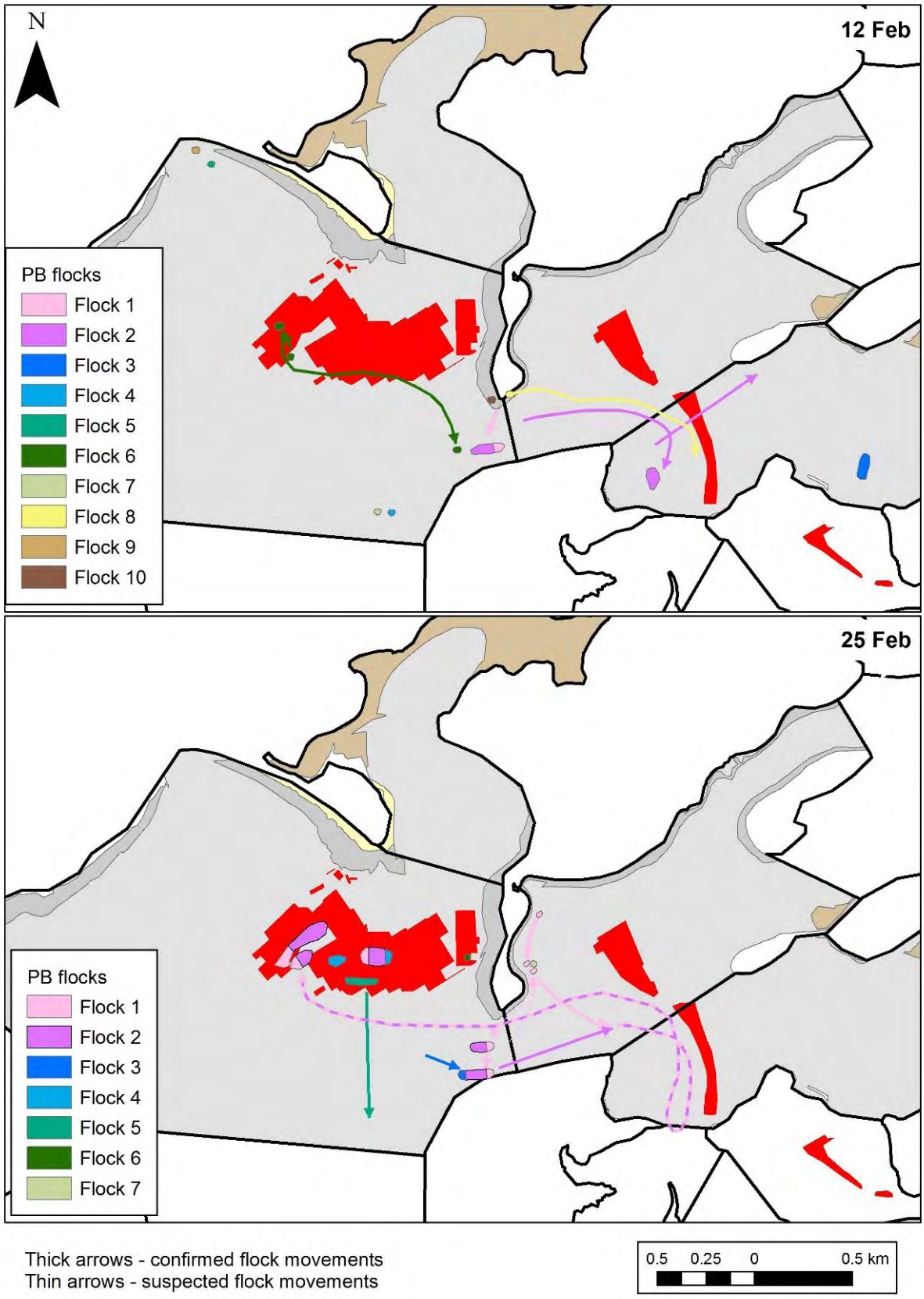

Figure B.9 - Light-bellied Brent Goose flocks recorded during the trestle monitoring on 12th and 25th February (excluding overflying flocks)

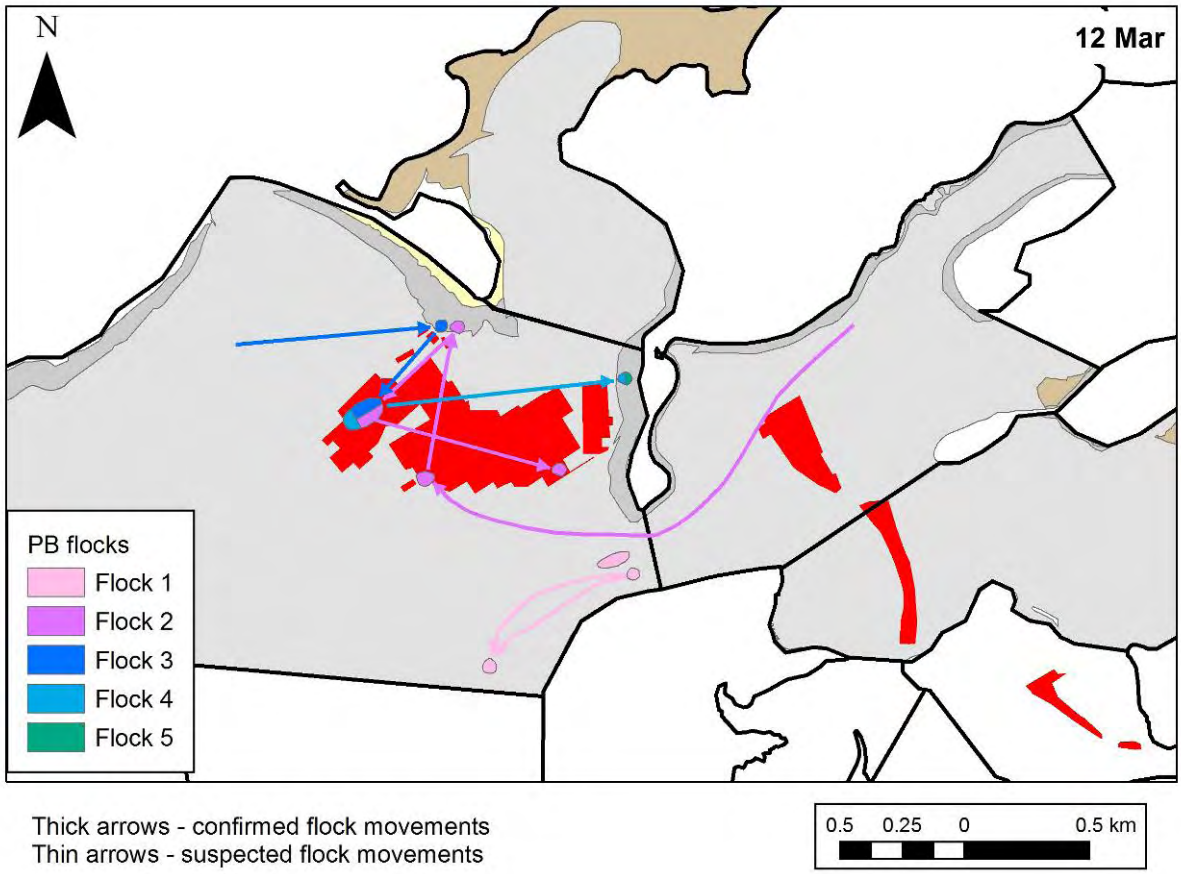

Figure B.10 - Light-bellied Brent Goose flocks recorded during the trestle monitoring on 12th and 25th February (excluding overflying flocks)

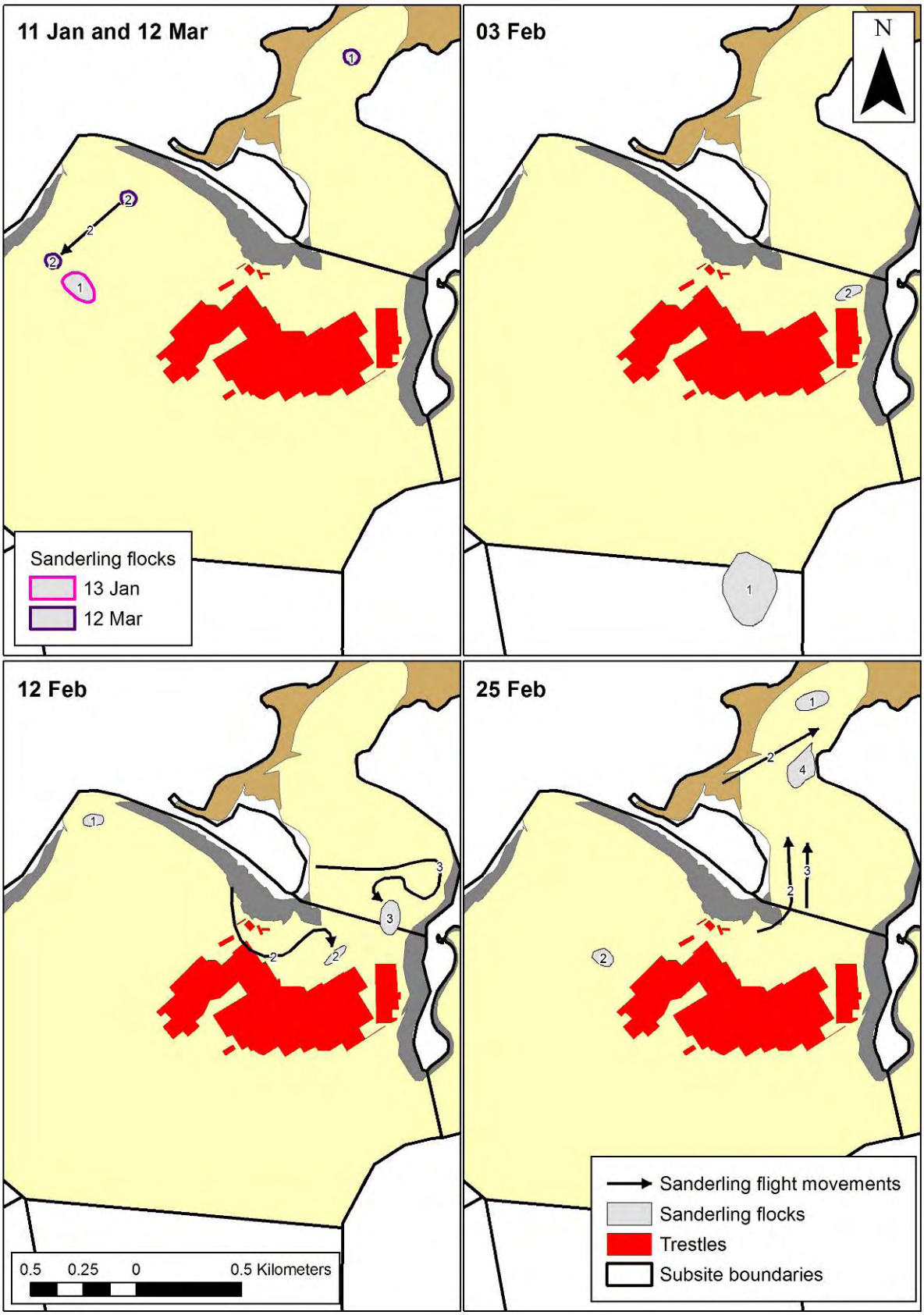

Figure B.11 – Sanderling flocks recorded within the trestle monitoring area

Appendix C – Diet of SCI species at Donegal Bay

C.1 Introduction

C.1.1 This appendix presents an assessment of the likely diet of the SCI species at Donegal Bay namely Sanderling, Light-bellied Brent Geese, Great Northern Diver and Common Scoter.

C.1.2 The assessment is based on a review of information contained within the Food sections of the relevant species accounts in Cramp and Simmons (2004), supplemented by additional sources where relevant. Unless otherwise stated, all information has been taken from Cramp and Simmons (2004).

C.1.3 The assessment focuses on the broad trophic groups consumed and the strata (benthic or pelagic) from which the prey is taken.

C.1.4 The assessment focuses on the relevant habitats and/or seasons.

Common Scoter

C.1.5 During winter and when feeding, Common Scoters are generally distributed in shallow coastal waters with a depth of no more than 20m, feeding primarily during daylight (Cramp & Simmons; BWPi, 2004). They are most often distributed across areas where there is a sandy substratum, linked to the distribution of their favoured prey of bivalve molluscs. Previous research varies somewhat in the range of dive depths undertaken by scoters; examples include a range 2.2 – 3.7m (BWPi, 2004) and a mean of 6.85m and 11.42m (Kaiser *et al*. 2006). Water depth is an important parameter and the distribution of foraging scoters is therefore likely to change in relation to the tidal state (Kaiser *et al*. 2006). As deeper dives are more costly in terms of dive duration and energy expenditure required, it follows that scoters are likely to maximise their energy intake by foraging where prey items are abundant and where the energy required obtaining the prey is minimised.

C.1.6 The diet of Common Scoters has been reviewed by Fox (2003), BWPi (2004) and Kaiser *et al*. (2005). Quantitative analyses of their diet show that it is overwhelmingly dominated by bivalves (88% or greater of the diet composition in the eight studies reviewed by Kaiser *et al*., 2005). A total of 30 species of bivalve have been recorded within their diet (Kaiser *et al*., 2005). A range of bivalve species such as *Mytilus edulis* (up to 40 mm), cockles *Cardium* (up to 40 mm), clams *Mya* and *Spisula* and gastropods (e.g. dogwhelk *Nassa recitulata*, periwinkles *Littorina*, and laver snails *Hydrobia*) are consumed. Occasionally crustaceans, particularly isopods (Idotea), amphipods (shrimps *Gammarus*), and small crabs (*Carcinus*); annelids (polychaetes); and echinoderms are also consumed (BWPi 2004). Fox (2003) concluded that: scoters seem to prefer foraging in clean sandy substrates that support benthic communities rich in bivalve biomass. Within such sites, prey species are probably taken in proportion to their abundance.

C.1.7 Literature reviews do not indicate any clear patterns of size selection of prey by Common Scoter (Fox, 2003; Kaiser et al., 2005). There does not appear to be any lower limit but there may be an upper limit of around 50 mm shell length (Fox, 2003). However, the latter limit may not apply to razor clams as these are likely to be ingested lengthways (Kaiser et al., 2005).

Light-bellied Brent Geese

C.1.8 Light-bellied Brent geese are herbivorous grazers which have a preference for grazing Eelgrass *Zostera* sp. on intertidal areas (NPWS, 2012; BWPi 2004). However, with recent decreases in coastal sea grasses, brent geese also diversified into consuming species such as *Enteromorpha*, sea lettuce (*Ulva lactuca*) and *Cladophora*, in addition to saltmarsh species such as glasswort *Salicornia*; grasses *Puccinellia*, *Festuca*, and *Spartina*; arrow-grass *Triglochin maritima*; and sea

aster *Aster tripolium*) (BWPi 2004) and even winter wheat, despite the lower energy content of these sources compared to eelgrass (Kuhlmann, *et al*. 2012). Animal materials very rarely form part of the Brent's diet, but may include molluscs and crustaceans and lugworms (BWPi 2004). In more recent years there has also been a progressive shift in some sites to feeding on amenity and agricultural grasslands. In Northern Ireland Brent have been reported to follow a sequential pattern of habitat use, utilising the eelgrass beds in early autumn, and subsequently moving onto saltmarsh and farmland in late winter and early spring, though the body condition of birds who remain to feed on saltmarsh and farmland is significantly reduced compared to period of available eelgrass in early autumn (Tinkler, *et al*. 2009).

Sanderling

C.1.9 Sanderling are carnivorous, and generally feed on invertebrates. Sanderling have been reported to utilise a flexible foraging strategy which varies from site to site, dependant on local conditions The diet of wintering Sanderlings consists primarily of polychaetes, molluscs, small crustaceans and insects (Reneerkens *et al*. 2009). Though they feed predominantly by pecking small invertebrates such as sandhoppers (*Talitrus* sp.) and wrack flies (Coelipidae) off of dried seaweed (wrack) (Chelazzi & Vannini, 1988), they frequently probe for polychaetes (with an apparent preference for *Scolelepis squamata*) (Vanermen *et al*., .2009), while beetles (Laccobius, Berosus, Philhydrus, Helophorus, Elateridae), lepidopterans, bugs (Hemiptera), and hymenopterans. Crustacea are all taken, especially when abundant, including shrimps (Gammaridae) and eggs of Limulus (on the east coast of North America) also form a staple component of the sanderling's diet (BWPi, 2004).

C.1.10 Though wrack provides a rich food source, its occurrence can be irregular; during the course of their migration Sanderling have been observed at Teesmouth (Hartlepool, UK) feeding on *Nerine cirratulus* (a polychaete), *Bathyporeia* spp. (amphipods), and *Eurydice pulchra* (an isopod) (Roberts, 1990). Wrack seems to be a common foraging source for Sanderling, containing Coelipidae (both larvae and adults), mites, *Gammarus* and staphylinid beetles, they have also been observed feeding on mussel fragments and spat deposited on the beach, sand eels and small crabs, they will also scavenge remnants of large mussels left by oystercatchers (Cooper, 1987), in addition to taking other crustaceans, fish and molluscs as carrion (BWPi, 2004).

Great Northern Diver

C.1.11 Great Northern Divers are carnivorous, feeding primarily on fish up to 28 cm, though this can vary with both locality and season, their diet has also been noted to include crustaceans, molluscs, annelids, insects, and amphibia. (NPWS, 2012; BWPi, 2004). There is very little information regarding the diet of Great Northern Divers in Irish or British Waters, though it is accepted that they generally forage in deeper waters and can hence occur up to 10km off shore diving up to 70m (though generally 4-10m), but can follow prey items into shallower waters (NPWS, 2012; BWPi 2004).

C.1.12 Great Northern Divers have a diverse bentho-pelagic piscivorous prey base which can include haddock *Melanogrammus aeglefinus*, cod *Gadus morhua*, whiting *Merlangius merlangus*, herring *Clupea harengus*, sprat *Sprattus sprattus*, gurnard *Eutrigla gurnardus*, bull rout *Myoxocephalus scorpius*, sand-eel (Ammodytidae), pipefish (Syngathidae), goby (Gobiidae), flat-fish (Pleuronectidae), eel-pout Zoarces, eel *Anguilla anguilla*, stickleback (Gasterosteidae), trout *Salmo trutta*, perch *Perca fluviatilis*, roach *Rutilus rutilus*, and char *Salvelinus alpinus*. Crustaceans include crabs (*Portunus, Carcinus*), shrimps, and prawns; molluscs, razorshell (Solen), Planorbis, and small cephalopods; annelids, polychaete worms. In 38 stomachs collected during winter in British Isles 55·3% fish, 24·0% crustaceans, 18·5% molluscs, and 2·1% unidentified materials (BWPi, 2004). The visibility within and hence quality of the water have been

shown to influence both dive duration, and are likely to influence prey selection of wintering Great Northern Divers; e.g. relying on easily captured bottom dwelling crustaceans in waters with poor visibility (Thompson & Price, 2006).