Marine Institute

Cork Harbour SPA

Cork Harbour: Appropriate Assessment of Aquaculture

April 2020

Marine Institute Bird Studies

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Notice

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Executive Summary

This report presents the results of an Appropriate Assessment of aquaculture in Cork Harbour. There are a total of seven aquaculture sites considered, covering a total area of 314 ha, within Cork Harbour. Five of the sites are small oyster trestle sites (combined area of 19 ha). Two of these sites occur in the North Channel within the Cork Harbour SPA, and three are in the lower harbour outside the SPA. The sixth and seventh sites are large bottom mussel culture sites (total area of 295 ha), which occupy a large part of the East Harbour zone and is partly within the SPA.

The report assesses the potential impact of the development of these aquaculture sites on the Special Conservation Interests (SCIs) of the Cork Harbour SPA, and on the SCIs of other SPAs where these SCIs may have connectivity with Cork Harbour. The potential for cumulative impacts from development of these aquaculture sites in combination with other relevant activities and plans is also assessed. The in-combination activities and plans assessed include: four Fishery Orders, which permit additional aquaculture development in Cork Harbour, and other marine traffic.

The SCIs of the Cork Harbour SPA covered by this assessment are: Shelduck, Wigeon, Teal, Pintail, Shoveler, Red-breasted Merganser, Cormorant, Grey Heron, Little Grebe, Great Crested Grebe, Oystercatcher, Golden Plover, Grey Plover, Lapwing, Curlew, Black-tailed Godwit, Bar-tailed Godwit, Dunlin, Redshank, Black-headed Gull, Common Gull, Lesser Black-backed Gull and Common Tern. The SCIs of other SPAs covered by this assessment are: the wintering Mallard population of the Gearagh SPA, and the breeding Cormorant population of the Sovereign Islands SPA.

The small scale of the oyster trestle cultivation activity covered by this assessment, and the location of three of the five sites in areas of the harbour that do not hold high concentrations of intertidal/shallow subtidal waterbirds, mean that no significant displacement impacts are likely to occur. There is a possibility of disturbance impacts to Common Tern roosts on Spike Island. Any such impacts are unlikely to be significant, but further information about Common Tern usage of the Spike Island and about the intensity of husbandry activity, would be required to definitively assess this potential impact.

Bottom mussel cultivation is not predicted to cause significant disturbance impacts to foraging Red-breasted Merganser, Cormorant or Great Crested Grebe during the day. There is potential for bottom mussel cultivation to cause disturbance impacts to the nocturnal roosts of these species when the boat is returning to the North Channel in the evening. While the number of nights on which this would occur would be limited to 4-5 nights per month, the potential significance is difficult to evaluate as the behavioural consequences of disturbance to nocturnal roosts in these species are poorly understood. Oyster fishing activity in the East Harbour Fishery Order, and other boat traffic and recreational watercraft activity in Cork Harbour, could have additional cumulative disturbance impacts on these roosts in combination with the impact from the bottom mussel culture activity.

Potential disturbance impacts to these roost sites could be minimised by not carrying out any fishing activity within two hours of dusk. Alternatively, a combination of spatial exclusion zones and monitoring could be used as an adaptive strategy to manage the potential disturbance impacts to the roosts. As disturbance impacts would only become potentially significant if repeated over a period of time, this strategy would allow the impact to be managed before it became potentially significant.

The conclusions of this assessment only apply to the scale of the proposed operations described in the information supplied. Any intensification of the proposed operations may require further assessment.

Acknowledgements

We are grateful to Francis O Beirn (Marine Institute), Tristan High-Jones (Atlantic Shellfish) and David Millard (BIM) for providing information about the proposed aquaculture operations that has informed this assessment.

This assessment relies heavily on data from Irish Wetland Bird Survey (I-WeBS) counts, and associated waterbird monitoring (included coordinated Cormorant and Great Crested Grebe roost counts and compilation of the high tide roost database), that have been carried out in Cork Harbour. We are grateful for all the volunteers who have contributed to these counts over the years, many of who are acknowledged in Gittings (2006, 2019, 2020). The Irish Wetland Bird Survey is a joint scheme of BirdWatch Ireland and the National Parks and Wildlife Service of the Department of Arts, Heritage & the Gaeltacht.

This assessment also uses data from the NPWS Waterbird Survey Programme 2010/11 as undertaken by the National Parks & Wildlife Service.

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 In 2019, we prepared an Appropriate Assessment report which assessed the impact of aquaculture in Cork Harbour on SCIs of the Cork Harbour SPA, and other relevant SPAs (Gittings and O'Donoghue, 2019). The present report presents an updated Appropriate Assessment of aquaculture in Cork Harbour following changes to the proposed bottom mussel cultivation sites. There have been no changes to the proposed oyster trestle cultivation sites, and the assessment of oyster trestle cultivation is unchanged from the 2019 assessment.

1.3 The subjects of the assessment are areas that have either already been licensed for aquaculture, or for which there are applications for such licenses; these are collectively referred to as aquaculture sites. The information on the licensing status of aquaculture sites used in this report was provided by the Department of Agriculture, Food and the Marine.

1.4 Three of the aquaculture sites are within, or partly within, the Cork Harbour SPA, while another four aquaculture sites that are outside the SPA are also included in the assessment. Therefore, the assessment covers all the aquaculture sites in Cork Harbour. The Cork Harbour SPA is the primary focus of this assessment. In addition, following a screening exercise, a Special Conservation Interest (SCI) from The Gearagh SPA is included in this assessment. The SPAs covered by this assessment are shown in Figure 1.1.

1.5 This assessment is based on a desktop review of existing information. Where relevant, it identifies information gaps that may affect the reliability of the conclusions of this assessment. Both authors have a high level of knowledge of Cork Harbour and its waterbird populations, which has informed the assessment.

1.6 Tom Gittings has carried out regular I-WeBS counts in Cork Harbour since 1996 and has been coordinator of the Cork Harbour I-WeBS counts since 2002. He is currently the regular counter of five I-WeBS subsite, and has carried out counts in all the other I-WeBS subsites in Cork Harbour. He has also carried out numerous other waterbird counts and studies in Cork Harbour for a wide range of projects and has recently published the results of a study of Great Crested Grebe roosting behaviour based largely upon work in Cork Harbour (Gittings, 2017).

1.7 Paul O'Donoghue is also an IWeBS counter having carried out counts in three I-WeBS subsites in Cork Harbour. He has also carried out numerous other waterbird counts and studies in Cork Harbour for a wide range of projects and has recently undertaken a review of the spatial distribution of birds in Cork Harbour for Cork County Council.

1.8 This report relies heavily on the research carried out for a previous Marine Institute project: *The effects of intertidal oyster culture on the spatial distribution of waterbirds*. The results of this project have been published as technical report (Gittings and O'Donoghue, 2012) and a scientific paper (Gittings and O'Donoghue, 2016b). The report and paper, and additional unpublished data from this project, are referred to hereafter as the *trestle study*.

1.9 The data analysis and report writing was done by Tom Gittings. Paul O'Donoghue assisted with project design, document preparation and undertook document review.

1.10 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

1.11 The structure of the report is as follows:

- Chapter 2 of the report describes the methodology used for the assessment.
- Chapter 3 of the report contains a preliminary screening assessment that reviews the Special Conservation Interests (SCIs) of the Cork Harbour SPA, and the SCIs of other SPAs in the wider vicinity, and screens out SCIs that do not show any significant spatial overlap with the activities being assessed.
- Chapter 4 of the report describes the Conservation Objectives, and their attributes and targets, of the SCIs that were screened in for this assessment.
- Chapter 5 of the report contains a summary of waterbird habitats and distribution in the Cork Harbour SPA, and of the status and distribution of the SCI species included in the assessment.
- Chapter 6 provides a description of the current and proposed future extent of the aquaculture activities covered by this assessment and the nature of their operations.
- Chapter 7 assesses the likely impact of the oyster trestle cultivation activity included in this assessment on the SCIs that were screened in for this assessment.
- Chapter 8 assesses the likely impact of the bottom mussel cultivation activity included in this assessment on the SCIs that were screened in for this assessment.
- Chapter 9 contains an assessment of cumulative impacts.
- Chapter 10 concludes the report by assessing the impact of aquaculture activities in the Cork Harbour, and any in-combination impacts (if relevant), on the conservation objectives of the SCIs included in this assessment. This chapter also includes recommendations for managing and monitoring aquaculture activities where there is uncertainty about the potential impacts.

Constraints to this assessment

1.12 There is a lot of detailed information available about waterbird populations in Cork Harbour and we have also been able to use our personal knowledge to inform the assessment. However, there are still some information gaps. In particular, there is very little waterbird count data available for the areas around the Corkbeg Bay and Spike Island aquaculture sites, although the small scale of these aquaculture sites means that this is not a critical information gap.

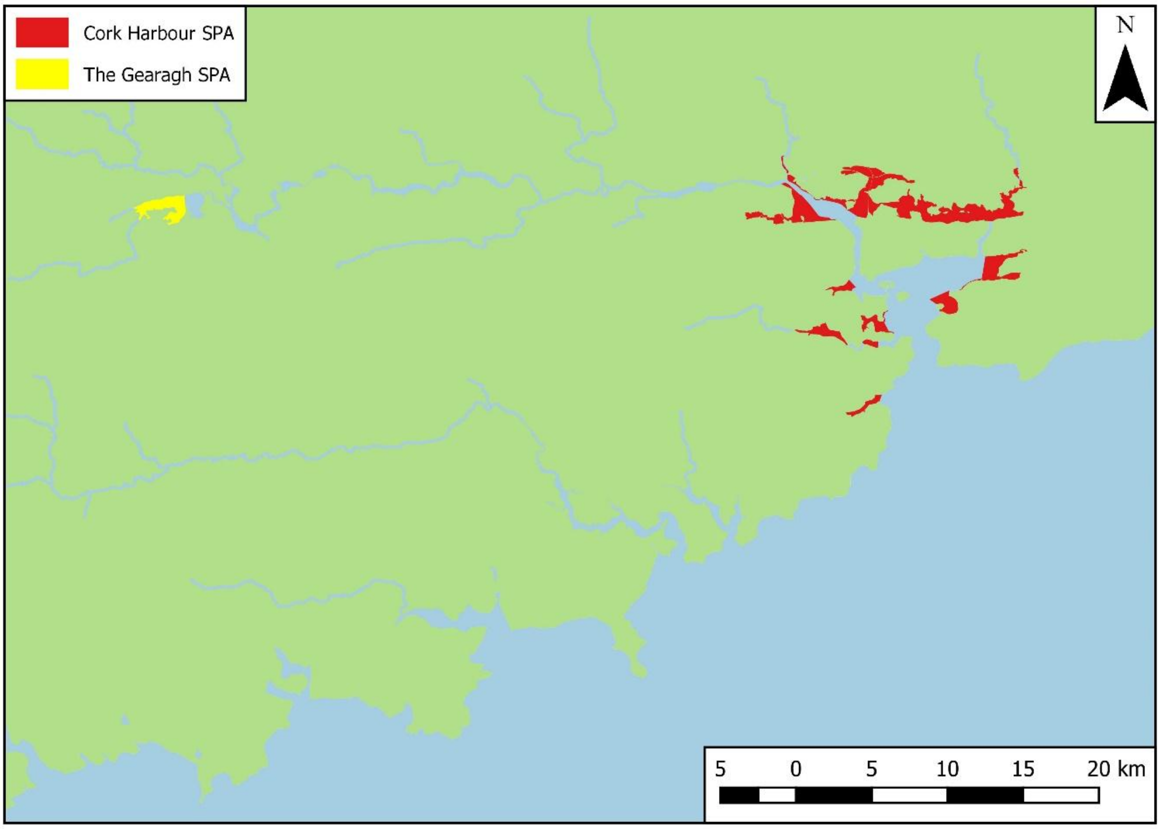

Figure 1.1 – SPAs included in this assessment.

2. Methodology

General

2.1 This assessment is based on a desktop review of existing information about waterbird population trends and distribution in Cork Harbour, supplemented by site visits to assess the habitat characteristics and tidal regimes in the areas around the aquaculture sites.

2.2 The authors have very detailed personal knowledge of the waterbird habitats and distribution patterns in Cork Harbour and this has also been used to inform the assessment. Unless otherwise stated, all comments on waterbird status, distribution, habitat use and behaviour in Cork Harbour are based on the authors' personal knowledge.

Data sources

2.3 The SPA boundaries are derived from NPWS shapefiles[1] (which were last updated in December 2019).

2.4 The spatial extents of the aquaculture sites have been derived from shapefiles supplied by the Marine Institute (shapefile dated November 2017 for sites T05/294A, T05/294B, T05/546A, T05/546B and T05/546C; shapefile dated February 2020 for sites T05/522A and T05/522B).

2.5 Information on the development and current practices of aquaculture activities in Cork Harbour was obtained from the aquaculture profile document compiled by Bord Iascaigh Mhara (BIM) in March 2018, supplementary notes about some of the sites (Hugh-Jones, 2019), and further information provided about the bottom mussel cultivation sites (Tristan Hugh-Jones, Atlantic Shellfish, pers. comm., March 2020).

2.6 The bird data sources used for the assessment are as follows:

- Irish Wetland Bird Survey (I-WeBS) counts, 1994/95-2019/20.
- NPWS Waterbird Survey Programme (WSP) 2010/11 counts.
- The descriptions of waterbird distribution within the Cork Harbour SPA in the SPA Conservation Objectives Supporting Document (NPWS, 2014c).
- Other relevant publications (Smiddy *et al.*, 1995; Gittings, 2017; O'Mahony and Smiddy, 2017).
- The authors' personal knowledge based on monitoring waterbirds in Cork Harbour since 1995.

2.7 Information on the distribution of biotopes was taken from the surveys of intertidal habitats by MERC (2012) and subtidal habitats by Ecoserve (2012).

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/).

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[1] www.npws.ie/maps-and-data/designated-site-data/download-boundary-data (accessed 5th December 2019).

Mapping

Intertidal habitat definitions and mapping

2.9 The intertidal habitat mapping is based on the Ordnance Survey Ireland (OSI) Discovery Series mapping. We edited this mapping to align with the current shoreline configuration and current configuration of major tidal channels using recent aerial imagery. We also separately mapped significant areas of *Spartina* and other saltmarsh habitat. Therefore, the intertidal habitat was divided into three categories: unvegetated intertidal habitat (referred to as intertidal habitat); *Spartina* beds (referred to as *Spartina*); and other saltmarsh (referred to as saltmarsh).

2.10 The lower limit of the intertidal zone in the OSI mapping represents the mean low tide mark but is based on mapping from the early 20th century. While it would be desirable to update this mapping, such an exercise was beyond the scope of this assessment. In any case, due to the enclosed estuarine nature of most of the intertidal areas in Cork Harbour, changes to the overall distribution of the intertidal habitat at the scales analysed in this assessment will have been relatively minor.

2.11 For the assessment of the bottom mussel cultivation sites, we mapped the tideline along the southern and eastern shore of the East Harbour zone at around four hours before high tide on 20th March 2020. The tideline along most of the section of shoreline closest to the sites was mapped by GPS while the remaining sections of tideline were mapped by eye from suitable vantage points.

Subtidal habitat definitions and mapping

2.12 We divided subtidal habitats into three categories to reflect waterbird usage of the habitat: shallow, moderately deep and deep. We defined shallow subtidal habitat as subtidal habitat less than 0.5 m deep. This corresponds to the depth range used by most species of geese and dabbling ducks for foraging (Kirby *et al.*, 2000; Cramp and Simmons, 2004). We defined moderately deep subtidal habitat as subtidal habitat less than 5 m deep. This corresponds to the depth range used by various species of seaduck and grebes, including Red-breasted Merganser and Great Crested Grebe (Kirby *et al.*, 2000; Cramp and Simmons, 2004). All subtidal habitat more than 5 m deep was defined as deep subtidal habitat. Species associated with offshore and pelagic habitats, including Cormorant, can feed in this depth range.

2.13 We used the Admiralty Chart mapping to assess the distribution of these subtidal habitat categories within the Cork Harbour SPA. We defined the shallow subtidal zone as the zone between the OSI intertidal/subtidal boundary and the 0 m contour on the Admiralty Chart, which represents the lowest astronomical tides, and we used -5 m contour on the Admiralty Chart to define the boundary between the moderately deep and deep subtidal zones. 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. Varying amounts of the shallow subtidal zone will be exposed on spring low tides. Therefore, the shallow subtidal zone was also treated as being available to birds that feed in the intertidal zone on spring low tides.

Site definition and divisions

Site definition

2.14 The Cork Harbour SPA comprises a number of discrete sections scattered around the harbour and includes one section (the Ringabella Estuary), which is located outside the harbour proper. However, several of the SCI species, particularly those associated with subtidal habitats, make significant use of areas outside the SPA and, for some of these species, the majority of their habitat is outside the SPA. Therefore, it does not make sense to consider the SPA in isolation and for this assessment we have defined the area of interest as comprising all the tidal habitat within Cork Harbour. The outer boundary of Cork Harbour is generally taken as a line running due west from Roches Point. However, because the Ringabella Estuary is outside this boundary, but is included within the SPA, we have instead defined the outer boundary as a line running from Roches Point to the headland on the southern side of Ringabella Bay (Figure 2.1).

Broad zones

2.15 Cork Harbour is a complex site with a number of separate estuarine areas separated by extensive areas of subtidal habitat. Therefore, to help summarise waterbird distribution patterns, we have divided the harbour into six broad zones: the Inner Harbour, Fota Channel, North Channel, Owenacurra Estuary, East Harbour, West Harbour and Outer Harbour (Figure 2.1). The Inner Harbour, Fota Channel, North Channel and Owenacurra Estuary are collectively referred to as the upper harbour, while the West Harbour, East Harbour and Outer Harbour are collectively referred to as the lower harbour. The zones are based on our knowledge of waterbird distribution patterns and, particularly the relationship between high and low tide distribution. Ideally, all the waterbirds that feed in a zone at low tide would roost there at high tide although, in practice this is not always the case. In addition, for two species (Red-breasted Merganser and Great Crested Grebes) species-specific sectors have been defined (merganser sectors and grebe sectors) to better reflect their distribution patterns (see species accounts in Chapter 5).

Waterbird count subsites

2.16 The Cork Harbour SPA includes two distinct I-WeBS sites: Cork Harbour (0L403) and Ringabella Creek (0L423).

2.17 The Cork Harbour I-WeBS site is currently divided into 21 subsites for I-WeBS counts while the Ringabella Creek I-WeBS site contains a single subsite (Figure 2.2). The Cork Harbour subsites are grouped into eleven count units, with each count unit representing a discrete area that can be covered by a single counter during a single high tide period. The subsites cover most of the intertidal habitat within Cork Harbour. There have been various minor changes in subsite coverage over the I-WeBS monitoring period but the overall level of spatial coverage has remained broadly equivalent.

2.18 Cork Harbour including Ringabella Creek was divided into 74 subsites for the WSP counts (Figure 2.3). These subsites were based on the I-WeBS subsites, but some were sub-divided to allow finer scale recording of waterbird distribution, while additional subsites were included in areas not covered by the I-WeBS counts.

Wintering waterbird datasets

I-WeBS

2.19 Waterbird populations and distribution in Cork Harbour have been monitored as part of the Irish Wetland Bird Survey (I-WeBS) each winter since 1994/95.

2.20 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. In most winters, coordinated monthly counts have been carried out in at least five of the seven months but there have been significant gaps in subsite coverage in some winters (Gittings, 2006). Coverage has been relatively good since 2011/12. The 2011/12-2017/18 dataset has been used for most of the analyses in this report, as this provided the most up to date data at the time of the preparation of the original assessment. For some of the updated assessments of the BMSs in the present report, we used the 2011/12-2019/20 dataset.

2.21 The Cork Harbour I-WeBS counts are mainly carried out around high tide. However, in recent winters some counts in the East Harbour zone have been carried out at low tide due to limited counter availability.

Waterbird Survey Programme

2.22 Details of the Waterbird Survey Programme (WSP) methodology and results in Cork Harbour are described in Cummins and Crowe (2011), NPWS (2014c) and Lewis and Tierney (2014).

2.23 Four low tide and one high tide counts were carried out. The counts were carried out by a coordinated team of eight professional counters. Each count was completed over two days (Cummins and Crowe, 2011). The low tide counts were carried out on 7th-8th October 2010, 8th-9th November 2010, 6th-7th December 2010 and 3rd-4th February 2011. The high tide count was carried out on 13th-14th January 2011.

2.24 The WSP 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.

2.25 As part of the WSP, a high tide roost survey was carried out in November 2010. This survey counted each high tide roost and mapped its position. However, as a one-off survey this does not provide very reliable information on high tide roost distribution and usage patterns. Instead, most of the information on high tide roosts used in this assessment derives from the high tide roost database (see below), supplemented by the authors' personal knowledge and data.

High tide roost database

Identification and mapping of roost sites

2.26 The main sources used for mapping high tide roosts were roost questionnaires completed by I-WeBS counters. The roost questionnaires were originally completed in 2011-2014, as part of a national information gathering exercise organised by the I-WeBS office. The information compiled for the roost questionnaires included: the frequency of usage of the roost (regular, occasional, seldom used, or used in the past but not in the past five years); the state of the tide when the roost is used; and the typical numbers of each waterbird species using the roost. Roost questionnaire information was not available for Ringabella Creek, and data on high tide roosts in Ringabella Creek have not been used in the analyses carried out for this assessment.

2.27 We used the information from the roost questionnaires to compile a GIS database of all high tide roosts listed in the questionnaires (excluding those that were categorised as used in the past but not in the past five years). This database included details of the frequency of usage, and numbers of each SCI species, for each roost site. Where the questionnaire gave a range for the numbers of any species, the midpoint of the range was used. Where the questionnaire, gave numbers in the form of c. 50, or 50+, the value of the number given was used. In a few cases, where there appeared to be obvious errors in the information in the roost questionnaires, we made corrections based on our knowledge of waterbird roost sites in Cork Harbour.

2.28 As I-WeBS counts do not cover all of Cork Harbour, we used a variety of other sources to identify additional high tide roost sites, which we added to the GIS database. For each of these additional roost sites we compiled data on the frequency of usage of the roost (using the same categorisation as used in the roost questionnaires) and the typical numbers of each waterbird species using the roost. Where there was limited data available on the usage of the roost, we made a precautionary assumption of regular usage of the roost. The sources used to identify these additional roost sites are described below.

2.29 Information on additional high tide roost locations in the West Harbour zone was obtained from surveys carried out for the Lower Harbour Wind Turbine project (DePuy, 2011; Janssen, 2011; Novartis, 2011; Simms *et al.*, 2011, SKB, 2011) and for the Port of Cork development (RPS, 2012, 2014). These sources present the results of regular surveys across one or more winters, so roost sites identified by these sources can be assumed to be regularly occupied.

2.30 High tide roost locations in Cork Harbour were also mapped by the WSP in November 2011 (see paragraph 2.25). However, this was a one-off survey and many of the roost locations mapped only held a handful of birds. Therefore, use of this information requires a degree of interpretation. We have only mapped additional roost locations from the WSP survey data where these roosts satisfy three conditions: they are located in areas that are not regularly covered by I-WeBS counts; there was either no information available from other sources about these roost sites, or the information available from other sources supported the occurrence of a regular roost site at the location; and they held at least 20 SCI ducks and waders.

2.31 Most respondents to the roost questionnaires, and most of the information from other sources, only identified shoreline roosts. However, the dabbling duck SCI species can use both shoreline and open water areas for roosting. Therefore, for each count unit, we reviewed the roost information for the dabbling duck species and, where there were apparent missing birds, we used our knowledge of the distribution patterns of these species to designate additional open water roosts.

Quantification of roost capacity

2.32 Usage of individual roost sites varies significantly with some roost sites used on most high tides and other roost sites used less frequently (e.g., only on neap or spring tides, or only in particular weather conditions). Therefore, to assess the importance of an individual roost site it is necessary to consider both the typical numbers of birds using the site when it is occupied, and the frequency with which it is used. In this assessment we have combined these factors to quantify the roost capacity of each site.

2.33 In the information compiled for the roost questionnaires the frequency of usage of each roost site was categorised as regular (75-100% of counts), occasional (25-75% of counts), or seldom used (0-25% of counts). For each roost site, we took the midpoint of these ranges and multiplied the numbers of each species using the roost by the appropriate value (0.875, 0.5, or 0.125) to give the roost capacity for each species. The roost capacity parameter, therefore, provides an index of the importance of each roost site for each species.

Other datasets

Cormorant

2.34 Cormorants roost in shoreline and terrestrial habitats and uses separate locations for daytime and nocturnal roosts.

2.35 Co-ordinated annual counts of Cormorant nocturnal roosts in Cork Harbour have been carried out since 2013 during the period of peak occurrence of Cormorant in Cork Harbour (Gittings, 2020).

2.36 We used the information sources listed above for high tide roosts to identify Cormorant daytime roosts and assess the numbers using the roosts, and we compiled a GIS database of these roost sites. As data on the frequency of many of the Cormorant daytime roosts was not available, we quantified the roost capacity of these roosts as simply being the typical numbers supported by these roosts.

Great Crested Grebe and Red-breasted Merganser

2.37 A detailed study of Great Crested Grebe distribution and roosting behaviour in Cork Harbour was carried out by one of the present authors between 2015 and 2017. The results of this study are reported by Gittings (2017). As part of this study, coordinated Great Crested Grebe roost counts were carried out in 2015-2016, and were subsequently continued in 2018-2020 (Gittings, 2020). Data on Red-breasted Merganser distribution and roosting behaviour was also collected as part of this study (Gittings, unpublished data).

Common Tern

2.38 Common Tern breeding colonies in Cork Harbour have been monitored annually since 1983 (O'Mahony and Smiddy, 2017). Common Tern post-breeding/autumn roosts in the Lough Beg area were monitored by one of the present authors between 2016 and 2018 (Gittings, unpublished data).

Cormorant disturbance responses

2.39 A study was carried out by one us (Tom Gittings) on the responses to marine traffic of Cormorant (among other species) at Roches Point in the outer part of Cork Harbour. This study is currently been written up for submission to a peer-reviewed journal.

Analyses of waterbird population trends

2.40 We analysed the Cork Harbour population trends of the three waterbird species (Red-breasted Merganser, Cormorant and Great Crested Grebe) most likely to be affected by bottom mussel cultivation and compared them with the national trends for these species.

2.41 The Red-breasted Merganser and Great Crested Grebe analyses used data from November-February which is the main period of seasonal occurrence of the species in Cork Harbour. These analyses used count totals for the whole of Cork Harbour. The Lough Mahon subsites (Douglas Estuary, Dunkettle and East Lough Mahon) were excluded from the analyses, due to coverage issue, and we only included counts where all other relevant subsites for Red-breasted Merganser and Great Crested Grebe were covered.

2.42 The Cormorant analyses used data from September-March, as large numbers of Cormorant are present throughout the winter. Because Cormorant are widely distributed across Cork Harbour, there were too few whole harbour counts with complete coverage of all relevant subsites for Cormorant. Instead we based the analysis on the zones (Figure 2.1) and only included counts for each zone where all relevant subsites in the zone were covered.

2.43 We used the standard methodology for analysing waterbird population trends to calculate the Cork Harbour waterbird population indices (Atkinson *et al.*, 2006; Appendix 3 in NPWS, 2014c). First, we used Generalised Linear Modelling (GLM) with Poisson error distribution to model the counts as *count ~ month + winter* for Red-breasted Merganser and Great Crested Grebe, and *count ~*

month + winter + zone for Cormorant. We then used the month and winter factors, and the zone factor for Cormorant, from the GLMs to calculate imputed values for counts with incomplete coverage. Imputed values were required for 24% of the monthly counts included in the dataset in the Red-breasted Merganser and Great Crested Grebe datasets, and 30% of the monthly zone counts included in the Cormorant dataset. We then used the full dataset of actual and imputed counts to calculate population indices for each winter, where the index value is the sum of the monthly counts for that winter. Finally, we standardised the index values by dividing each winter's index by the index for the winter of 1994/95.

2.44 We obtained the national population indices by reading off values from the online species trends graphs[2]. Note that the index values read off the graphs are only precise to one decimal place, while the graphs are plotted used more precise index values.

2.45 We used Local Polynomial Regression Fitting (LOESS) in R to fit smoothed curves to the index values. While Generalised Additive Modelling (GAM) is normally used to fit smoothed curves in analyses of waterbird population trends, we found LOESS to provide a better reproduction of the smoothed curves for the national population trends shown in Lewis *et al*. (2019).

Analyses of waterbird distribution

2.46 The quantitative analyses of waterbird distribution in this assessment 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. However, we have included assessment of potential impacts on roosting birds, where relevant.

2.47 We compared the broad waterbird distribution patterns of waterbirds across Cork Harbour by calculating the mean percentage of each I-WeBS and each WSP count that occurred in each of the zones. The analyses of the I-WeBS counts used the 2011/12-2017/18 dataset, excluded counts with incomplete coverage and, for each species, excluded months outside their main periods of occurrence in Cork Harbour. For the WSP counts, this analysis was restricted to birds that were recorded in intertidal and subtidal habitat on the low tide counts, but included birds recorded in supratidal and terrestrial habitat on the high tide count (as many of the birds that feed in intertidal habitat at low tide may roost in supratidal or terrestrial habitat at high tide). Counts with very low overall totals were excluded from the analyses.

2.48 Similar analyses were carried out to assess waterbird distribution within zones in relation to specific aquaculture sites.

2.49 We also analysed changes in Red-breasted Merganser and Great Crested Grebe distribution patterns across four time periods: 1994/95-1999/00, 2002/03-2008/09 and 2010/11-2014/15, and 2015/16-2019/20. These analyses were restricted to data from November-February which is the main period of seasonal occurrence of both species in Cork Harbour. The Lough Mahon subsites (Douglas Estuary, Dunkettle and East Lough Mahon) were excluded from the analyses, due to coverage issue, and only included counts where all other relevant subsites were covered. The analyses compared the mean counts of Red-breasted Merganser and Great Crested Grebe in each of the merganser/grebe sectors between the three time periods.

[2] Accessed via https://birdwatchireland.ie/our-work/surveys-research/research-surveys/irish-wetland-bird-survey, 9th April 2020.

Assessment methodology

Screening

2.50 The SCIs of the Cork Harbour SPA were reviewed and screened in for detailed assessment if:

- The SCI was considered likely to have significant spatial overlap with the aquaculture activities in Cork Harbour, or the potential for such overlap could not be discounted; and
- The SCI was considered likely to be adversely impacted by the aquaculture activities, or the potential for adverse impacts could not be discounted.

2.51 For SCIs of other SPAs it is difficult to determine the likelihood of spatial overlap as there is generally little information about movements of wintering birds between sites, or about the foraging ranges from breeding colonies. Most of the SCIs of the other SPAs away from Cork Harbour are also SCIs of the Cork Harbour SPA. Therefore, these species were screened as part of the screening of the SCIs of the Cork Harbour SPA.

2.52 For additional waterbird SCIs of other SPAs designated for their wintering populations, we considered the general ecology of the species and, in particular, their Cork Harbour status and/or the degree of site faithfulness.

2.53 For SCIs designated for their breeding populations, we used information from the literature to define typical foraging ranges for various species.

2.54 The main source for our information on foraging ranges was the BirdLife Seabird Foraging Database (Thaxter *et al.*, 2012). This provides a range of values for foraging ranges (the mean, the mean maximum and the maximum). The explanatory document for the BirdLife Seabird Foraging Database (Lascelles, 2008) says "*it may be useful to think of areas within the average foraging range as a core zone of activity being exploited by the majority of the birds the majority of the time, and those between the average and the maximum foraging range as a buffer zone, exploited by fewer birds for less of the time*" (although it also acknowledges that this is not always the case). Therefore, we have generally focused on the mean foraging range (rather than the mean maximum or maximum) to give an indication of the core foraging zones.

2.55 It should be noted that the above approach is analogous to the approach recommended by Scottish Natural Heritage for considering connectivity between SPAs and wind farm developments for the purposes of screening (Scottish Natural Heritage, 2016). The Scottish Natural Heritage guidance states that:

> "*In most cases the core range should be used when determining whether there is connectivity between the proposal and the qualifying interests. Maximum ranges are also provided to indicate that birds will, at times, travel further. In exceptional cases distances up to the maximum foraging range may be considered; for example, whilst osprey core foraging range is 10 km an osprey foraging at a loch well beyond this distance from its SPA may still be connected if there is a lack of other closer foraging sites.*"

2.56 We are not aware of any other explicit guidance relating to this issue. Therefore, we consider that our approach for screening the SCIs designated for their breeding populations is in accordance with recognised best practise for assessing potential connectivity between breeding bird populations and development proposals.

Identification of potential impacts

2.57 The potential impacts of the activities covered in this assessment were assessed under three broad categories: ecosystem effects, habitat impacts and disturbance impacts.

Ecosystem effects

2.58 Large-scale bivalve aquaculture could, theoretically, have impacts on ecosystem functioning and reduce the abundance of food resources for waterbird species. This could occur as a result of reduced recruitment (due to direct consumption of eggs and larvae by the cultured bivalves), and/or through indirect food web effects (e.g., consumption of organic matter by the cultured bivalves that would have otherwise been available to support other species). We describe these potential impacts as ecosystem effects as they are not spatially restricted to the areas in the vicinity of the aquaculture sites, but could affect the whole ecosystem.

2.59 Detailed consideration of ecosystem effects and / or ecosystem modelling in order to provide a robust assessment of potential impacts is beyond the scope of this assessment. However, the scale of the aquaculture activities covered by this assessment, relative to the overall size of the Cork Harbour ecosystem indicates that ecosystem effects from these activities are unlikely to be an issue at the whole harbour scale. Therefore, we have not analysed potential ecosystem impacts in this assessment.

Habitat and disturbance impacts

2.60 Potential negative impacts to SCI species have been identified where the activity may cause negative impacts to prey resources and/or cause disturbance impacts, 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.

2.61 For each of the aquaculture activities included in this assessment, we reviewed the scientific literature to assess the potential impact of the activity of intertidal and subtidal habitat structure and function and how this might affect the availability of food resources for the SCI species covered by this assessment.

2.62 For the assessment of oyster trestle cultivation we were able to use the results of detailed research to directly assess the potential impacts on waterbirds (Gittings and O'Donoghue, 2012, 2016b; referred to as the trestle study). The trestle study was carried out during periods with typical levels of husbandry activity so the effects of disturbance due to husbandry activity are included in the categorisation of species responses by these studies.

2.63 The trestle study focused on species associated with the intertidal and/or shallow subtidal habitats and did not assess potential impacts to fish-eating species that may use the trestle areas at high tide, while detailed scientific information on the potential impacts to waterbirds of bottom mussel cultivation is not available. For these potential impacts/activities, we used the literature review of the potential impact on food resources, as well as information from studies of analogous types of physical impacts, to assess the potential impacts of habitat alteration, and we used information on the timing and frequency of husbandry activity, and the sensitivity of the species concerned, to assess the potential impact of disturbance.

2.64 Detailed descriptions of the specific methodologies used for assessment of potential disturbance impacts from bottom mussel cultivation are included in the relevant sections of Chapter 8.

Assessment of impact magnitude

Displacement impacts

2.65 Where potential impacts from an aquaculture 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 assessed. 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 aquaculture activity.

Impacts on population trends

2.66 There has been aquaculture activity in the Cork Harbour SPA for over 100 years. Therefore, in theory, analysis of waterbird population trends in relation to the development of the aquaculture activity could reveal evidence about the nature of any impacts from aquaculture on the waterbird populations. However, the information on the timing of the development of aquaculture activity in Cork Harbour is very limited. Therefore, we do not consider that it would be appropriate to carry out detailed assessments of the potential impact of past aquaculture development on waterbird population trends in Cork Harbour. However, we have made comments on potential impacts in relation to some specific activities and species.

Assessment of significance

2.67 The significance of any potential impacts identified has been assessed with reference to the attributes and targets specified by NPWS (2014a). 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 2 – Distribution

2.68 For these SCIs, we have focused on attribute 2 (distribution) of the conservation objectives.

2.69 Assessing significance with reference to attribute 2 is difficult because the level of decrease in the range, timing or intensity of use 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 Cork Harbour population would be detectable against background levels of annual variation.

2.70 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.

2.71 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 Turnstone would be a decrease of two birds. 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, so 5% can be 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. This threshold is also likely to be very conservative in relation to levels that would cause reduced survivorship (see above).

Attribute 1 - Population trends

2.72 Impacts on this attribute are only likely to occur if there are high levels of displacement impacts. However, there is a high level of uncertainty about the magnitude of the displacement impacts that are likely to occur. Therefore, we do not consider that it would be appropriate to attempt to quantitatively assess the impact on this attribute given the current level of available data.

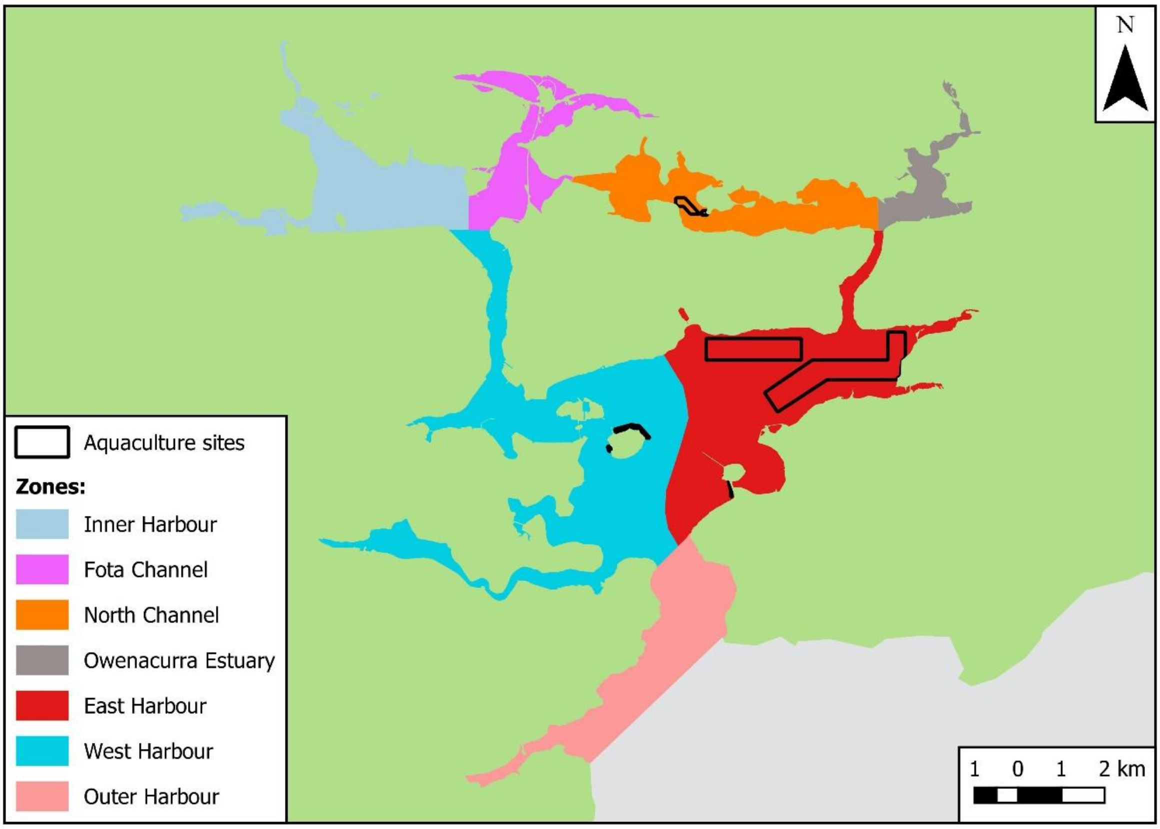


Figure 2.1 – Overall extent of Cork Harbour, as defined for this assessment, and the broad zones used for analysing waterbird distribution.

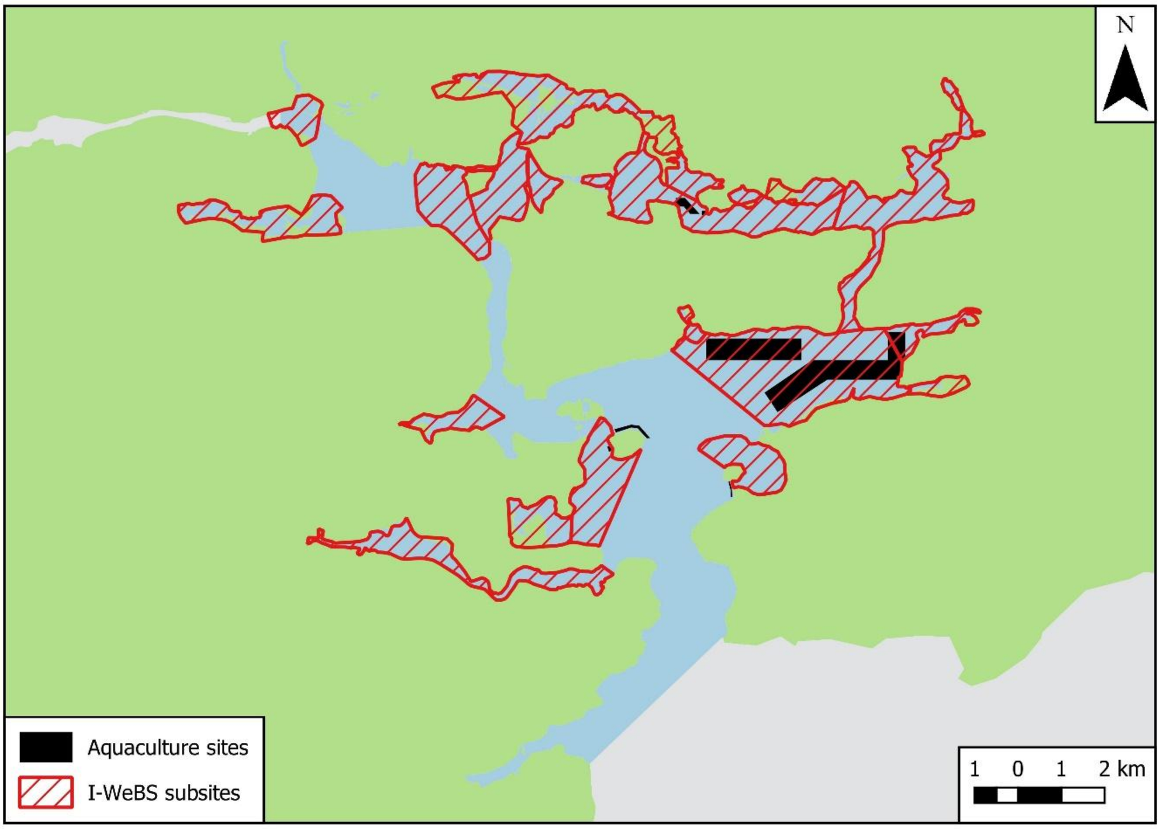


Figure 2.2 – Current subsite divisions used for Irish Wetland Bird Survey (I-WeBS) counts of Cork Harbour.

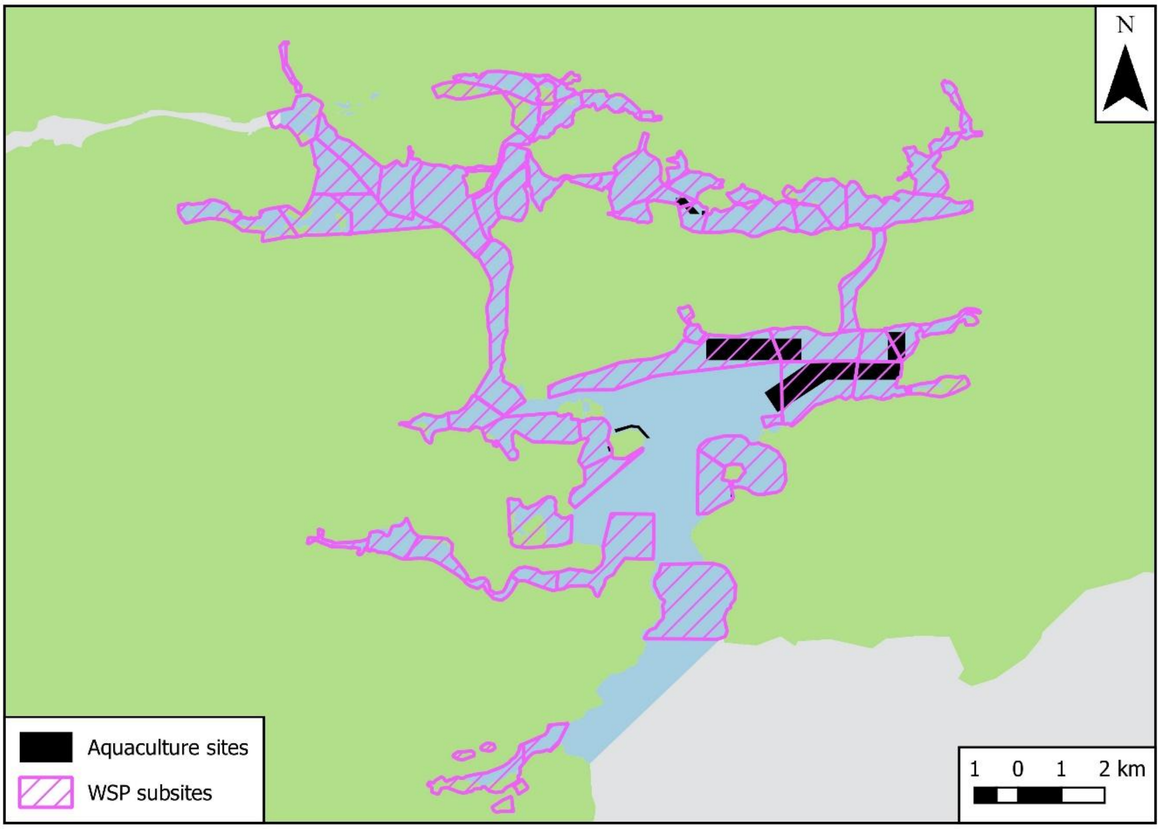


Figure 2.3 - Subsite divisions used for the 2010/11 Waterbird Survey Programme (WSP) counts of Cork Harbour.

3. Screening

Introduction

3.1 In addition to the Cork Harbour SPA, the Ballycotton Bay SPA is also within 15 km of the aquaculture sites in the Cork Harbour (Figure 3.1). There is also potential connectivity with a number of other SPAs located in the wider vicinity of Cork Harbour (Figure 3.1).

Cork Harbour SPA

Waterbird SCIs

3.2 All of the SCI species make significant use of subtidal and/or intertidal habitat in Cork Harbour. The aquaculture activities covered in this assessment will affect 920 ha of intertidal and subtidal habitat and have the potential to cause significant changes to habitat structure and/or food availability, and/or cause disturbance impacts to the SCI species. Therefore, the activities being assessed could potentially have significant impacts on SCIs that use subtidal and/or intertidal habitat.

Wetlands and waterbirds

3.3 The Conservation Objectives define the favourable conservation condition of the wetlands and waterbird SCI in the Cork Harbour SPA purely in terms of habitat area.

3.4 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.

Other SPAs

3.5 SPAs in the wider vicinity of Cork Harbour are shown in Figure 3.1. There are a number of SPAs along the coastline on either side of Cork Harbour, and inland from Cork Harbour, that are designated for various waterbird and/or seabird species. It is known that some waterbird species regularly move between some of these SPAs: e.g., Black-tailed Godwits move between the various coastal SPAs and the Blackwater Callows SPA. Therefore, it is necessary to consider the potential for impacts to Special Conservation Interests (SCIs) of other SPAs away from Cork Harbour.

3.6 Most of the SCIs of the other SPAs away from Cork Harbour are also SCIs of the Cork Harbour SPA. Therefore, these species will be assessed as part of the assessment of the potential impact to the Cork Harbour SPA. The additional waterbird and seabird species that are SCIs of other the SPAs are listed in Table 3.1.

3.7 Two of the additional waterbird species listed in Table 3.1 (Whooper Swan and Sanderling) are only rare visitors to Cork Harbour. Therefore, these SCIs can be screened out from further assessment.

3.8 Another four of the additional waterbird species listed in Table 3.1 are known to have high site fidelity to their wintering grounds (Light-bellied Brent Goose, Great Northern Diver, Ringed Plover and Turnstone). This means that individuals generally return to the same site each winter. Therefore, for these species, there is unlikely to be significant interchange between the SCI populations and the Cork Harbour populations and these SCIs can be screened out from further assessment.

3.9 One of the additional waterbird species (Mallard) listed in Table 3.1 has moderate site fidelity. Therefore, for these species, there is the possibility of significant interchange between the SCI populations and the Cork Harbour populations and these SCIs cannot be screened out from further assessment.

3.10 There are four seabird species that are listed as SCIs for their breeding populations in coastal SPAs: Cormorant, Herring Gull, Kittiwake and Guillemot.

Table 3.1 - Waterbird and seabird SCIs of other SPAs in the wider vicinity of Cork Harbour that are not SCIs of the Cork Harbour SPA.

Species	SPA	Cork Harbour status	Site fidelity	Preliminary screening
Whooper Swan	Blackwater Callows SPA	very rare	moderate/high	screened out
Light-bellied Brent Goose	Dungarvan Harbour	small wintering population	high	screened out
Mallard	The Gearagh SPA	large wintering population	moderate	screened in
Cormorant (breeding population)	Helvick Head to Ballyquin	non-breeding resident with large wintering population and significant numbers present in summer	-	screened out
Cormorant (breeding population)	Sovereign Islands	non-breeding resident with large wintering population and significant numbers present in summer	-	screened in
Great Northern Diver	Courtmacsherry Bay	small wintering population	high	screened out
Coot	The Gearagh SPA	very small wintering population	unknown	screened out
Ringed Plover	Ballycotton Bay	small wintering population	high	screened out
Sanderling	Ballymacoda Bay	rare	high	screened out
Turnstone	Ballycotton Bay, Ballymacoda Bay, Dungarvan Harbour	small wintering population	high	screened out
Herring Gull	Helvick Head to Ballyquin	non-breeding resident with large wintering population and significant numbers present in summer	-	screened out
Kittiwake	Helvick Head to Ballyquin, Old Head of Kinsale	regular visitor to the Outer Harbour	-	screened out
Guillemot	Old Head of Kinsale	scarce winter visitor	-	screened out

Site fidelity categorisations based on the classifications in the NPWS Conservation Objectives Supporting Documents, except for Great Northern Diver, which is based on East *et al.* (2015).

3.11 Cormorant is a SCI of the Cork Harbour SPA but is presumed to be listed for its wintering population. It is listed as a SCI of two SPAs: the Helvick Head to Ballyquin SPA (c. 50 km by sea from Cork Harbour) and the Sovereign Islands SPA (c. 18 km by sea from Cork Harbour). The mean foraging range of Cormorants from their breeding colonies is 5.2 km, with a mean maximum of 25 km and a maximum of 35 km (Thaxter *et al.*, 2012). Therefore, birds from the Helvick Head to Ballyquin SPA are unlikely to use Cork Harbour. There is potential for birds from the Sovereign Islands colony to make some usage of Cork Harbour, but it is likely to be a peripheral area.

3.12 Herring Gull is a SCI of the Helvick Head to Ballyquin SPA (c. 50 km by sea from Cork Harbour). Cramp and Simmons (2004) quote foraging ranges from breeding colonies in various studies ranging from 22-63 km, while Ratcliffe *et al.* (2000, quoted by Langston, 2010) gave a foraging range of 40 km from breeding colonies. Therefore, Cork Harbour may be within the foraging range of the Helvick Head to Ballyquin SPA population. However, while significant numbers of this species are present in summer in Cork Harbour these are mainly immature birds. Therefore, it is unlikely that the Helvick Head to Ballyquin SPA population makes significant use of Cork Harbour and this SCI can be screened out from further assessment.

3.13 Kittiwake is a SCI of the Helvick Head to Ballyquin SPA (c. 50 km by sea from Cork Harbour) and the Old Head of Kinsale SPA (c. 28 km by sea from Cork Harbour). This species can occur in large numbers in Cork Harbour, particularly after storms. However, it mainly occurs in the Outer Harbour zone and rarely comes further into the harbour in any numbers. Therefore, as there are no proposed aquaculture sites in the Outer Harbour zone, these SCIs can be screened out from further assessment.

3.14 Guillemot is a SCI of Old Head of Kinsale SPA (c. 28 km by sea from Cork Harbour). This species is a scarce winter visitor to Cork Harbour, although large numbers can occur occasionally after storms. However, during the summer it rarely comes into the harbour. Therefore, as the SCI is listed for its breeding population, this SCI can be screened out from further assessment.

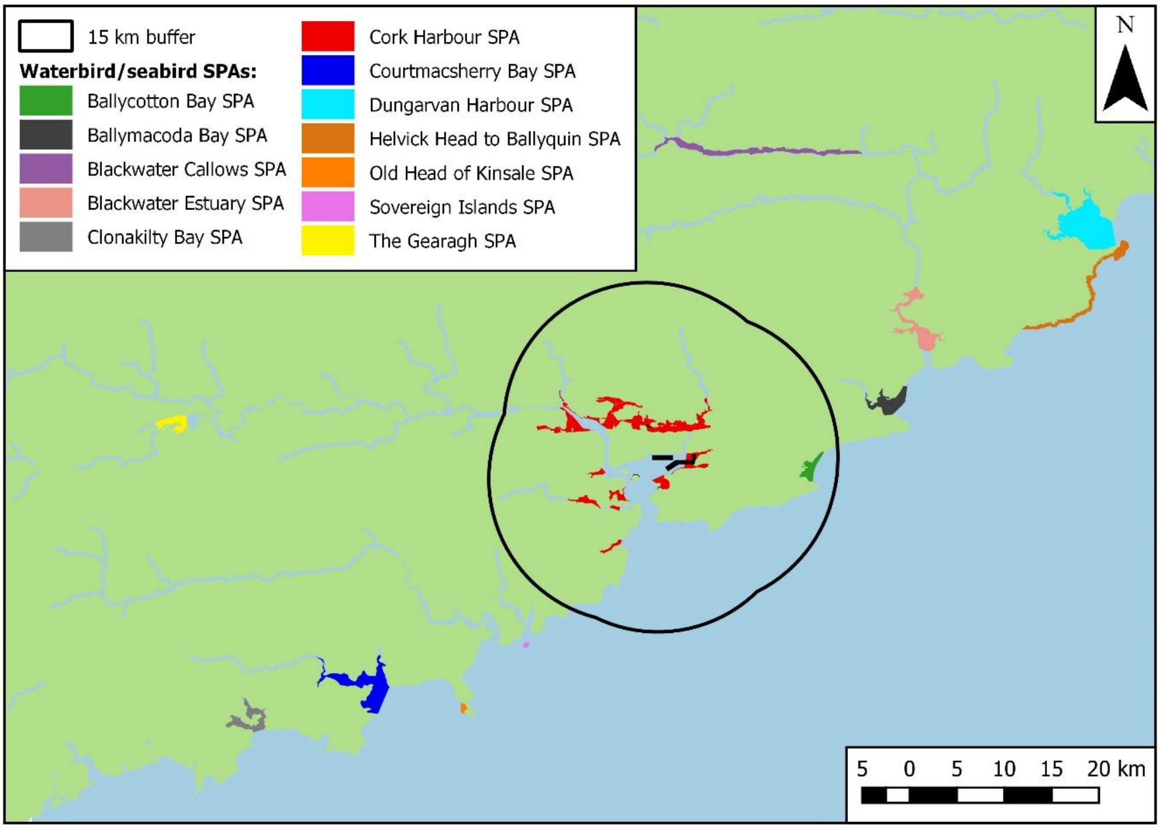


Figure 3.1 - Waterbird/seabird SPAs in the vicinity of Cork Harbour.

4. Conservation objectives

Cork Harbour SPA

SCIs listed for their wintering populations

4.1 The conservation objectives for the wintering populations of Shelduck, Wigeon, Teal, Pintail, Shoveler, Red-breasted Merganser, Cormorant, Grey Heron, Little Grebe, Great Crested Grebe, Oystercatcher, Golden Plover, Grey Plover, Lapwing, Curlew, Black-tailed Godwit, Bar-tailed Godwit, Dunlin, Redshank, Black-headed Gull, Common Gull and Lesser Black-backed Gull are to maintain their favourable conservation condition (NPWS, 2014a).

4.2 The favourable conservation conditions of these SCIs in the Cork Harbour SPA 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 the wintering populations of Shelduck, Wigeon, Teal, Pintail, Shoveler, Red-breasted Merganser, Cormorant, Grey Heron, Little Grebe, Great Crested Grebe, Oystercatcher, Golden Plover, Grey Plover, Lapwing, Curlew, Black-tailed Godwit, Bar-tailed Godwit, Dunlin, Redshank, Black-headed Gull, Common Gull and Lesser Black-backed Gull in the Cork Harbour SPA.

Attribute		Measure	Target	Notes
1	Population trend	Percentage change	Long term population trend stable or increasing	Waterbird population trends are presented in part four of the Conservation Objectives Supporting Document
2	Distribution	Range, timing and intensity of use of areas	There should be no significant decrease in the range, timing and intensity of use of areas by … [SCI species] other than that occurring from natural patterns of variation	Waterbird distribution from the 2010/2011 waterbird survey programme is discussed in part five of the Conservation Objectives Supporting Document

Source: NPWS (2014a).

Attributes are not numbered in NPWS (2014a), but are numbered here for convenience.

SCI listed for its breeding population

4.3 The conservation objective for the Common Tern breeding population in the Cork Harbour SPA is to maintain its favourable conservation condition (NPWS, 2014a). The favourable conservation condition of this population is defined by the following attributes: breeding population abundance, productivity rate, distribution of breeding colonies, availability of prey biomass, barriers to connectivity, and disturbance at the breeding site (NPWS, 2014a).

The Gearagh SPA

4.4 Site-specific conservation objectives have not yet been prepared for The Gearagh SPA. However, it can be assumed that the attributes and targets listed in Table 4.1 also apply to the Mallard SCI of The Gearagh SPA.

5. Status and habitats and distribution of the SCI species

Status of the SCI species

Cork Harbour SPA

5.1 The current status of the non-breeding SCI species in Cork Harbour is summarised in Table 5.1. It should be noted that Ringabella Creek, which lies just outside the harbour, was only added to the SPA in 2015. Ringabella Creek has been counted separately from the rest of Cork Harbour, and the data from Ringabella Creek was not included in the assessment of site trends reported by NPWS (2014c).

Table 5.1 – Non-breeding Special Conservation Interests of the Cork Harbour SPA.

Species	5 year means		Site trend[3]	National trend[4]	International trend[5]
	Cork Harbour[1]	Ringabella Creek[2]			
Shelduck	1060	24	Unfavourable	Stable	Increasing
Wigeon	1556	30	Unfavourable	Declining	Stable
Teal	1323	114	(Intermediate) Unfavourable	Stable	Increasing
Pintail	20	1	Highly Unfavourable	Increasing	Increasing
Shoveler	22	0	Highly Unfavourable	Increasing	Increasing
Red-breasted Merganser	72	0	Highly Unfavourable	Stable	n/c
Cormorant	352	3	Highly Unfavourable	Increasing	Stable
Grey Heron	105	3	(Intermediate) Unfavourable	Stable	Increasing
Little Grebe	85	6	Favourable	Stable	Increasing
Great Crested Grebe	109	0	Unfavourable	Declining	Declining?
Oystercatcher	1587	11	(Intermediate) Unfavourable	Stable	Declining
Golden Plover	2418	0	Favourable	Declining	Declining
Grey Plover	20	0	Highly Unfavourable	Declining	Declining?
Lapwing	1696	109	Highly Unfavourable	Declining	Stable
Curlew	1535	105	Unfavourable	Declining	Declining
Black-tailed Godwit	3308	140	Favourable	Increasing	Increasing
Bar-tailed Godwit	270	0	Favourable	Stable	Increasing
Dunlin	3285	84	Unfavourable	Declining	Stable
Redshank	1636	54	Unfavourable	Stable	Stable/Increasing?
Black-headed Gull	3645	168	Highly Unfavourable	n/c	n/c

Species	5 year means		Site trend[3]	National trend[4]	International trend[5]
	Cork Harbour[1]	Ringabella Creek[2]			
Common Gull	377	77	Highly Unfavourable	n/c	n/c
Lesser Black-backed Gull	171	56	Highly Unfavourable	n/c	n/c

[1] 5-year mean annual peak counts, 2013/14-2017/18 (Gittings, 2018). The 5-year means for Shelduck, Golden Plover, Lapwing, Curlew, Black-tailed Godwit, Bar-tailed Godwit and Dunlin exclude data from 2016/17 as the annual maxima for that winter is considered to have been significantly affected by missing data from the Douglas Estuary for these species.

[2] 5-year mean annual peak counts, 2011/12-2015/16 (I-WeBS site summary table for 0L423 Ringabella Creek; data were supplied by the Irish Wetland Bird Survey (I-WeBS), a joint scheme of BirdWatch Ireland and the National Parks and Wildlife Service of the Department of Arts, Heritage & the Gaeltacht).

[3] Change between the 1995/96-1999/00 and 2008/09-2012/13 mean annual peak counts (NPWS, 2014c).

[4] All-Ireland trend 1999/00-2010/11 from NPWS (2014c), where a species is deemed to be increasing or declining if the annual rate of change is equal to or greater than 1.2%, after Crowe and Holt (2013).

[5] Current international trend from NPWS (2014c), after Wetlands International (2012).

n/c = not classified.

5.2 Common Tern is listed as a SCI of the Cork Harbour SPA for its breeding population. The conservation condition of this SCI has not been formally assessed by NPWS. However, the breeding population has increased significantly in recent years and is now at its highest recorded levels with a five-year (2013-2017) mean of 127 apparently occupied nests (O'Mahony and Smiddy, 2017).

Population trends

5.3 The Cork Harbour and national population trends for the three species most likely to be affected by bottom mussel cultivation are shown in Text Figure 5.1.

5.4 The Cork Harbour populations of Red-breasted Merganser and Great Crested Grebe have both shown strong declines across the period monitored by I-WeBS counts. For Red-breasted Merganser, this appears to be a continuation of a long-term historical decline since the 1970s (Smiddy *et al*., 1995). Both species show fluctuations in the national trend across the I-WeBS period, but without any consistent declining trend. Therefore, this comparison indicates that site specific factors may have caused the decline in the Cork Harbour populations of Red-breasted Merganser and Great Crested Grebe, although it is possible that there may be regional variation in population trends.

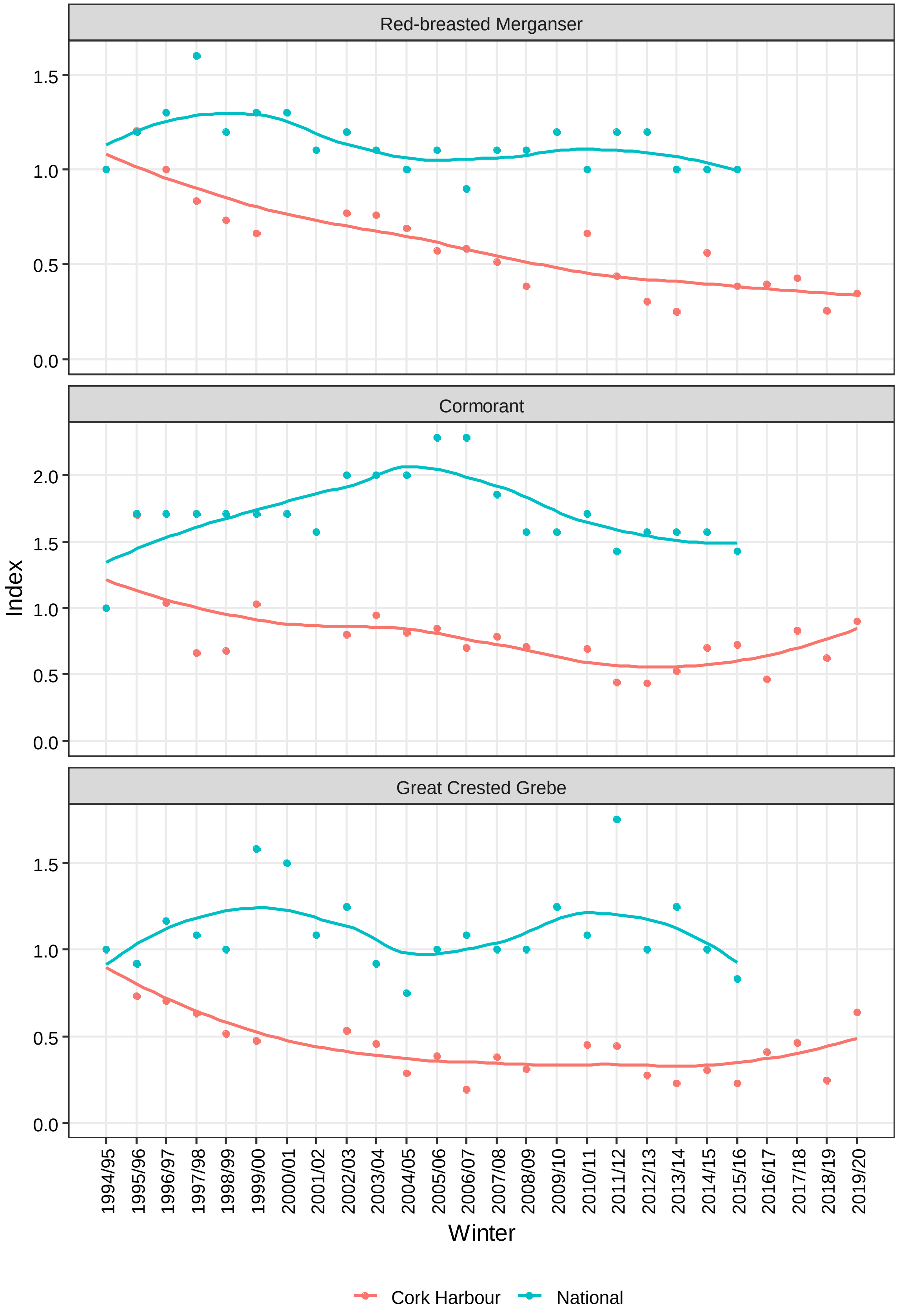
5.5 The trend line fitted to the Cormorant Cork Harbour index shows a declining trend from the early 2000s to the mid-2010s with a recovery in recent winters. There was high variability in Cormorant counts in the 1990s, so the trend over the early part of the I-WeBS period is unclear. It should also be noted that the Cormorant index for Cork Harbour is less reliable than for the other two species, due to the greater influence of coverage issues (see paragraph 2.42).

The Gearagh SPA

5.6 The conservation condition of the Mallard SCI of The Gearagh SPA has not been assessed by NPWS.

The Sovereign Islands SPA

5.7 The conservation condition of the breeding Cormorant SCI of the Sovereign Islands SPA has not been assessed by NPWS.



Text Figure 5.1 – Trends in Cork Harbour and national Red-breasted Merganser, Cormorant and Great Crested Grebe population indices, with index values set to 1 for 1994/95.

Waterbird habitats in Cork Harbour

5.8 A total of around 1840 ha of intertidal habitat and 4350 ha of subtidal habitat occurs in Cork Harbour (Table 5.2). The Cork Harbour SPA includes around 85% of the intertidal habitat in the harbour, but only includes around 20% of the subtidal habitat (Table 5.2). The intertidal habitat mainly occurs in the upper harbour with additional more isolated areas in estuaries and bays in the lower harbour, while the large central section of the harbour is mainly occupied by subtidal habitat (Figure 5.1).

Table 5.2 – Percentage distribution of waterbird habitats between the zones of Cork Harbour.

Zones	Intertidal		Subtidal					
			shallow		moderate		deep	
	all	SPA	all	SPA	all	SPA	all	SPA
Inner Harbour	17%	18%	39%	37%	6%	1%	4%	1%
Fota Channel	17%	19%	7%	12%	3%	11%	1%	0%
North Channel	22%	24%	5%	9%	8%	40%	2%	75%
Owenacurra Estuary	9%	10%	4%	8%	1%	5%	0%	23%
East Harbour	11%	9%	13%	20%	43%	34%	23%	0%
West Harbour	19%	16%	26%	8%	33%	9%	37%	1%
Outer Harbour	6%	3%	5%	5%	6%	1%	34%	0%
Total area (ha)	**1840**	**1592**	**724**	**383**	**2136**	**428**	**1496**	**31**

Intertidal includes *Spartina* beds and other saltmarsh. Subtidal habitats: shallow = between mean low tide and 0 m chart datum; moderate = subtidal habitat of 0-5 m deep; deep = subtidal habitat > 5 m depth.

5.9 The intertidal habitat is mainly littoral sediment habitat. Some littoral rock habitat occurs in the East Harbour, West Harbour and Outer Harbour. Extensive *Spartina* beds occur in the North Channel where they form around 20% of the total extent of intertidal habitat in this zone. Small amounts of *Spartina* beds also occur in all the other zones. Apart from *Spartina*, saltmarsh is a very rare habitat in Cork Harbour and does not comprise more than 1-2% of the total extent of intertidal habitat in any of the zones.

5.10 The intertidal habitat within the Cork Harbour SPA (excluding Ringabella Creek) was surveyed by MERC Consultants (2012). Most of the intertidal soft sediment habitat was classified as the *littoral mud (LS.LMu)* biotope. The intertidal habitat in Whitegate Bay and on the shore of the Mahon peninsula was classified as the *polychaete/bivalve dominated muddy sand shores (LS.LSa.MuSa)*. Sections of shoreline in the North Channel, Owenacurra Estuary, East Harbour and West Harbour were classified as the *littoral mixed sediment (LS.LMx)*. NPWS have classified nearly all of the intertidal habitat within the SPA as the *mixed sediment to sandy mud with polychaetes and oligochaetes community complex* (NPWS, 2014e)[3].

5.11 Macroalgal blooms occur in intertidal areas in the upper harbour in late summer/autumn with the Glounthaune Estuary in the Fota Channel and Rossmore Bay in the North Channel being two areas that are particularly prone to such blooms.

[3] The mapped distribution of this community complex shown in Figure 2 of NPWS (2014e) excludes the Douglas Estuary. However, this is presumably a mapping error.

5.12 Apart from the Outer Harbour, most of the subtidal habitat within Cork Harbour is moderately deep. Deep subtidal habitat occupies most of the Outer Harbour and continues into the harbour along the navigation channel, progressively narrowing until it reaches the Inner Harbour, where the channel is maintained by dredging (Figure 5.1). There is also a channel of deep subtidal habitat running from the East Harbour through the East Ferry Channel and just reaching the North Channel and Owenacurra Estuary. The benthic sediments in subtidal habitats in the East Harbour, West Harbour and Outer Harbour are mainly slightly gravelly muddy sand, with sandy silt predominating in the Inner Harbour and heterogeneous sediments ranging throughout the sampling area from sandy silt to gravelly sand in the North Channel (Ecoserve, 2012). There does not appear to have been any classifications of the subtidal biotopes/community complexes in Cork Harbour.

5.13 Several lagoons occur around Cork Harbour, most of which are of artificial origin formed by the impoundment of the upper sections of intertidal areas (Figure 5.1). The most important of these for waterbirds are the Harper's Island borrow dyke and Slatty Pool in the Fota Channel; Cuskinny Marsh and Rostellan Lake in the East Harbour; and at Lough Beg in the West Harbour. A lagoon at Ballintubbrid was also formerly an important area but this habitat has been infilled in recent years.

5.14 Several of the waterbird SCIs of the Cork Harbour SPA make significant use of fields around the harbour as foraging habitats. Field areas that are particularly important for these SCIs are: the Bloomfield House field in the Inner Harbour; the Harper's Island and Slatty Pool fields in the Fota Channel; the Ballintubbrid fields in the North Channel and fields on the western side of Lough Beg in the West Harbour (Figure 5.1). These areas are all immediately adjacent to tidal habitats/lagoons. However, the field feeding waders and gulls will also range more widely away from the harbour and make opportunistic use of fields over a buffer of several kilometres around the harbour.

Waterbird distribution in Cork Harbour

Habitat use

5.15 The broad habitat usage recorded in the WSP low tide counts is summarised in Table 5.3. The Shelduck, waders and gulls mainly occurred in intertidal habitat. The WSP counts recorded relatively low numbers of waders in terrestrial habitats. However, this reflects the survey methodology and under-represents the importance of such habitats for the Cork Harbour populations of five of these wader species (Golden Plover, Lapwing, Oystercatcher, Curlew and Black-tailed Godwit). For example, counts of nocturnal Curlew roosts indicate that around half of the mid-winter Curlew population in Cork Harbour feed on fields during the day.

5.16 The dabbling duck species showed varied patterns of habitat use, reflecting differences in their foraging behaviour. Wigeon occurred in relatively high numbers in terrestrial habitats, which reflects the importance of a small number of field-feeding sites for the Cork Harbour population of this species. Teal and Pintail mainly occurred in intertidal habitat, while Mallard and Shoveler occurred in relatively high numbers in subtidal habitat.

5.17 Red-breasted Merganser, Little Grebe and Great Crested Grebe occurred mainly, or exclusively, in subtidal habitat, as would be expected for these species. The high percentage of Cormorant in the intertidal zone might seem surprising, as this species normally feeds in subtidal habitat. However, all the birds recorded feeding were in subtidal habitat. The high percentage in the intertidal zone reflects the habit of this species in forming daytime roosts in the intertidal zone.

Table 5.3 - Habitat use in the 2010/11 WSP low tide counts.

Species	Mean percentage of total count in habitat zones:			
	Intertidal	Subtidal	Supratidal	Terrestrial
Shelduck	85%	15%	0%	0%
Wigeon	28%	26%	0%	46%
Teal	68%	17%	0%	15%
Mallard	26%	45%	1%	28%
Pintail	100%	0%	0%	0%
Shoveler	17%	65%	13%	5%
Red-breasted Merganser	0%	100%	0%	0%
Cormorant	43%	32%	6%	19%
Grey Heron	34%	39%	19%	9%
Little Grebe	1%	67%	0%	32%
Great Crested Grebe	0%	100%	0%	0%
Oystercatcher	93%	4%	1%	2%
Golden Plover	98%	2%	0%	0%
Grey Plover	100%	0%	0%	0%
Lapwing	84%	0%	0%	16%
Curlew	87%	4%	0%	9%
Black-tailed Godwit	84%	4%	0%	12%
Bar-tailed Godwit	100%	0%	0%	0%
Dunlin	100%	0%	0%	0%
Redshank	96%	4%	0%	0%
Black-headed Gull	72%	23%	0%	5%
Common Gull	72%	23%	1%	4%
Lesser Black-backed Gull	85%	9%	4%	2%

Data source: 2010/11 Waterbird Survey Programme as undertaken by the National Parks & Wildlife Service.

Sample sizes: n = 4 for all species, except Pintail (n = 1), Shelduck, Shoveler, Grey Plover and Lapwing (n = 2), Wigeon, Red-breasted Merganser, Great Crested Grebe, Golden Plover, Bar-tailed Godwit and Dunlin (n =3) and Light-bellied Brent Goose (n =2).

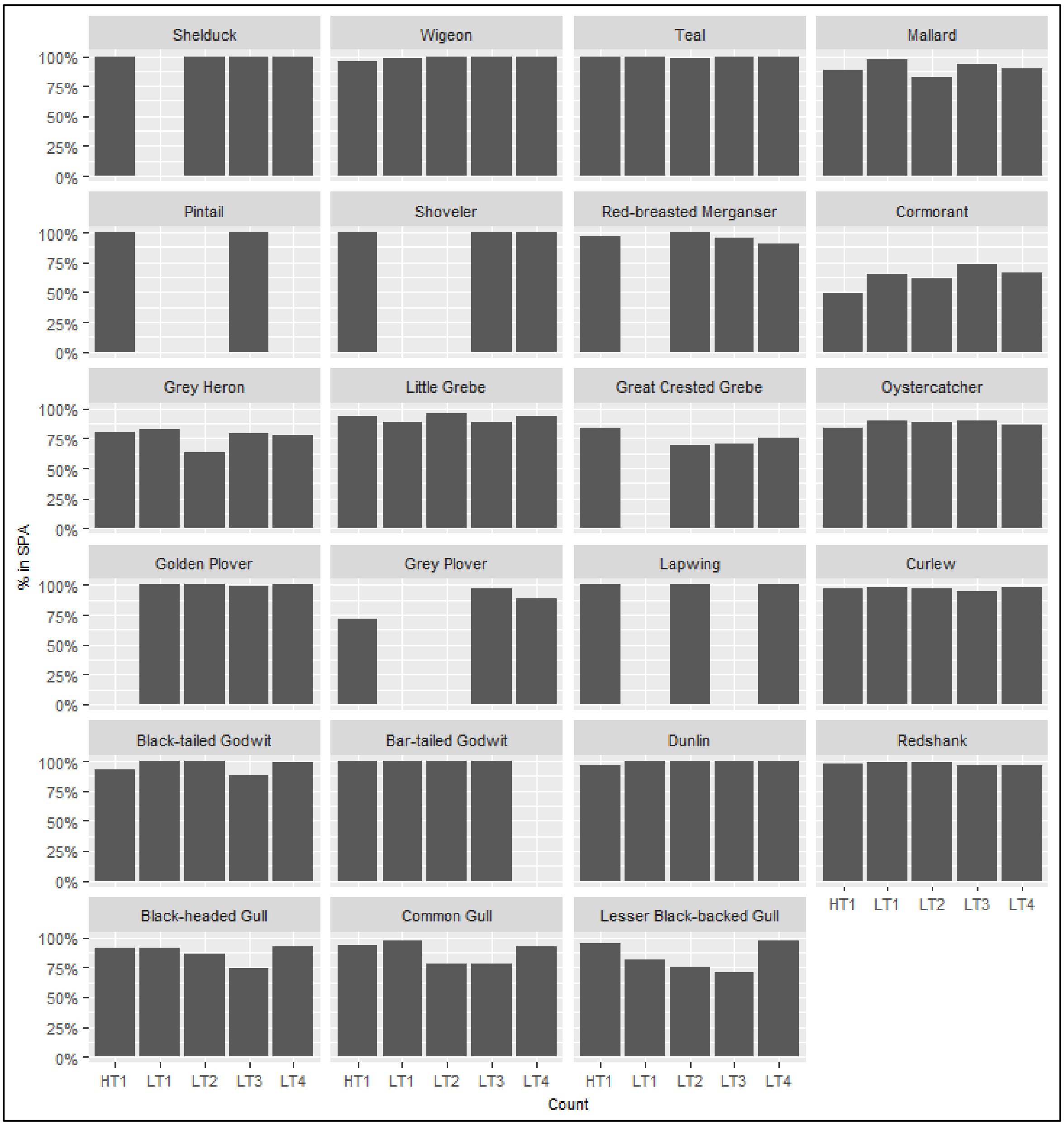
Distribution (non-breeding waterbirds)

Broad distribution patterns

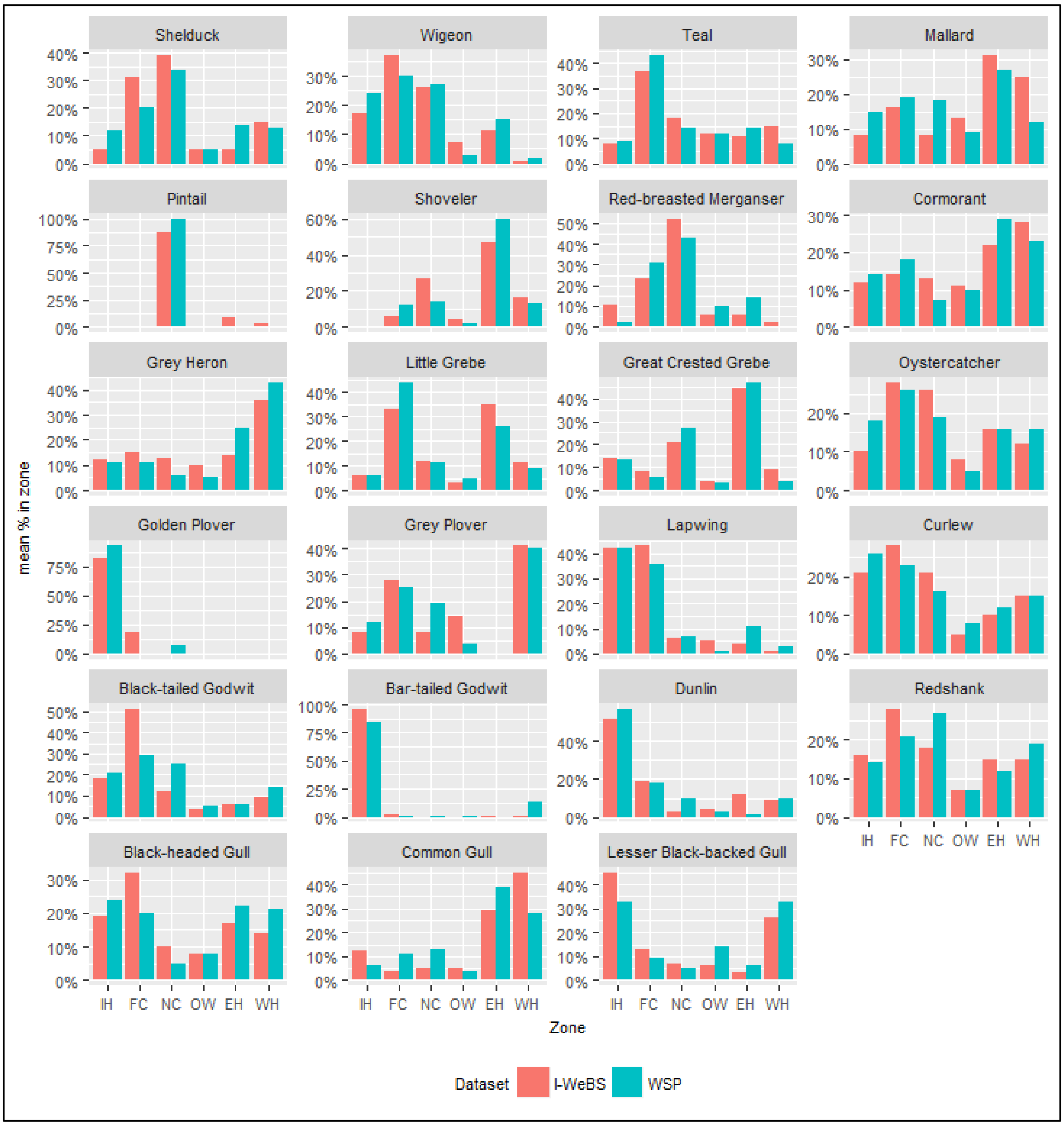
5.18 The Cork Harbour SPA only includes around 40% of the total area of tidal habitat in Cork Harbour. However, for most species during the WSP counts, over 90% of the total count was recorded in the SPA (Text Figure 5.2). This partly reflects the fact that the SPA contains over 75% of the intertidal and shallow subtidal habitat within the harbour, nearly all of which was covered by the WSP counts, and these are the primary habitats for 16 of the 24 species. The species that occurred in relatively low percentages were mainly species associated with subtidal habitats, reflecting the fact that the SPA contains less than 20% of the total area of subtidal habitat within the harbour. The WSP counts did not cover most of the moderately deep and deep subtidal habitat outside the SPA, so Text Figure 5.2 may overestimate the percentage SPA occupancies of the species associated with subtidal habitat.

5.19 The broad patterns of distribution of waterbird species during the WSP low tide counts and recent I-WeBS counts (mainly carried out at high tide) is compared in Text Figure 5.3.

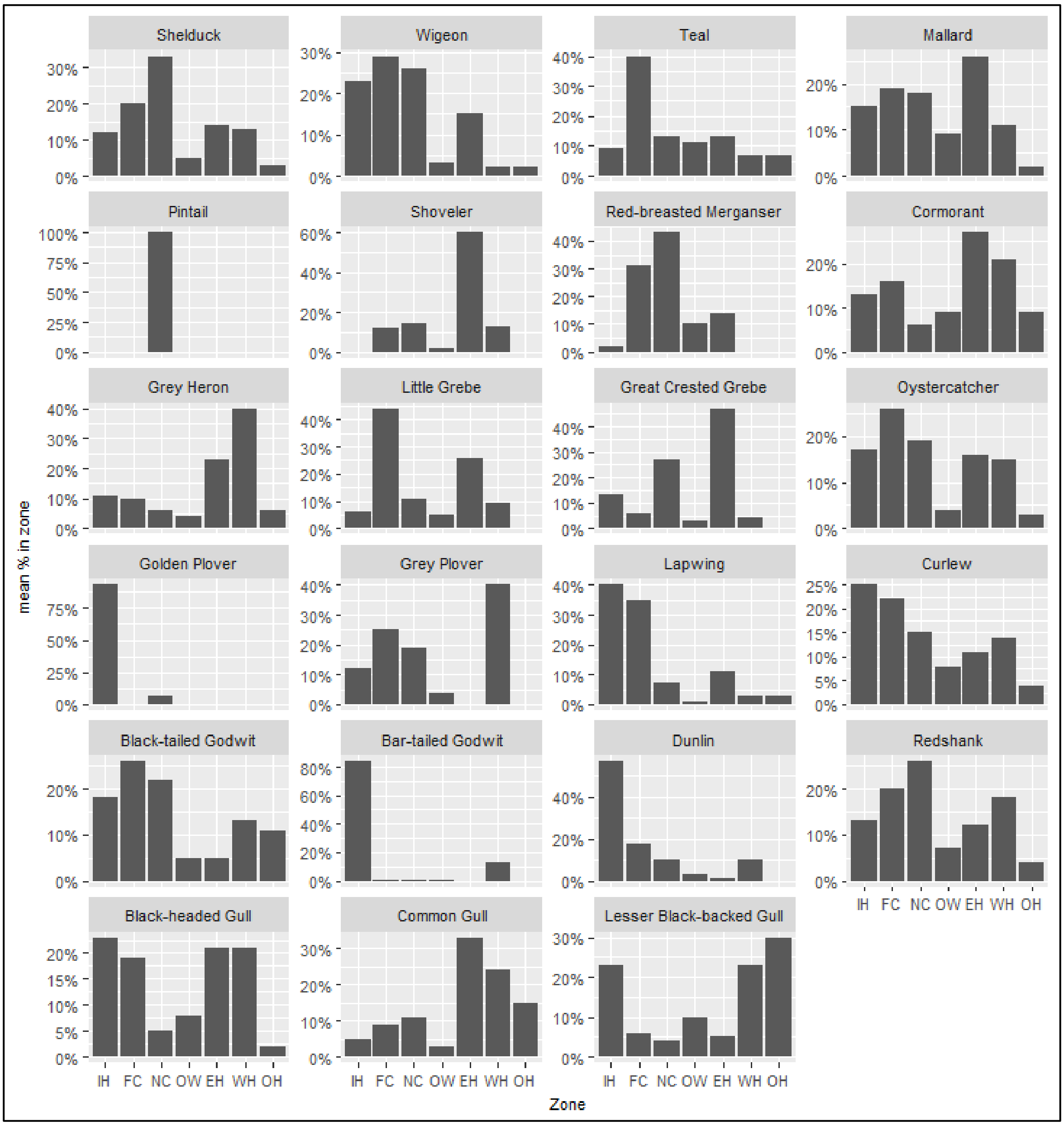
5.20 The Outer Harbour zone is not included in the analyses in Text Figure 5.3, as it is not included in the I-WeBS dataset. However, this zone was covered during the WSP counts (Text Figure 5.4).



Text Figure 5.2 – Percentage of total Cork Harbour count recorded within the Cork Harbour SPA during the WSP counts.



Text Figure 5.3 – Comparison of distribution patterns of waterbird species between broad zones of Cork Harbour (excluding the Outer Harbour) in the I-WeBS and WSP low tide counts datasets. Zones: IH = Inner Harbour; FC = Fota Channel; NC = North Channel; OW = Owenacurra Estuary; EH = East Harbour; WH = West Harbour.



Text Figure 5.4 – Distribution patterns of waterbird species between broad zones of Cork Harbour (including the Outer Harbour) in the WSP low tide count dataset. Zones: IH = Inner Harbour; FC = Fota Channel; NC = North Channel; OW = Owenacurra Estuary; EH = East Harbour; WH = West Harbour.

Sheldduck, Wigeon, Teal and Mallard

5.21 These four species are dabbling ducks feeding in muddy estuarine areas. Their distribution in Cork Harbour is principally associated with the estuarine areas in one or more of the Inner Harbour, Fota Channel and North Channel zones and is largely confined to the SPA sections of the harbour. In the lower harbour, some birds occur in Saleen Creek, Whitegate Bay, Ringabella Creek, the Owenboy Estuary, Lough Beg and Monkstown Creek. Mallard are relatively more evenly distributed around the harbour than the other three species, with a lower overall occupancy of the SPA. Wigeon also graze fields adjacent to estuarine areas in a few locations such at Bloomfield House in the Douglas Estuary, Harper's Island and Slatty Pool in Slatty Water, and (formerly) Ballintubbrid in the North Channel. Teal also utilise small brackish and freshwater wetlands in various locations around the harbour.

Pintail and Shoveler

5.22 These two species are dabbling ducks that occur in very low numbers in Cork Harbour. Pintail occur mainly in the North Channel between Belvelly Bridge and Rossleague. Shoveler occur erratically in various locations around the harbour, but are most frequent in the East Harbour zone, particularly in Whitegate Bay. Both species occur almost exclusively within the SPA.

Red-breasted Merganser

5.23 Red-breasted Merganser feed exclusively in subtidal habitat. They also usually roost in subtidal habitat, although they may sometimes use gravel banks, etc. They mainly occur in waters of less than 3·5 m depth (Cramp and Simmons, 2004). Therefore, the potential extent of suitable habitat in Cork Harbour can be broadly defined by the 5 m depth contour on the Admiralty charts. However, mergansers do not occupy all the available habitat within this depth zone in Cork Harbour. Therefore, Cork Harbour can be divided into four discrete sectors of merganser habitat: Lough Mahon and the Fota Channel; the North Channel from Rossmore to Rathcoursey; the open water in the East Harbour between Great Island, Whitegate, Aghada and Saleen; and the open water in the West Harbour from Haulbowline and around Spike Island to Lough Beg and Crosshaven (Figure 5.2).

5.24 The North Channel is the favoured area for Red-breasted Merganser in Cork Harbour, with birds typically occurring along the channel from Rossmore to Rathcoursey. A nocturnal roost occurs at Ballintubbrid, although some birds from the North Channel commute to the East Harbour roost, while others may commute to the Lough Mahon roost. A daytime roost also appears to occur in the enclosed waters behind Brick Island.

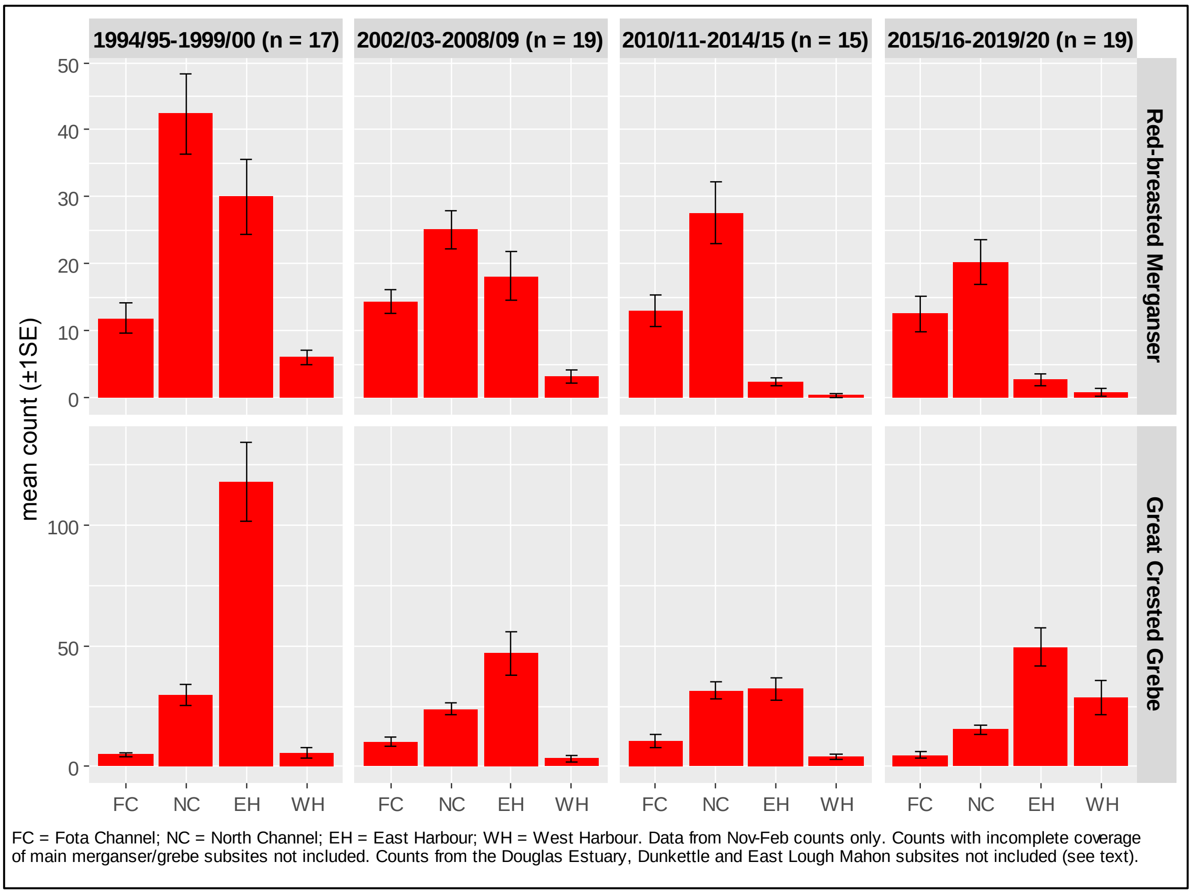
5.25 Fota Channel is the next most favoured area, with birds feeding along the channel from the southern end of the Carrigrennan peninsula to the N25 bridge over the Glounthaune Estuary and the lower part of Slatty Water. Mergansers formerly occurred further up both estuaries, but there have been very few records from these latter areas in recent years. The Fota Channel birds commute to a nocturnal roost in Lough Mahon just off the southern shore of Little Island. However, mergansers only occasionally feed in Lough Mahon during the day, although small numbers can also occur in the tidal impoundment at Dunkettle.

5.26 Red-breasted Merganser also occur in the East Harbour in the open waters between Great Island and Aghada, and in Whitegate Bay. In recent winters, only small numbers have been recorded in these areas during the day, mainly in the bay to the east of Aghada Pier and in Whitegate Bay. However, there is a regular nocturnal roosting flock of around 20 birds off the south-eastern shore of Great Island and at least some of these birds commute down the East Ferry Channel to this roost. A small roost also occurs in Whitegate Bay. In 2003/04, small numbers of mergansers were recorded on two dates feeding in the lagoons in the ESB Aghada Generating Station (ESB, 2004). However, during intensive monitoring work in 2018/19, Red-breasted Merganser were only rarely recorded on these lagoons. It is possible that the lagoons were used more frequently in the past when larger numbers of mergansers occurred in the East Harbour.

5.27 Red-breasted Merganser are only occasionally recorded during the day in the West Harbour, in the open waters south of Spike Island. However, there does appear to be a regular nocturnal roost of a handful of birds off the mouth of Lough Beg.

5.28 There has been a decline in overall Red-breasted Merganser numbers in Cork Harbour across the I-WeBS survey period (Text Figure 5.5) and this appears to be a continuation of a long-term decline (cf. Smiddy *et al.*, 1995). However, this decline has not been equally distributed around the harbour. Numbers in the East Harbour and West Harbour have shown a severe decline, with a much more moderate decline in the North Channel (Text Figure 5.5). Numbers in the Fota

Channel appear to have been relatively stable (Text Figure 5.5). However, this could possibly represent a shift of birds from Lough Mahon, which was not included in this analysis due to coverage issues.



Text Figure 5.5 – Changes in Red-breasted Merganser and Great Crested Grebe distribution patterns recorded by I-WeBS counts in Cork Harbour.

Cormorant

5.29 Cormorants feed in subtidal habitat, but roost in intertidal and terrestrial habitats. Their distribution in Cork Harbour does not appear to be restricted by water depth and birds can occur throughout the harbour. As a result, only around 50-75% of the birds counted in the WSP counts were within the SPA, and these figures overestimate the occupancy of the SPA due to lack of coverage of significant areas of subtidal habitat.

5.30 Cormorants typically feed individually, or in small, loose groups. However large feeding aggregations can occur at times. The aggregations appear to be associated with fast-running tides in deep water channels. For example, in October-January 2019/20, we regularly recorded such aggregations in the main navigation channel south of Spike Island.

5.31 The overall densities of feeding Cormorant recorded during the WSP counts ranged from 1.0 birds/km^{2}in January to 2.8 birds/km^2 in December. During the low tide counts, the subsite density of feeding Cormorant was correlated with the percentage of intertidal habitat within the subsites. This reflects the fact that, at low tide, the amount of subtidal habitat in the estuarine subsites is very small, so even a very small number of feeding Cormorants would result in very high densities. When subsites with over 40% intertidal habitat are excluded, the mean density of feeding Cormorant across the remaining subsites showed very little variation, ranging from 0-3.7

birds/km^2, apart from one subsite with a mean density of 7.3 birds/km^2 (Figure 5.3). As the overall number of Cormorant recorded across all these subsites was small (27-57 birds), and there will also have been variability in detecting birds and allocating them to subsites, the overall pattern suggests that there is little variation in the densities of feeding Cormorant across Cork Harbour.

5.32 Cormorant have distinct day and night roosts. During the day, they roost on piers, jetties, gravel banks, etc. There are a large number of day roosts holding small numbers of Cormorants in Cork Harbour, but a few large day roosts occur (Figure 5.4). The largest day roost is on the ADM jetty at the mouth of Monkstown Creek, while other sizeable day roosts occur on the sea wall enclosing the Dunkettle tidal impoundment, on a gravel bank on the northern shore at Rathcoursey and on a platform 500 m offshore from the northern side of ESB Aghada Generating Station. At night, the Cork Harbour Cormorant population is concentrated into a smaller number of roosts (Figure 5.4). These are mainly on trees where there are wooded shorelines, but some Cormorants commute to night roost outside the harbour on cliffs at Finure. In 2018/19 and 2019/20, some Cormorant remained on the ESB Platform day roost to roost at night, but this site was not regularly used as a night roost in 2013-2016 at least. If feeding birds are assumed to commute to the nearest roost, then the density of birds supported by the available habitat for each roost ranges from 12-30 birds/km^2, apart from the Rostellan Lake/Siddon's Tower and Finure roosts (Table 5.4). The low density apparently supported by the Rostellan Lake/Siddon's Tower may be due to some birds in the surrounding area commuting to the Bagwell's Hill roost, as we have observed Cormorants commuting up the East Ferry Channel close to dusk. Some of the birds at the Glanmire Wood roost probably commute from the River Lee within, and maybe above, Cork City, so the density apparently supported by this roost in Table 5.4 is probably exaggerated.

5.33 The overall density apparently supported by the night roosts (12 birds/km^2) is an order of magnitude higher than the overall density of feeding birds recorded in the WSP counts (1-3 birds/km^2). This may partly be due to feeding birds being missed during the counts because they were diving at the time the counter scanned the area of water. More significantly, at any time during the day a large proportion of the Cormorants will be at day roosts. Time budget analyses show that wintering Cormorants only spend a small proportion of daylight hours feeding: 27% in Scotland (Gremillett *et al.*, 2003), around 10% in Algeria (Ali *et al*., 2016), and 18% in Mississippi (for the closely related (Double-crested Cormorant; King *et al*. 1995). The variation in these figures may reflect the effect of latitude on day length. These figures suggest a mean density of feeding Cormorant in Cork Harbour during the peak months (October-December) of 1.2-3.1 birds/km^2, which is similar to the range of densities recorded during the WSP counts.

Table 5.4 - Cormorant night roost counts, Cork Harbour.

Roost	Roost counts						Habitat (km^2)	Density ($birds/km^2$)
	2013	2014	2016	2017	2019	mean		
Drake's Pool, Owenboy Estuary	19	18	19	19	20	19	1.6	12
Monkstown Creek	151	169	200	203	263	197	17	12
Glanmire Wood, Glashaboy Estuary	109	86	118	109	73	99	3.2	31
Fota Island	76	111	110	84	63	89	8	11
Bagwell's Hill, North Channel and East Ferry Channel	49	93	105	79	54	83	4.7	18
Siddon's Tower, Saleen Creek, Rostellan Lake and ESB platform	57	40	63	30	58	50	10.3	5
Finure	-	27	0	30	64	30	3.2	9
Totals	461	544	618	551	595	554	48	12

Counts carried out on 07-08/12/2013, 02-03/11/2014, 27/11/2016 and 04/11/2017 and 11/11/2019. The Finure and North Channel roosts were not counted in December 2013 and the Rostellan Lake roost was not counted in November 2016. The birds at the Drake's Pool roost in November 2016 birds flushed and abandoned roost before dusk, so may have been double-counted elsewhere. The ESB platform was only counted in 2019 but was not used up to 2016 at least. Data source: Gittings (2020).

Grey Heron

5.34 Grey Heron is widely distributed throughout the harbour but occurs in the highest numbers in the lower harbour. As a result, only around 50-75% of the birds counted in the WSP counts were within the SPA. Small numbers (up to five birds) occur at various high tide shoreline roosts. However, the roost on the ADM jetty at the mouth of Monkstown Creek regularly holds larger numbers (15-25 birds). Herons also regularly roost on trees adjacent to the water, including along the shores of Fota Island, in Ballyannan Wood, in Marlogue Wood at the southern end of the East Ferry Channel and in Currabinny Wood on the southern shore of Lough Beg. These roosts may be particularly used at night, but the herons appear to move into the trees at this time and are not often visible. Some of these roosts are also heronries where breeding takes place in spring/early summer.

Little Grebe

5.35 Little Grebe occur in estuarine areas and lagoons around Cork Harbour. The most favoured areas are the East Harbour and the Fota Channel. In the East Harbour, they mainly occur on Rostellan Lake, with a few birds usually present at the mouth of Saleen Creek. In the Fota Channel, they mainly occur upstream of Fota Island, particularly in Slatty Pool and the Harper's Island borrow dyke, with a few birds often present downstream of Fota and/or between the railway line and Great Island. During the WSP counts, around 90% of the birds were recorded within the SPA, with Cuskinny Marsh being the only non-SPA area of significance for this species.

5.36 During the day, groups of 10-20 roosting Little Grebe can sometimes gather in favoured areas (Rostellan Lake, the section of the Fota Channel between the N25 and Fota Island, and Harper's Island). It is not known whether they congregate to form nocturnal roosts, but no such roosts have been observed in any of the open water areas around the harbour.

Great Crested Grebe

5.37 Great Crested Grebe feed and roost exclusively in subtidal habitat. They typically feed in waters of depths less than 4 m (Cramp and Simmons, 2004). Therefore, the potential extent of suitable habitat in Cork Harbour can be broadly defined by the 5 m depth contour on the Admiralty charts. However, they do not occupy all the available habitat within this depth zone in Cork Harbour and do not usually occur in the upper estuarine areas. Therefore, Cork Harbour can be divided into four discrete sectors of grebe habitat: Lough Mahon and the Fota Channel; the North Channel from Rossmore to Rathcoursey; the open water in the East Harbour between Great Island, Whitegate, Aghada and Saleen; and the open water in the West Harbour from Haulbowline and around Spike Island to Lough Beg and Crosshaven (Figure 5.5). Great Crested Grebes in Cork Harbour roost communally at night. In each of the four sectors of grebe habitat, there are primary roost locations, where all, or most of, the grebes from that sector usually roost each night (Figure 5.5). There are also a number of secondary roost locations, which are used less frequently, and/or by smaller numbers of grebes (Figure 5.5). In the East Harbour sector, the E2 roost is the main roost used at the start of the season, with birds gradually switching to the E1 roost as the winter progresses.

5.38 Accurate daytime counts of grebes in Cork Harbour are difficult to achieve, but dusk roost counts provide a reliable index of grebe numbers in each of the four sectors of grebe habitat (Gittings, 2017). The East Harbour sector supports the highest numbers of grebes, followed by the Lough Mahon/Fota Channel sector (Table 5.5). During the grebe roost study (2014/15-2016/17), the North Channel and West Harbour sectors generally supported lower numbers and appeared to be occupied later in the winter. However, coordinated roost counts carried out in 2018-2020 suggest that there has been a shift in grebe distribution from the East Harbour to the West Harbour (Table 5.7).

5.39 The distribution of roosting grebes between the sectors in the grebe roost study was broadly similar to the distribution of foraging habitat, although the East Harbour sector held relatively higher densities compared to the North Channel and West Harbour sectors (Table 5.6). The overall density apparently supported by the night roosts (5-7 birds/km^2) is around twice the mean density of feeding grebes recorded in the WSP counts (3 birds/km^2), which probably reflects the fact that, at any one time during the day, up to 50% of the grebes are roosting.

5.40 During the WSP counts, around 75% of birds counted occurred within the SPA. However, this significantly overestimates the occupancy of the SPA for this species due to the limited coverage of the East Harbour sector. Based on the grebe distribution between sectors recorded in the grebe roost study, and the proportion of grebe habitat within the SPA in each sector, the SPA only holds around 30% of the total Cork Harbour population.

Table 5.5 - Mean (and ranges) of dusk roost counts of Great Crested Grebes at Cork Harbour.

Sector	Parameter	2014/15	2015/16		2016/17	
		Jan-Feb	Oct-Nov	Jan-Feb	Oct-Nov	Jan-Feb
East Harbour	mean	105	93	79	86	109
	range	(95-114)	(76-120)	(54-103)	(49-119)	(98-120)
	n	3	8	4	4	2
Lough Mahon/Fota Channel	mean	33	35	50	54	35
	range	(20-42)	(24-50)	(41-64)	(42-64)	(28-47)
	n	4	4	3	3	3
North Channel	mean	39	8	26	8	9
	range	(35-44)	(4-12)	(26-27)	-	-
	n	3	2	3	1	1
West Harbour	mean	35	5	39	16	46
	range	(30-39)	(3-9)	(35-45)	(11-21)	(44-47)
	n	3	3	3	2	2
Total		212	142	194	164	199

Data source: Gittings (2017).

Table 5.6 - Comparison of distribution of Great Crested Grebes in Cork Harbour in 2014/15-2016/2017 with the availability of grebe foraging habitat.

Sector	% of grebe habitat		% of grebe population
	subtidal	intertidal and subtidal	
East Harbour	42%	37%	53% (41-66%)
Lough Mahon/Fota Channel	21%	23%	23% (16-33%)
North Channel	10%	15%	9% (5-18%)
West Harbour	27%	25%	15% (10-23%)

Data source: Gittings (2017).

Table 5.7 – Coordinated Great Crested Grebe roost counts in Cork Harbour, February 2015, 2016, and 2018-2020.

Sector	2015	2016	2018	2019	2020	Mean percentage
East Harbour	114	77	86	39	58	36%
Lough Mahon/ Fota Channel	20	41	57	28	21	16%
North Channel	35	27	6	0	10	8%
West Harbour	39	45	93	101	117	40%
Total	208	190	242	168	206	-

Data source: Gittings (2020).

Waders

General distribution patterns

5.41 Oystercatcher, Curlew and Redshank are widely distributed around the harbour. The highest numbers occur in one or more of the Inner Harbour, Fota Channel and North Channel zones, probably reflecting the distribution of preferred muddy intertidal habitat. Black-tailed Godwit shows a broadly similar distribution patterns. However, they show a high concentration in the Fota Channel zone in the I-WeBS dataset, but this is not reflected in the WSP low tide count dataset, probably reflecting observed movement patterns of birds from the Inner Harbour and North Channel zones to high tides roosts in the Fota Channel zone. Oystercatcher, Curlew and Black-tailed Godwit also feed on fields around the harbour and, in mid-winter, the numbers of birds feeding on the fields may be higher than those feeding in the intertidal zone. The field feeding birds return to the estuaries to roost at night.

5.42 During the WSP counts, most of these species occurred almost exclusively within the SPA. However, Oystercatcher had a slightly lower occupancy of the SPA, reflecting the more dispersed distribution of this species which extends out to mixed sediment and littoral rock shores in the lower and outer harbour. The WSP counts will also have significantly exaggerated the SPA occupancy for Oystercatcher, Golden Plover, Lapwing, Curlew and Black-tailed Godwit as there was only limited coverage of field feeding areas during the counts.

5.43 Golden Plover and Lapwing mainly feed on fields and use the estuaries for roosting. These species are primarily associated with the Inner Harbour and Fota Channel zones, and Golden Plover is rarely recorded away from these areas.

5.44 Grey Plover is currently a scarce species of somewhat erratic occurrence in Cork Harbour. The main areas for this species are the Belvelly area in the Fota Channel and North Channel zones and Lough Beg in the West Harbour zone.

5.45 Bar-tailed Godwit shows a very concentrated distribution pattern in Cork Harbour, with the vast majority occurring in the Inner Harbour, where they feed on the extensive mudflats in Lough Mahon at low tide, and roost in the Douglas Estuary at high tide. Small numbers occur quite regularly at Lough Beg in the West Harbour zone.

High tide roosts

5.46 The distribution of high tide wader roosts in Cork Harbour is shown in Figure 5.6. The majority of the roost sites, and nearly all of the major roost sites, occur in the upper harbour at the Douglas Estuary, Dunkettle, the Glounthaune Estuary/Slatty Water and along the North Channel to Rathcoursey. Clusters of smaller roosts occur in the East and West Harbour zones at the Owenboy Estuary, Lough Beg, Monkstown Creek, Saleen Creek and Whitegate Bay. There are very few, or no, roosts along the Passage West channel, the southern shore of Great Island, the East Ferry Channel, the coastline between Saleen and Whitegate, and in the Outer Harbour (excluding Ringabella Creek).

Gulls

5.47 Black-headed Gulls occur throughout the harbour. In autumn, particularly large numbers occur in Fota Channel and the East Harbour but they are common in all parts of the harbour. Common Gulls occur mainly in the East Harbour and West Harbour, particularly in the Lough Beg subsite, with only low numbers elsewhere in the harbour. Lesser Black-backed Gulls occur mainly in the Inner Harbour and the West Harbour and the Outer Harbour.

5.48 During the WSP counts, most Black-headed Gulls were recorded within the SPA, with slightly lower SPA occupancy being recorded for Common Gull and Lesser Black-backed Gull, reflecting the distribution of the latter species in the lower harbour. The WSP counts will have overestimated the occupancy of the SPA due to lack of coverage of significant areas of subtidal habitat. Large numbers of gulls can occur in subtidal habitats in the lower harbour: e.g., in the autumn and early winter of 2016, when there were exceptional levels of juvenile fish and sprat in the harbour, 500-1000 Black-headed Gulls were regularly present in the East Harbour zone feeding over open water between Great Island and Aghada.

5.49 Gulls often occur at high tide wader roosts but can also roost on open water. At low tide, gulls may form roosts in intertidal areas. The numbers of gulls in Cork Harbour increase at night when large numbers commute to the harbour to roost from inland feeding grounds. The main Black-headed Gull nocturnal roost occurs in the Inner Harbour where tens of thousands roost off the Mahon peninsula. This is also a major Lesser Black-backed Gull nocturnal roost. There are a number of other Black-headed Gull nocturnal roosts around the harbour, while a significant Common Gull nocturnal roost occurs in the open water off Lough Beg.

Distribution (Common Tern)

5.50 The Cork Harbour Common Tern population is distributed between a variable number of breeding colonies in the Fota Channel and West Harbour zones (Figure 5.7). In recent years, the most important colonies have been on the Marino Point Martello Tower in the Fota Channel and the Port of Cork deepwater quay in the West Harbour (means of 41 and 58 apparently occupied nests, 2013-2017; O'Mahony and Smiddy, 2017). Other sites occupied in some recent years are the Raffeen Golf Club lagoon, the rocky island in Lough Beg and the Ballybricken Point ADM jetty (O'Mahony and Smiddy, 2017).

5.51 Between late July and early September, post-breeding roosts of Common Terns occur in the western part of the harbour, although these may be supplemented by migrant birds (Figure 5.7). The main roost usually occurs in Lough Beg where birds roost on the intertidal in the outer part of the lough at low tide and on the rocks around the peninsula at the mouth of the lough, or on the island, at high tide. Peak annual dusk roost counts here in recent autumns were 200 in 2016, 45 in 2017 and 400 in 2018[4] (T. Gittings, unpublished data). Other roosting sites include the ADM jetty (up to 80 birds; T. Gittings, unpublished data) and small numbers at the Cork Harbour Marina at Monkstown, the CMRC pontoons and the western shore of Spike Island.

5.52 Feeding terns occur widely throughout most of the harbour, although they are rarely recorded in the Outer Harbour zone during the breeding season. Typical foraging range distances from breeding colonies are 4.5 km (mean), 15.2 km (mean max) and 20 km (max) (Thaxter *et al.*, 2012). This suggests that the core foraging areas for the Cork Harbour Common Tern population are in the western side of the harbour (Figure 5.7), although the entire harbour is likely to be used at times.

5.53 The Port of Cork colony is outside the SPA, while the other three colonies are inside the SPA. The main roost at Lough Beg is also inside the SPA. Feeding terns are not restricted by water depth. As most of the subtidal habitat in the vicinity of the colonies is outside the SPA, it is likely that the occupancy of the SPA by feeding terns is relatively low.

[4] Note that these are counts of Commic Terns (Common/Arctic Terns) although the majority of birds will have been Common Terns.

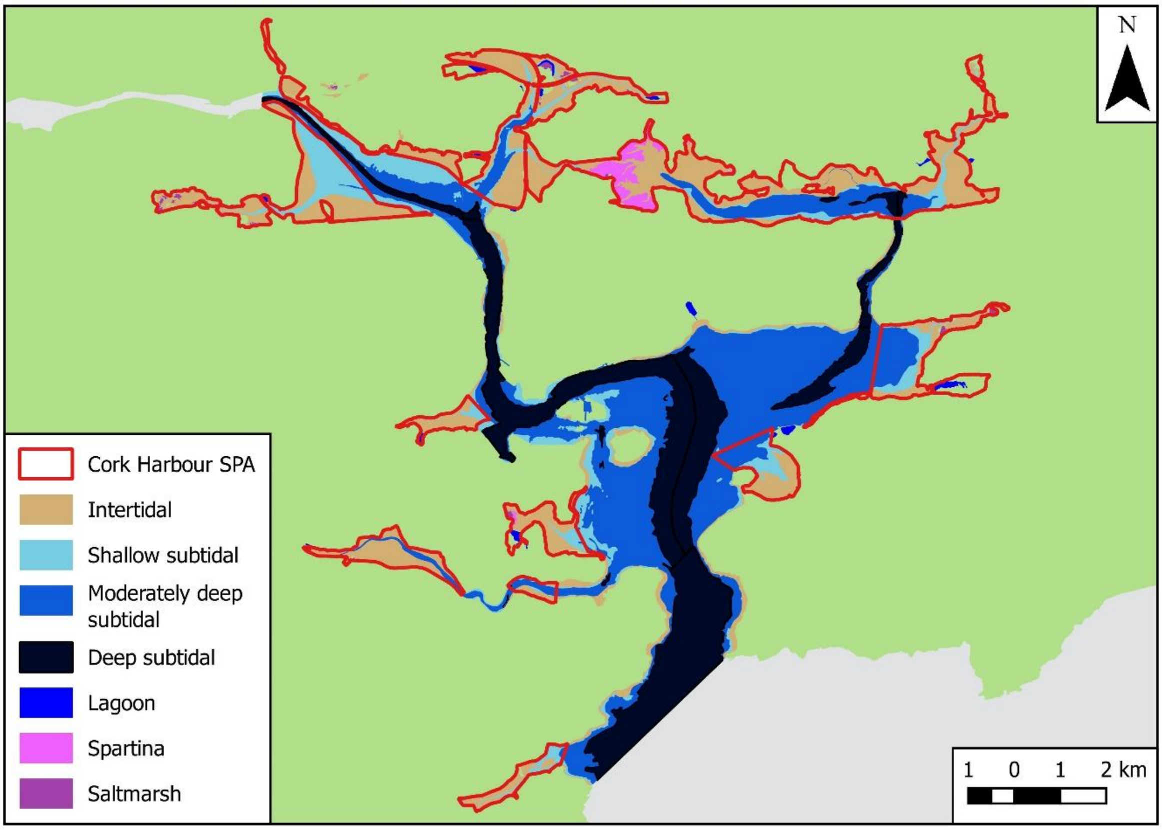


Figure 5.1 – Waterbird habitats in Cork Harbour.

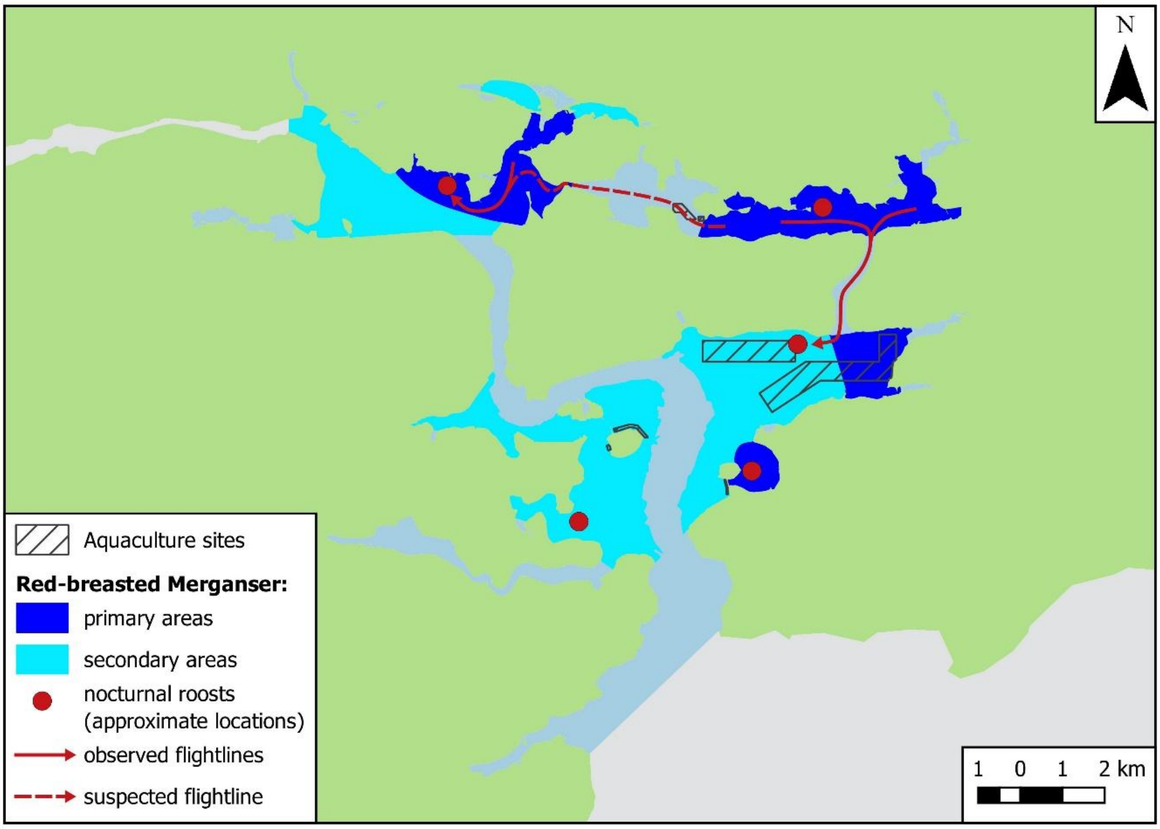


Figure 5.2 – Distribution of Red-breasted Merganser habitat and nocturnal roost locations in Cork Harbour.

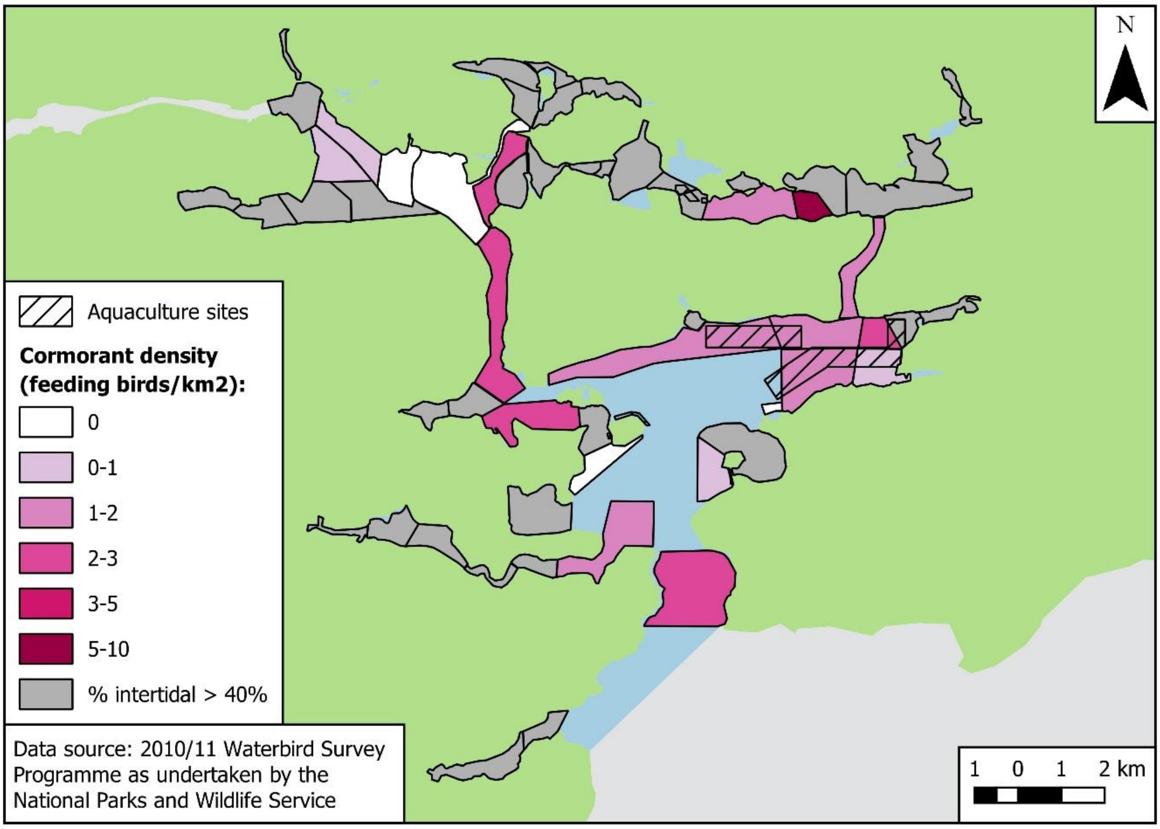


Figure 5.3 – Mean densities of feeding Cormorant recorded during the 2010/11 WSP low tide counts.

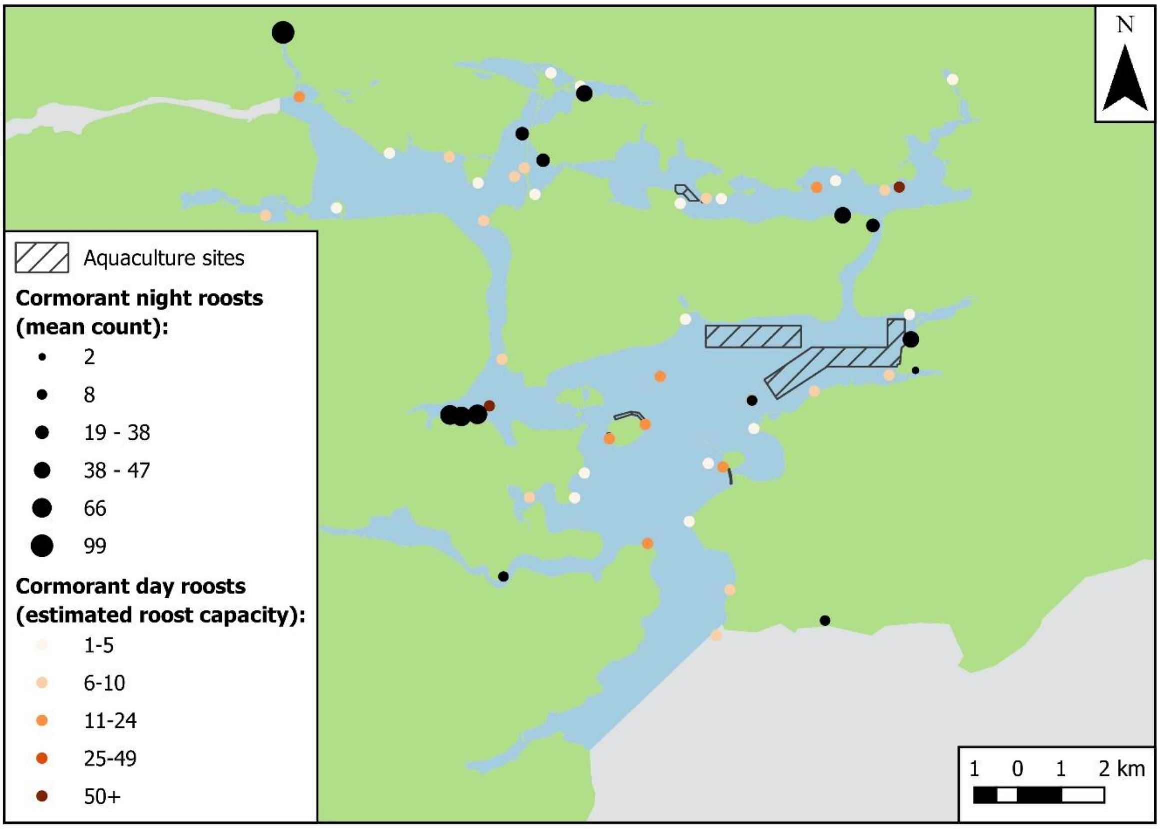


Figure 5.4 – Cormorant roost sites in Cork Harbour.

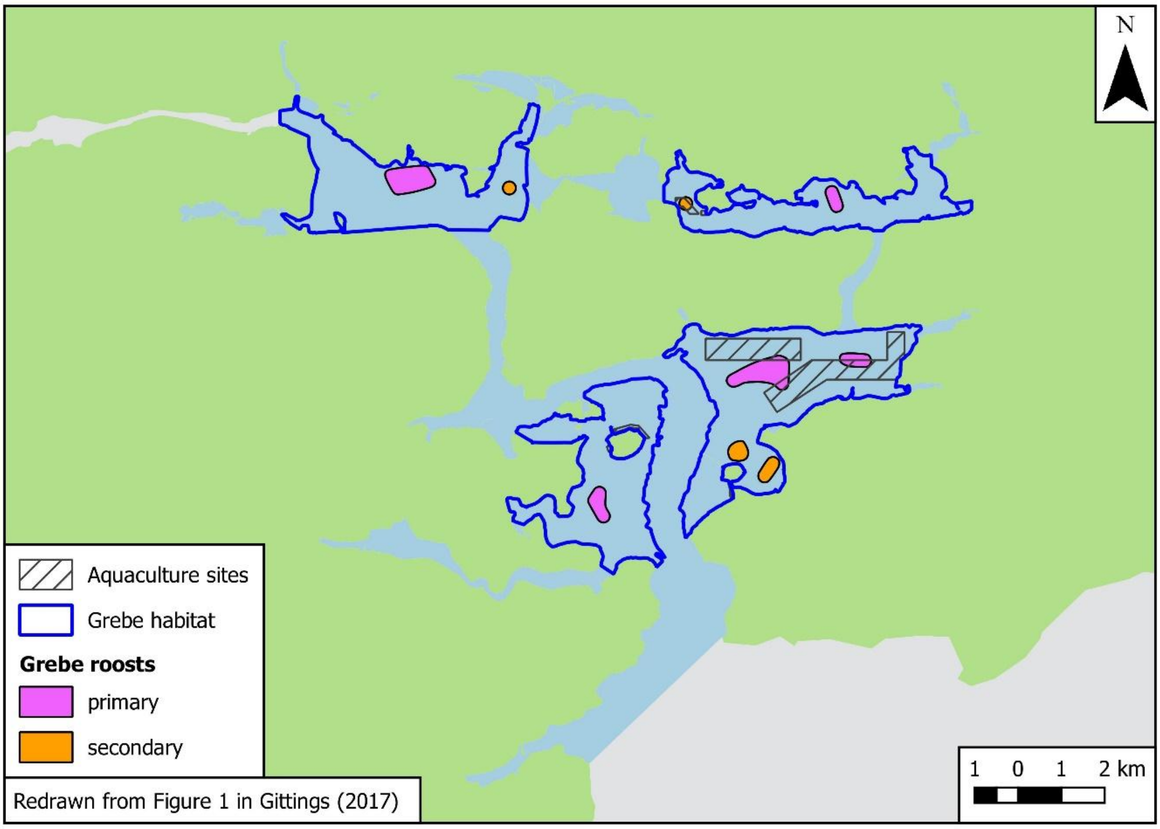


Figure 5.5 – Distribution of Great Crested Grebe habitat and nocturnal roost locations in Cork Harbour.

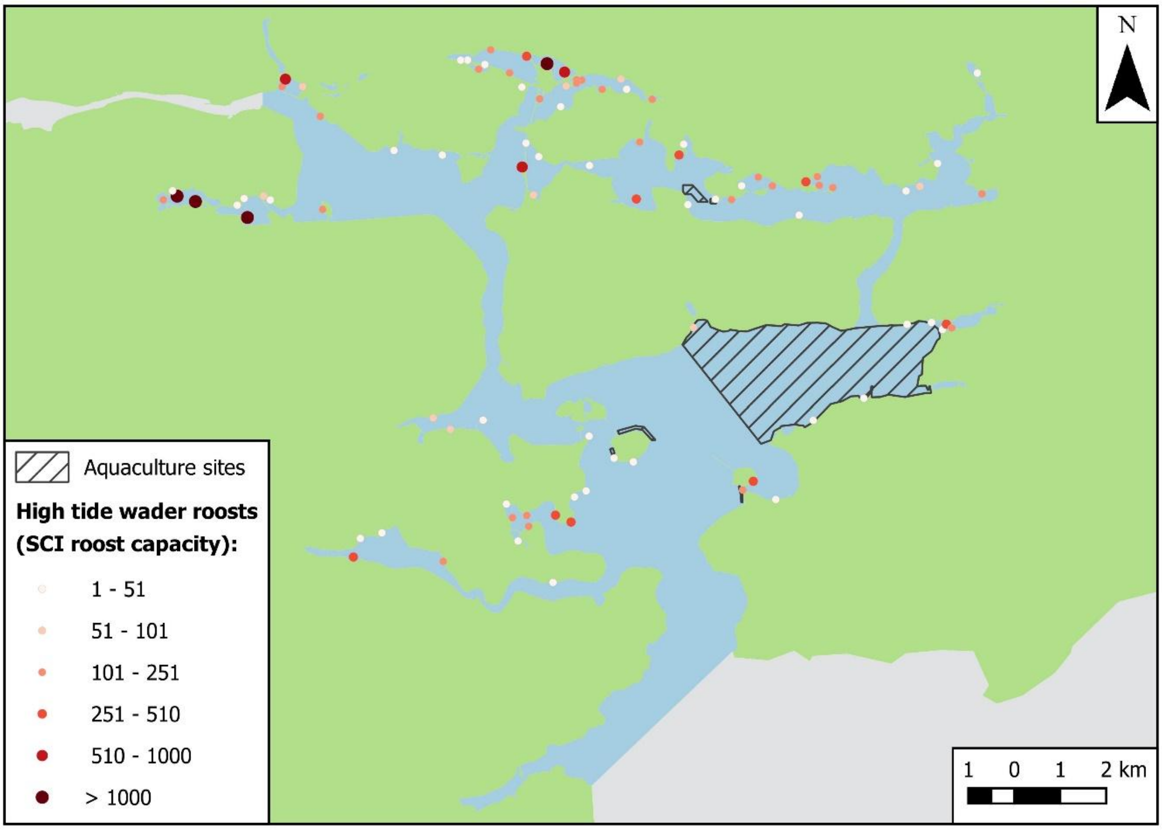


Figure 5.6 – High tide wader roost sites in Cork Harbour.

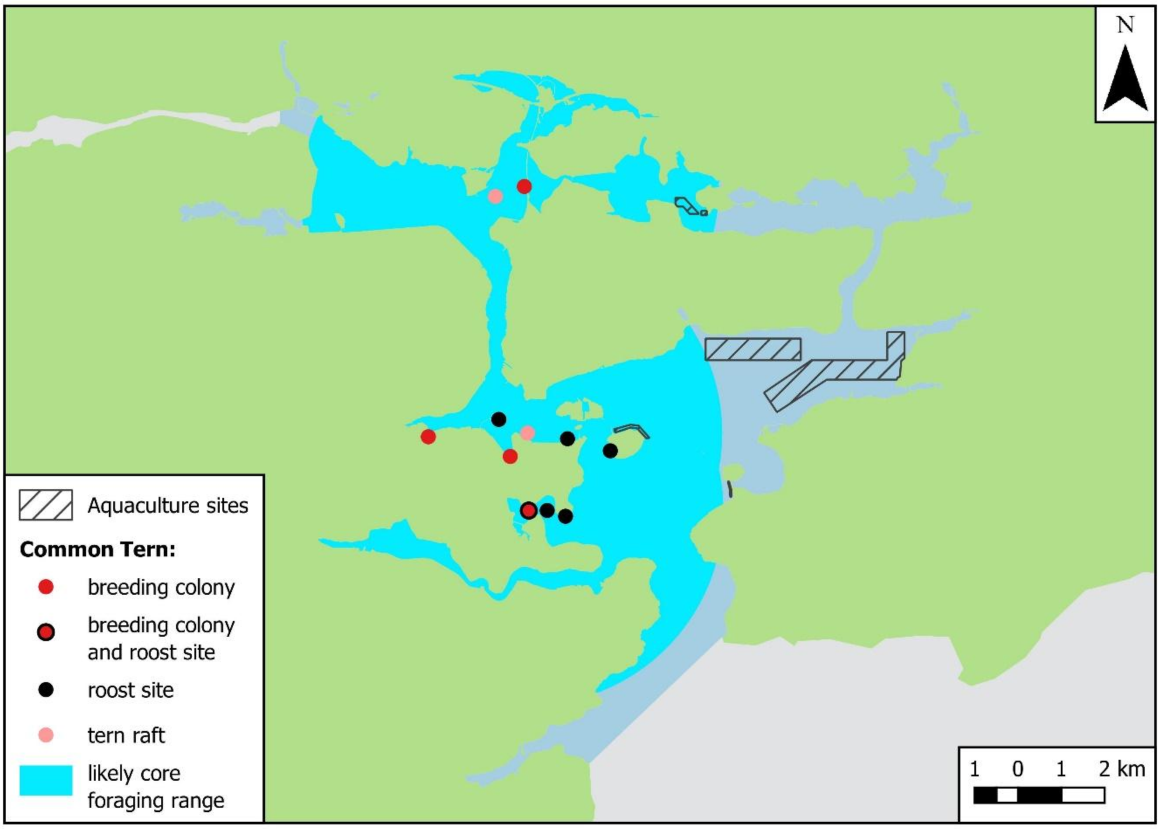


Figure 5.7 – Common Tern breeding colonies and roost sites in Cork Harbour.

6. Aquaculture activities within Cork Harbour

Scope of activity

6.1 A total of seven aquaculture sites, covering a total area of 314 ha, occur within Cork Harbour. These include two sites in the North Channel with a total area of 11 ha, and five sites in the lower harbour with a total area of 303 ha. The distribution of these aquaculture sites is shown in Figure 6.1 and summarised in Table 6.1. Five of the seven sites are small (1-9 ha) sites where suspended oyster cultivation using the bag and trestle method (oyster trestle cultivation) currently takes place, or is proposed, but only two of these sites are within the Cork Harbour SPA. The other two sites are large bottom mussel cultivation sites covering a total area of 295 ha in the East Harbour zone, with around 24% within the Cork Harbour SPA.

6.2 In addition to the aquaculture sites, there are four areas within Cork Harbour covered by Fishery Orders. These areas are not the subject of the present assessment, but are included within the in-combination assessment (Chapter 9).

Table 6.1 – Aquaculture sites in Cork Harbour.

Site	Location	Type	Activity	Area (ha)	
				Total	within SPA
T05/294A	North Channel	Application*	Oysters (bag and trestle)	9.48	9.43
T05/294B	North Channel	Renewal	Oysters (bag and trestle)	1.3	1.1
T05/522A	East Harbour	Application	Bottom mussels	110	0
T05/522B	East Harbour	Application	Bottom mussels	185	72
T05/546A	Spike Island	Application	Oysters (bag and trestle)	6.0	0
T05/546B	Spike Island	Application	Oysters (bag and trestle)	1.1	0
T05/546C	Corkbeg	Application	Oysters (bag and trestle)	0.8	0

* T05/294A is an application for a revised site boundary to replace the existing licensed site 294A.

Oyster trestle cultivation

6.3 Oyster trestle cultivation has taken place in the North Channel and the East Harbour since at least the 1990s. In the North Channel oyster trestle cultivation has taken place in the old site 294A as well as in other areas within the Rossmore Fishery Order. In the East Harbour, oyster trestle cultivation has taken place along the shoreline between Rostellan and the mouth of Saleen Creek within the East Harbour Fishery Order. The only recently active area of cultivation is in site 294A and there has been no oyster trestle cultivation activity in the East Harbour for many years.

6.4 Site 294A currently holds around 2 ha of trestles. These are located in the tidal channel at the north-western end of the site and are unusual compared to other typical oyster trestle cultivation sites because the sediment under the trestles is not exposed even on spring low tides, although the bags are exposed. The current annual production levels are 50-100 tonnes. The aim is to expand the trestles, as well as to use floating bag cultivation in the deeper parts of the site, to increase production to 700 tonnes/year. It is also proposed to cultivate native red seaweeds

(*Porphyra* sp. and *Palmaria palmata*) with a production target of 2 tonnes/year. Site 294B is held by the same operator and may be included in the above plans.

6.5 Sites 546A-C are new applications in areas where there has been no previous oyster trestle cultivation. The operator aims to produce 240 tonnes/year in these sites.

6.6 The combined production target of 940 tonnes across all the oyster trestle cultivation sites equates to 50 tonnes/ha and the actual production density will be higher as not all parts of the sites will be occupied by trestles. This appears to be an ambitious target relative to production levels at other sites: e.g., at Dungarvan Harbour mean production over the last ten years of around 1800 tonnes from around 110 ha of trestles represents a production density of around 17 tonnes/ha.

6.7 The aquaculture profile provides the following information about the oyster trestle cultivation husbandry methods and associated details:

> *Pacific oysters are predominantly grown in trestles and bags. Trestles are typically 0.6 m-1 m in height, 3 metres long and carry 5-6 bags, but this can vary.*
>
> *Seed is generally imported in the spring and in the autumn of each year, or as half grown. The intake size ranges, packed in oyster bags at a predetermined density and taken to the inter-tidal zone, where the bags are attached to trestles for the growing process to begin.*
>
> *Packing densities of seed is individually determined by each producer.*
>
> *Oysters are thinned out and graded as the oysters grow. As the oysters grow, they are taken to a handling / sorting facility or foreshore area for splitting and re-packing, and returned to the trestles. The seed will be split following a few months once growth starts. Producers generally split the oysters either once or twice over the growth cycle. Again the density following splitting varies from producer to producer.*
>
> *Producers generally turn each bag on site once a month. Turning takes place when the oysters are growing. This means turning takes place from March up to Oct/Nov depending on growth. Both spring tides of each month are generally used by producers to get out to their sites.*
>
> *The trestles are arranged in rows and blocks on site. Rows are often set out in pairs with sufficient gap between pairs for flat-bottomed vessels or tractors to pass, allowing servicing.*
>
> *The sites will either be accessed by boat from a nearby pier or by tractor across the foreshore.*

6.8 In relation to sites 294 A and 294B, husbandry activity averages 14 days per month, and four hours per day (David Millard, BIM, pers. comm.).

Bottom mussel cultivation

6.9 There are two application sites for bottom mussel cultivation: Sites T05/522A and T05/522B, referred to hereafter as Sites A and B. These sites occupy large parts of the East Harbour zone, extending from the eastern side of Cuskinny Bay and the Aghada Generating Station east to Rostellan and the mouth of Saleen Creek, but with a large gap around the mouth of the East Ferry Channel (Figure 6.2). However, only areas of permanent subtidal habitat (below 0 m Chart Datum) will be used. Therefore, most of the eastern end of Site B will not be used.

6.10 It is proposed to use natural mussel seed fished from around Spike Island to stock this site. This mussel seed would then be placed on the bottom for approximately 12 months until harvested by dredge.

6.11 The annual production target is 500 tonnes. This will require a total area of 20 ha (Francis O Beirn, Marine Institute, pers. comm.). Therefore, only small sections of the sites will be used at any one time.

6.12 The operator initially plans to use four plots to test different areas of the sites. Each plot will be approximately 5 ha (225 x 225 m, or equivalent). One plot would be located in Site A. The other three plots would be located in Site B: one in the deep water channel, one on the edge of the deep water channel, and one near the oyster beds. Once the operator has identified the most productive area, the focus of the production would shift to that area: i.e., all 20 ha would be concentrated in that area.

6.13 Harvesting will take place on 4-5 days per month between September and March, with the plots being visited on one day per month in the other months to lay seed, check stock, etc. (Table 6.2). During harvesting, a single plot will be fished on 3-4 days per month, with all the plots visited on one day per month. Fishing will take place over around eight hours per day during harvesting and four hours per day at other times. Fishing activity will be restricted to a period of four hours either side of high tide. No night fishing will take place.

Table 6.2 – Proposed fishing activity for the bottom mussel cultivation sites in the East Harbour.

Month	Days fishing	Hours fishing/day	Tidal restrictions
Jan	4	8	4 hours either side of high tide
Feb	4	8	4 hours either side of high tide
Mar	4	8	4 hours either side of high tide
Apr	1	4	4 hours either side of high tide
May	1	4	4 hours either side of high tide
Jun	1	4	4 hours either side of high tide
Jul	1	4	4 hours either side of high tide
Aug	1	4	4 hours either side of high tide
Sep	5	8	4 hours either side of high tide
Oct	5	8	4 hours either side of high tide
Nov	5	8	4 hours either side of high tide
Dec	5	8	4 hours either side of high tide

Information supplied by Tristan Hugh-Jones, Atlantic Shellfish.

6.14 The plots will be fished using the Haematopus, which is a 30 foot boat (Plate 6.1). This boat is moored next to Brick Island in the North Channel (Figure 6.3). It will access the bottom mussel cultivation sites via a route along the North Channel and down the East Ferry Channel (Figure 6.3), travelling at a speed of 5-6 knots. At this speed, the journey time from its mooring to the southern end of the East Ferry Channel will be around 33 minutes, with up to another 20 minutes required to reach the area being fished depending on the location of the plot.

Plate 6.1 - The Haematopus (photograph supplied by Tristan Hugh-Jones, Atlantic Shellfish).

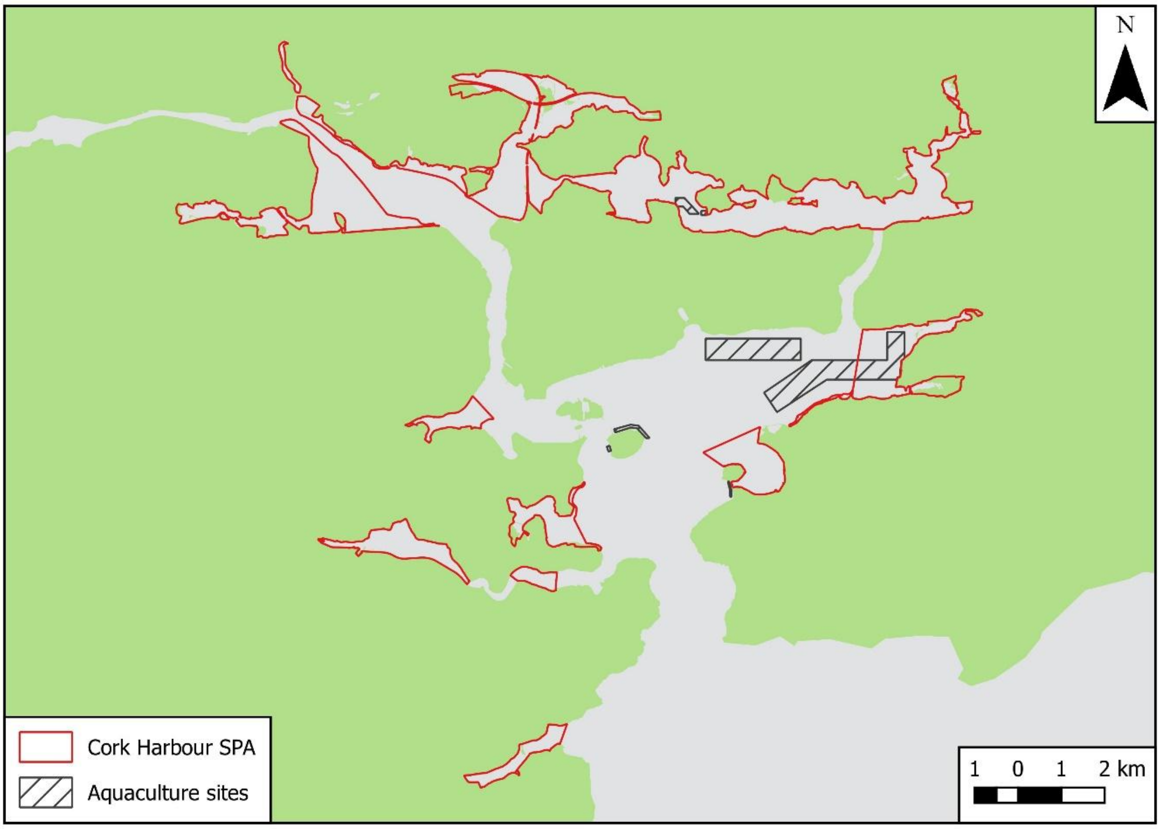


Figure 6.1 – Aquaculture sites in Cork Harbour.

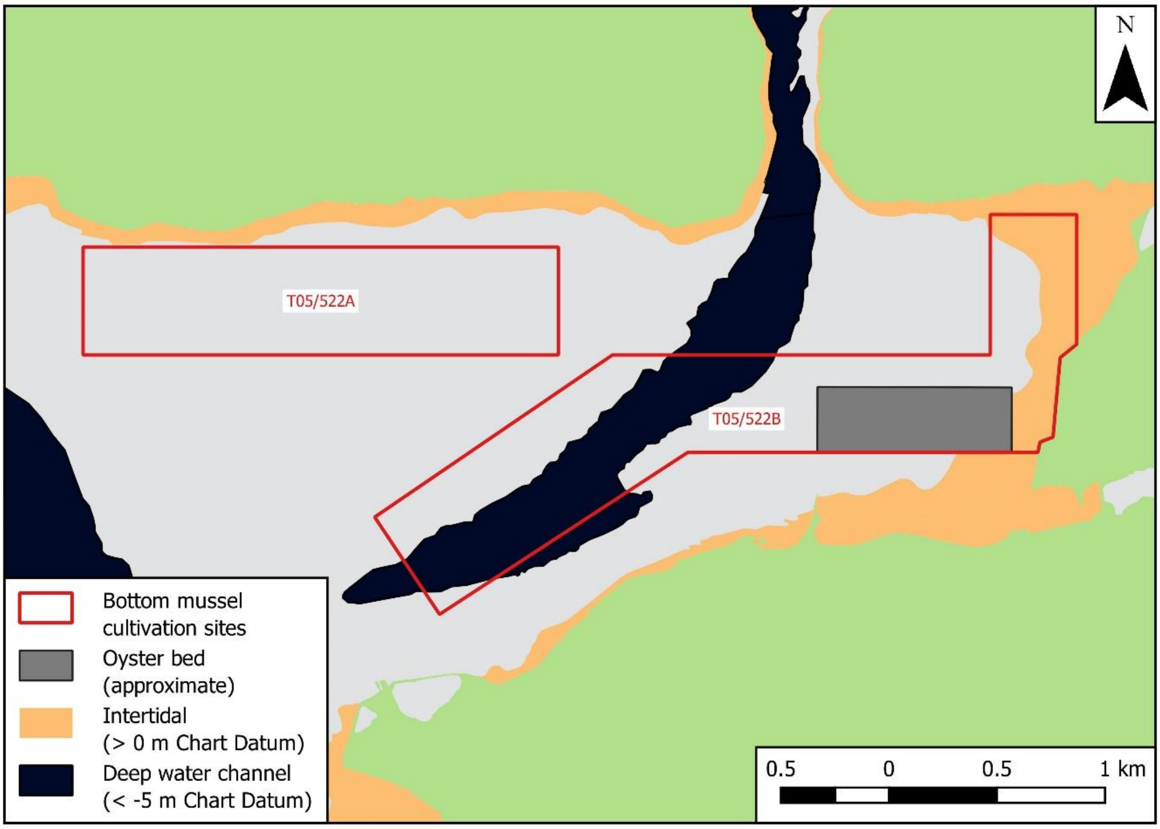


Figure 6.2 – Bottom mussel cultivation sites in the East Harbour zone.

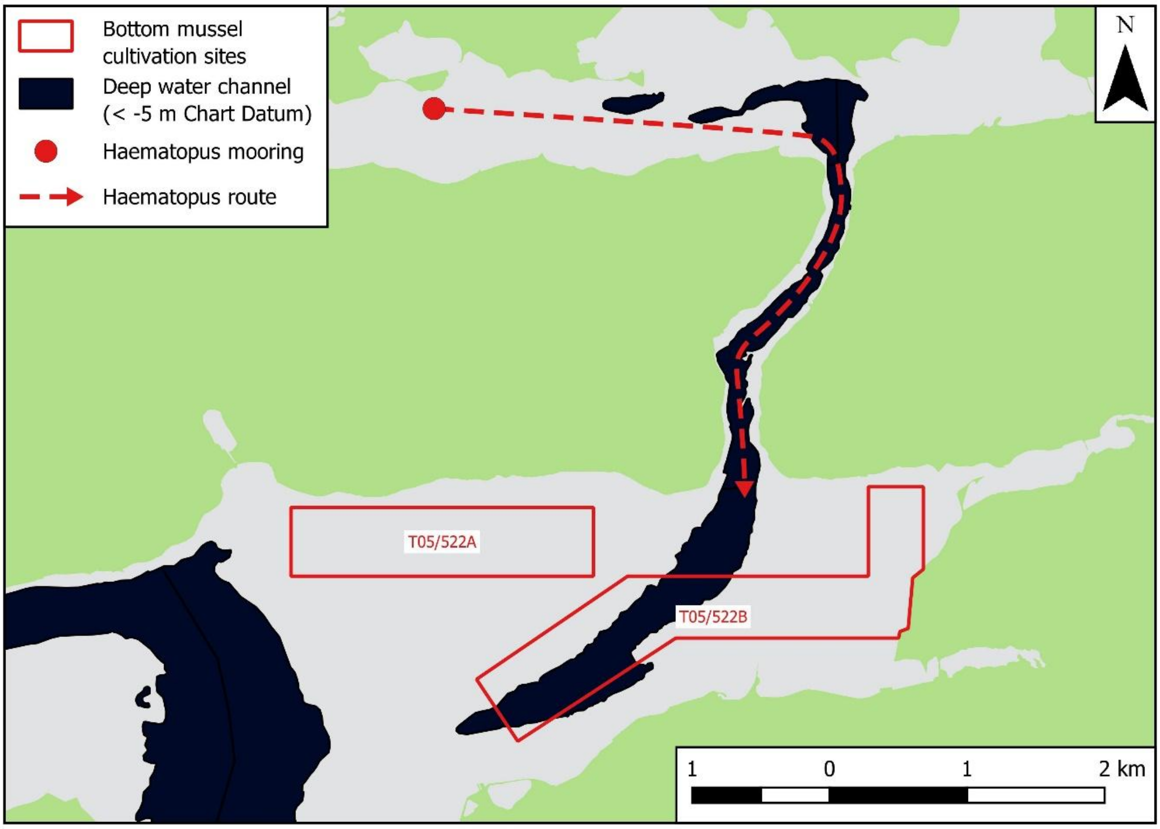


Figure 6.3 – Boat access from the North Channel mooring to the bottom mussel cultivation sites in the East Harbour.

7. Assessment of oyster trestle cultivation activity

Introduction

7.1 This section presents a detailed assessment of the potential impacts of the existing and proposed oyster trestle cultivation activities in Cork Harbour on the SCI species covered by this assessment.

7.2 Husbandry activity takes place in a 3-4 hour period around low tide. Therefore, husbandry activities will not cause any disturbance impacts outside the low tide period and will not cause impacts to any high tide roosts.

7.3 Parts of the North Channel oyster trestle cultivation sites will be used for floating bag cultivation of Pacific Oysters, while the trestles will also be used for seaweed cultivation. These activities are likely to have similar (seaweed cultivation) or lesser (floating bag cultivation) impacts on waterbirds, so for the purposes of this assessment all of the North Channel oyster trestle cultivation sites are treated as though they will be used for oyster trestle cultivation.

Potential impacts

Habitat structure

7.4 Oyster trestle cultivation causes a significant alteration to the three-dimensional structure of the tidal habitat (which includes the air and water space occupied by birds feeding on the habitat) through the placement of physical structures (oyster trestles) on substrate. This alteration may alter the suitability of the habitat for waterbirds by interfering with sightlines and/or creating barriers to movement. Based on the characteristics of species showing positive/neutral or negative responses to trestles, we have hypothesised that trestles may interfere with flocking behaviour causing species that typically occur in large, tightly packed flocks to avoid the trestles. Trestles could also interfere with the visibility of potential predators causing increased vigilance and reduced foraging time (Gittings and O'Donoghue, 2012, 2016b).

Food resources (benthic fauna)

7.5 Oyster trestle cultivation may cause impacts to benthic invertebrates and this could potentially affect food resources for waterbird species.

7.6 In a review of the literature, Dumbauld *et al.* (2009) found variation in the effects of intertidal oyster cultivation on the benthic fauna. In studies in England, France and New Zealand, intertidal oyster cultivation caused increased biodeposition, lower sediment redox potential and reduced diversity and abundance of the benthic fauna. However in studies in Ireland and Canada, few changes in the benthic fauna were reported, due to high currents preventing accumulation of biodeposits.

7.7 The Irish study referred to above was carried out at Dungarvan Harbour (De Grave *et al.*, 1998). This study compared an oyster trestle block (in the north-eastern section of the main block of trestles) with a control site approximately 300 m away, with both areas being at the mean tide level. Within the trestle block areas underneath trestles and areas in access lanes were compared. The study found no evidence of elevated levels of organic matter or high densities of organic enrichment indicator species within the trestle blocks. There were minor differences in the benthic community between the control area and the areas sampled under the trestles (higher densities of *Nephtys hombergii*, *Bathyporeia guiiliamsoniana*, *Gammarus crinicomis*, *Microprotopus maculatus* and *Tellina tenuis* including increased abundance of *Capiteila capitata* in the latter area), but these were considered to be probably due to increased predation by epifaunal decapods and fishes. There appeared to be stronger changes in the benthic community in the access lanes with increased densities of three polychaete species (*Scolopos armiger*, *Eteone longa* and *Sigalion mathildae*) and higher overall diversity, and these changes were considered to be due to the compaction of the habitat by vehicular traffic.

7.8 In more recent work commissioned by the Marine Institute, Forde *et al.* (2015) looked at benthic invertebrates along access tracks, under trestles and in close controls at a four sites along the west and south coasts of Ireland. There was a strong site effect from the study in that significant differences were observed using a variety of invertebrate response (dependent) variables among the sites. Access routes were considered more disturbed than trestle and control locations; most likely due to the influence of compaction from regular vehicle movements. Abundance (among other variables) was significantly higher in control and trestle samples when compared with those derived from access routes. No noticeable difference between control and trestle samples was detected. This research indicates that oyster trestle cultivation in typical Irish sites is unlikely to have had major impacts on food resources for waterbirds that feed on benthic fauna.

Food resources (fish and other nekton fauna)

7.9 Dumbauld *et al.* (2009) reviewed studies of the effects of bivalve shellfish aquaculture on nekton (fish and mobile invertebrates such as crabs). There was only one study that specifically examined intertidal oyster cultivation using bags and trestles (Laffargue *et al.*, 2006). This study found that, in an experimental pond mesocosm, sole used the oyster trestles as resting areas during the day, moving out into the open areas (which simulated tidal flats) to forage at night and the authors considered that the "*oyster trestles offered cover, camouflage, and safety and were therefore attractive to sole (as artificial reef-structuring effects)*". Similarly, De Grave *et al.*, (1998) noted that the trestles in their Dungarvan Harbour study site acted as refuges for scavenging crabs and shrimps. There were also a number of studies reviewed by Dumbauld *et al.* (2009) of related types of oyster cultivation (included suspended culture in subtidal waters, rack and bag systems, longlines and oyster grow-out cages). These all involve placing physical structures in the intertidal or subtidal waters and the potential impacts from organic enrichment and benthic community changes associated with oyster cultivation, so provide some degree of analogous situations to intertidal oyster cultivation using bags and trestles. These have generally found either little differences between oyster cultivation areas and nearby uncultivated habitats, or higher densities of nekton in the oyster cultivation areas.

Disturbance

7.10 Oyster trestle cultivation requires intensive husbandry activity and this may cause impacts to waterbirds using intertidal and/or shallow subtidal habitats through disturbance. Disturbance will not affect high tide roosts, or waterbirds that mainly, or only, use trestle areas when they are covered at high tide (such as Red-breasted Merganser, Cormorant and Great Crested Grebe), because no husbandry activity takes place during the high tide period.

7.11 There is a very extensive literature on the impact of disturbance from human activity on waterbirds. However, the trestle study (Gittings and O'Donoghue, 2012, 2016b) 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 the disturbance component of the potential impacts separately for the species covered by the trestle study.

Waterbird responses

Trestle study

7.12 The results of the trestle study (Gittings and O'Donoghue, 2012, 2016b) allowed us to categorise the nature of the association between oyster trestles and bird distribution patterns for many of the species included in this assessment.

7.13 Grey Plover appear to be completely excluded from areas occupied by oyster trestles. This was first demonstrated in the data from the trestle study and has been further supported by subsequent monitoring work at Dungarvan Harbour (Gittings and O'Donoghue, 2015, 2018a, 2018b).

7.14 Dunlin and Bar-tailed Godwit both showed strong avoidance of oyster trestles in the data from the trestle study. For Bar-tailed Godwit, this avoidance was further supported by subsequent monitoring work at Dungarvan Harbour (Gittings and O'Donoghue, 2015, 2018a, 2018b). However, the monitoring work at Dungarvan Harbour has shown a more complex picture for Dunlin with distribution patterns in relation to the presence of oyster trestles being complicated by apparent variation in the distribution of food resources.

7.15 Mallard and Lesser Black-backed Gull were also classified as having a negative response to trestles. However, this was based on limited data. In the case of Lesser Black-backed Gull, this largely reflected apparent avoidance of trestles by roosting flocks, rather than impacts on feeding birds.

7.16 The trestle study only produced limited data for Wigeon, with a neutral/positive patterns of association at one site, and negative pattern at another site. This species can feed on the algae that attaches to the trestle bags.

7.17 Curlew, Black-headed Gull and Common Gull also showed a variable response pattern in the trestle study with neutral/positive patterns of association at some sites, and negative patterns at other sites[5].

7.18 Oystercatcher and Redshank were classified as having an overall neutral/positive pattern of association with oyster trestles. Oystercatcher often feeding the trestles, where depending on the mesh size of the bags, they can extract oysters through the mesh when the shells are gaping on ebb and flood tides.

Species not covered by the trestle study

7.19 The other intertidal/shallow subtidal species included in this assessment are: Shelduck, Teal, Pintail, Shoveler, Grey Heron, Golden Plover, Lapwing, Black-tailed Godwit and Greenshank. These species were not recorded in sufficient numbers in the trestle study to carry out formal analyses of their association with trestles across sites. This reflects that fact that these species tend to occur on muddier sediments, unlike the sandier sediments typically used for intertidal oyster cultivation. However, for Shelduck, Lapwing and Black-tailed Godwit, the trestle study found some weak evidence of negative (Shelduck, Lapwing and Black-tailed Godwit), or positive (Grey Heron) association with trestles, from ordination analyses and/or qualitative assessment of count data (Gittings and O'Donoghue, 2012). For Golden Plover, we have some evidence of a

[5] Note that Curlew was classified as having a neutral/positive pattern of association in Gittings and O'Donoghue (2012), but, based on further analysis of the dataset, was re-classified as variable in Gittings and O'Donoghue (2016b).

negative association with trestles from other work (Gittings and O'Donoghue, 2015 and unpublished data).

7.20 Shelduck are large ducks that stand over 0.5 m tall. Therefore, trestles may impede their movements while foraging as, unlike smaller waders, they will not be able to freely move under the trestles.

7.21 Golden Plover and Lapwing mainly use intertidal areas for roosting. Golden Plover typically roost in large expanses of open mudflat or sandflat, while Lapwing use more varied substrates for roosting, including mixed sediments and rocky shores. It is very unlikely that Golden Plover would roost within trestle blocks but one could imagine that Lapwing might roost on trestles. Monitoring work at Dungarvan Harbour has provided some evidence that roosting Golden Plover flocks avoid trestles (Gittings and O'Donoghue, 2015 and unpublished data).

7.22 Black-tailed Godwit is behaviourally and ecologically similar to Bar-tailed Godwit, as indicated by the fact that small numbers of Bar-tailed Godwits often associate with Black-tailed Godwits in Cork Harbour. Therefore, it seems likely that Black-tailed Godwit will show a similarly strong negative response to trestles, as shown by Bar-tailed Godwit.

7.23 We have no evidence about the nature of the response of Teal, Pintail and Shoveler to trestles. For these species, we have made a precautionary classification of a negative response.

7.24 Red-breasted Merganser, Cormorant, Great Crested Grebe are species that primarily, or exclusively, exploit subtidal habitats, although Cormorant will roost in exposed intertidal areas. These species were not covered by the trestle study. Red-breasted Merganser, Cormorant and Great Crested Grebe feed mainly on fish and mobile invertebrates such as crabs and oyster trestles are likely to have neutral or positive impacts on these food resources (see paragraph 7.9). Both Red-breasted Merganser and Great Crested Grebe regularly feed over the oyster trestle blocks in Dungarvan harbour when these are flooded at high tide. Therefore, Red-breasted Merganser, Cormorant and Great Crested Grebe are likely to have a neutral/positive response to oyster trestles.

7.25 Little Grebe also primarily exploits subtidal habitats and was not covered by the trestle study. Fish are a significant component of their diet, but insects, small crustaceans and benthic invertebrates are also important (Cramp and Simmons, 2004). Little Grebe generally feed in very shallow water and occur in narrow tidal channels within exposed mudflats at low tide. Therefore, Little Grebe could potentially exploit habitats within oyster trestle sites at low tide when the trestle structures could potentially interfere with their use of these sites. Therefore, we have made a precautionary classification of a negative response for this species.

7.26 Common Tern is a summer visitor to Ireland and was not, therefore, covered by the trestle study (which was carried out in winter). This species primarily exploits subtidal habitats for feeding where it feeds on fish and mobile invertebrates. However, intertidal habitats are important as roost sites, both as daytime and nocturnal roosts. The impact of trestles on the utilisation of intertidal habitat be roosting terns is not known. Terns will often use artificial structures for roosting such as piers and jetties. However, any husbandry activity within the trestles would be likely to flush the terns. For this assessment, we have made a precautionary classification of a negative response for this species when roosting in intertidal habitat.

Cork Harbour study

7.27 Hilgerloh *et al.* (2001) studied the distribution and behaviour of waterbirds in relation to oyster trestle cultivation at Cork Harbour. They used one plot with oyster trestles and one control plot (both 1 ha) located on mudflats in Saleen Creek on the eastern side of Cork Harbour. From the information in the paper, it appears that their trestle plot corresponds to the isolated block of now derelict trestles at the mouth of Saleen Creek and that the control plot was immediately adjacent on either the eastern or western side of the trestle block. They carried out 64 scan counts and a series of focal observations on four days between 2nd and 7th March 1999.

7.28 Oystercatcher, Curlew, Black-headed Gull and Common Gull occurred in significantly lower numbers[6] in the trestle area compared to control plot, while there was no difference in the numbers of Dunlin and Redshank. There was no significant difference in the percentage of feeding birds of any of these species between the plots and the feeding rate of Oystercatchers did not differ between the plots. They also report various data on the behaviour of birds in areas of trestles with bags compared to areas without bags.

7.29 This study has no replication of treatments and the authors acknowledge that "*the differences observed in the distribution of the other species [Oystercatcher, Curlew, Black-headed Gull and Common Gull] cannot only be explained by the presence of the trestles, since not all environmental parameters were identical in both areas*". Furthermore, the very limited temporal range of the study (five days between the first and last count days) means that the results may not be very representative of overall distribution patterns.

7.30 Due to the methodological issues discussed above, and acknowledged by the authors, we do not consider that this study provides reliable information on waterbird responses to oyster trestle cultivation and we have not used its results in this assessment.

Assessments

North Channel sites

Habitats

7.31 The aquaculture sites in the North Channel are located in a narrow section of the channel between the eastern side of the Rossleague peninsula and the western side of Rossmore peninsula. This section of the North Channel has a wide channel of moderately deep subtidal habitat with 100-300 m wide bands of mudflats on either side. Immediately to the north and west of the aquaculture sites, the North Channel widens into large bays with extensive mudflats.

7.32 The larger of the aquaculture sites is largely occupied by the tidal channel. This is mainly mapped as moderately deep subtidal habitat, but with an area mapped as shallow subtidal habitat, which corresponds approximately to the location of the trestles. On the site visit on 10th October 2018, during a low spring tide, there was no intertidal habitat exposed under the trestles, although some of the trestles were in very shallow water.

7.33 The smaller of the aquaculture sites is mainly occupied by intertidal and shallow subtidal habitat. Around half of the intertidal habitat within the site is mixed sediment, with the remainder being mudflat.

7.34 The two aquaculture sites occupy a combined area of around 1% of the total intertidal habitat in the North Channel, and 2% of the total intertidal habitat in the Rossmore section (Table 7.1).

[6] The authors present data on densities in the tables in the paper but refer to numbers in the text.

Table 7.1 – Tidal habitats in the North Channel aquaculture sites.

Habitat	Area (ha)	% of total area in	
		Rossmore	North Channel
Saltmarsh	0	0%	0%
Intertidal	1.9	2%	1%
Intertidal and shallow subtidal	3.8	4%	1%
Shallow and moderately deep subtidal	7.1	24%	4%
Deep subtidal	0	-	0%

Waterbird distribution

7.35 The percentage of the total Cork Harbour count recorded in the North Channel during the I-WeBS counts and the WSP low tide counts is compared in Table 7.2. The occurrence patterns in the I-WeBS dataset are quite consistent for most species as indicated by the narrow confidence intervals. The occurrence patterns in the WSP dataset are broadly comparable to those in the I-WeBS dataset. Given the fact that the WSP dataset only includes four counts from a single winter this is quite impressive.

Table 7.2 – Mean percentages of the total Cork Harbour count recorded in the North Channel during the I-WeBS counts and the WSP low tide counts.

Species	I-WeBS	WSP
Shelduck	39% (33-44%)	34%
Wigeon	26% (21-32%)	27%
Teal	17% (14-21%)	14%
Mallard	8% (6-10%)	18%
Pintail	88% (66-110%)	100%
Shoveler	27% (12-42%)	14%
Little Grebe	12% (8-16%)	11%
Golden Plover	0%	7%
Grey Plover	8% (1-16%)	19%
Lapwing	6% (1-10%)	7%
Curlew	21% (18-24%)	16%
Black-tailed Godwit	12% (8-16%)	25%
Bar-tailed Godwit	0%	1%
Dunlin	3% (1-6%)	10%
Black-headed Gull	10% (7-13%)	5%
Common Gull	5% (1-8%)	13%
Lesser Black-backed Gull	7% (3-10%)	5%

95% confidence intervals for the I-WeBS percentages are shown in parentheses. The WSP analyses exclude data from the Outer Harbour zone.

7.36 The low tide distribution patterns, as recorded in the WSP counts, are summarised in Table 7.3. Shelduck mainly occur in the extensive muddy bays of the Belvelly and Rossmore sectors. Ballintubbrid was the key area for most of the dabbling duck species, except for Pintail which occurred exclusively in the Belvelly sector. Most of the waders and gulls were quite widely distributed and some of the variation in distribution patterns will be random effects due to small numbers and/or erratic occurrence of the species concerned.

7.37 The two subsites containing the aquaculture sites hold around 9% of the total area of intertidal habitat in the North Channel and this is reflected in the percentage occurrence of several of the species that feed on intertidal habitat (Shelduck, Curlew, Black-tailed Godwit, Bar-tailed Godwit and Black-headed Gull) which ranged from 7-14% (Table 7.3). Grey Plover had a relatively high percentage occurrence but this was based on a combined total across all the counts of just 17 birds.

Table 7.3 – Percentage distribution of waterbirds between the four sectors of the North Channel, and percentage occurrence in the aquaculture sites subsites, during the WSP low tide counts.

Species	North Channel sectors				Aqua subsites
	Belvelly	Rossmore	Brick Island	Ballintubbrid	
Shelduck	41%	38%	17%	5%	10%
Wigeon	16%	3%	5%	75%	3%
Teal	38%	2%	3%	57%	2%
Mallard	2%	2%	25%	71%	2%
Pintail	100%	0%	0%	0%	0%
Shoveler	0%	0%	0%	100%	0%
Little Grebe	57%	7%	16%	19%	7%
Golden Plover	100%	0%	0%	0%	3%
Grey Plover	24%	24%	18%	35%	24%
Lapwing	44%	31%	0%	25%	0%
Curlew	35%	22%	21%	22%	9%
Black-tailed Godwit	27%	45%	21%	7%	14%
Bar-tailed Godwit	57%	14%	29%	0%	14%
Dunlin	43%	25%	1%	32%	0%
Black-headed Gull	25%	45%	21%	9%	8%
Common Gull	0%	19%	56%	25%	33%
Lesser Black-backed Gull	56%	0%	44%	0%	0%

Percentages are the mean percentages across the four WSP counts, with the exception of Pintail, Shoveler, Grey Plover, Bar-tailed Godwit and Dunlin for which the percentages are based on the summed count data (due to the low numbers of birds recorded).

7.38 Feeding Common Tern occur within the North Channel, but there are no known Common Tern roosts within the North Channel.

Assessment

7.39 The predicted displacement impacts that would result from full occupation of the aquaculture sites T05/294A and T05/294B in the North Channel are shown in Table 7.4. For most species, the predicted displacement in < 0.05% and the highest predicted displacement impact is only 0.3-0.6% (for Shelduck). Therefore, as the predicted displacement impacts are an order of magnitude below the 5% threshold, and the predictions are based on worst-case assumptions, it can be safely concluded that full occupation of these aquaculture sites will not cause significant impacts to any of the waterbird species covered by this assessment.

7.40 As there are no known intertidal Common Tern roosts within the North Channel, no impacts to this species are predicted to result from full occupation of the North Channel aquaculture sites.

Table 7.4 – Potential displacement impact (% of Cork Harbour population) predicted from full occupation of the aquaculture sites T05/294A and T05/294B in the North Channel.

Species	Likelihood of negative impact	Displacement based on waterbird occupancy of:	
		Rossmore sector	aquaculture subsites
Shelduck	2	0.5-0.6%	0.3-0.5%
Wigeon	1	0.0%	0.1-0.1%
Teal	1	0.0%	0.0%
Mallard	2	0.0%	0.0%
Pintail	1	0.0%	0.0%
Shoveler	1	0.0%	0.0%
Little Grebe	1	0.2-0.4%	0.2-0.4%
Golden Plover	2	0.0%	0.0%
Grey Plover	3	0-0.1%	0-0.2%
Lapwing	2	0-0.1%	0.0%
Curlew	1	0.1-0.1%	0.1-0.1%
Black-tailed Godwit	2	0.1-0.2%	0.1-0.2%
Bar-tailed Godwit	3	0.0%	0.0%
Dunlin	3	0-0.1%	0.0%
Black-headed Gull	1	0.1-0.2%	0.1-0.1%
Common Gull	1	0-0.1%	0-0.4%
Lesser Black-backed Gull	2	0.0%	0.0%

Likelihood of a negative impact: 1 = species shows a variable response to oyster trestles, so a neutral or positive impact may occur, or species with no evidence available about response to trestles; 2 = species considered to show a negative response to oyster trestles but evidence for this is weak; 3 = strong evidence that species shows a negative response to oyster trestles.

Lower Harbour aquaculture sites

Habitats

7.41 The aquaculture sites in the LH are located in Corkbeg Bay in the East Harbour zone and on Spike Island in the West Harbour zone.

7.42 The Corkbeg aquaculture site is located on Corkbeg Beach. This is a narrow, moderately sloping, sand beach on the western side of the causeway that leads out to Corkbeg Island. The beach is around 400 m long with a maximum exposure at low tide of less than 50 m width. This beach holds the only soft sediment intertidal habitat in Corkbeg Bay, with littoral rock habitat occurring along the western side of Corkbeg Island and along the southern shore of the bay.

7.43 The Spike Island aquaculture sites are located on the northern and western shores of Spike Island. Littoral rock/mixed sediment shore occupies most of the Spike Island shoreline. Areas of muddy sand occur in the lower part of the intertidal zone and the larger of the two aquaculture sites occupies the most extensive such area in the bay to the east of the pier.

Table 7.5 – Tidal habitats in the Corkbeg aquaculture site.

Habitat	Area (ha)	% of total area in	
		Corkbeg Bay	East Harbour
Saltmarsh	0	0%	0.0%
Intertidal	0.4	7%	0.2%
Intertidal and shallow subtidal	1.1	11%	0.2%
Shallow and moderately deep subtidal	0	0%	0.0%
Deep subtidal	0	0%	0.0%

Table 7.6 – Tidal habitats in the Spike Island aquaculture sites.

Habitat	Area (ha)	% of total area in	
			West Harbour
Saltmarsh	0	0%	0.0%
Intertidal	2.7	8%	0.8%
Intertidal and shallow subtidal	6.5	8%	0.9%
Shallow and moderately deep subtidal	0.3	0%	0.0%
Deep subtidal	0	0%	0.0%

Waterbird distribution

7.44 Corkbeg Bay is not covered by the Cork Harbour I-WeBS counts. During the WSP counts, four of the SCI species covered in this assessment were recorded in Corkbeg Bay. The counts of Black-headed Gulls were mainly birds roosting in subtidal waters (Table 7.7). From our own casual observations, other SCI species covered by this assessment which can occur in Corkbeg Bay include Wigeon, Lesser Black-backed Gull and Common Tern. However, all these species occur irregularly and/or in very low numbers. There are no records of Common Tern breeding colonies or roost sites from Corkbeg Bay.

Table 7.7 - Waterbird counts of Corkbeg Bay, 2010/11.

Species	07/10/2010	08/11/2010	06/12/2010	13/01/2011	03/02/2011
Mallard	0	0	0	9	14
Curlew	0	2	2	0	0
Black-headed Gull	0	16	55	0	2
Common Gull	0	0	6	0	0

Source: 2010/11 Waterbird Survey Programme as undertaken for the National Parks and Wildlife Service.

7.45 The western and southern shores of Spike Island are included in the Spike Island I-WeBS subsite (Table 7.8) and were also covered by the WSP counts (Table 7.9).

7.46 At high tide, small numbers of Shelduck, Curlew and Black-headed Gulls roost on the western shoreline of Spike Island and these birds may remain on Spike Island at low tide. There is also a Cormorant day roost on the western shoreline of Spike Island, which can be occupied at low tide.

There is a semi-regular Grey Plover, Dunlin and gull roost on Luc Strand[7], while there is also at least one record of Dunlin roosting on Spike Island. Most of the Grey Plover and Dunlin probably feed in Lough Beg at low tide, while Dunlin may also commute across the harbour to Whitegate Bay. The Black-headed Gulls recorded in the WSP low tide counts were mainly feeding in intertidal habitats and are most likely to have been on Luc Strand.

7.47 Small aggregations of roosting terns (including Common Tern) can occur on the southern and western shorelines of Spike Island during spring (April-early May) and late summer/autumn (July-September). These are mainly daytime roosts but it is possible that Spike Island is also a disturbance refuge used when the terns are flushed from the Lough Beg nocturnal roost site.

7.48 The northern and eastern shorelines of Spike Island contains around 7.5 ha of intertidal habitat (compared to 25 ha in the adjacent WSP subsites) and 6 ha of shallow subtidal habitat (compared to 39 ha in the adjacent WSP subsites). This includes a muddy/sandy bay along the northern shoreline, with rocky shore habitat along the eastern shoreline. There does not appear to be any waterbird count data available for these areas. However, given the low numbers of SCI species using the Haulbowline, Luc Strand and Spike Island WSP subsites, which contain much larger areas of habitat (25 ha of intertidal habitat and 39 ha of shallow subtidal habitat), and the isolated position of Spike Island, it is very unlikely that significant numbers of SCI species feed on the northern and eastern shorelines of Spike Island at low tide. It is possible that high tide and/or tern roosts occur on these shorelines (particularly the northern shoreline).

Table 7.8 – Annual maximum counts in the Spike Island I-WeBS subsite, 2011/12-2017/18.

Species	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18
Shelduck	32	2	7	9	6	4
Grey Plover	0	0	0	0	0	10
Curlew	1	2	8	0	31	8
Black-tailed Godwit	0	0	6	0	0	0
Dunlin	0	0	0	2	60	250
Black-headed Gull	2	13	76	106	12	6
Common Gull	1	2	6	30	0	2
Lesser Black-backed Gull	1	6	43	4	0	3

Source: Irish Wetland Bird Survey (I-WeBS), a joint scheme of BirdWatch Ireland and the National Parks and Wildlife Service of the Department of Arts, Heritage & the Gaeltacht.

[7] During the winters of 2012/13-2015/16, the regular I-WeBS counter did not count Luc Strand so the I-WeBS data for the Spike Island subsite for those winters does not reflect the usage of Luc Strand as a roost site by Grey Plover and Dunlin.

Table 7.9 - Waterbird counts of the Haulbowline, Luc Strand and Spike Island area, 2010/11.

Species	07/10/2010 (low tide)	08/11/2010 (low tide)	06/12/2010 (low tide)	13/01/2011 (high tide)	03/02/2011 (low tide)
Wigeon	0	0	0	0	5
Grey Plover	0	0	2	13	3
Curlew	2	3	6	0	5
Dunlin	0	0	6	200	0
Black-headed Gull	0	82	96	16	35
Common Gull	0	0	7	0	7
Lesser Black-backed Gull	1	4	3	2	3

Source: 2010/11 Waterbird Survey Programme as undertaken for the National Parks and Wildlife Service.

Assessment

7.49 The aquaculture site in Corkbeg Bay occupies a small area of intertidal and shallow subtidal habitat which comprises a tiny fraction of the total extent of intertidal and shallow subtidal habitat in the East Harbour zone. The SCI species covered by this assessment only occur irregularly and/or in very small numbers in the intertidal and shallow subtidal habitat in Corkbeg Bay. Therefore, development of this site for oyster trestle cultivation is not likely to have any measurable negative impacts on the SCIs species covered by this assessment.

7.50 The aquaculture sites in on Spike Island occupy small areas of intertidal and shallow subtidal habitat which comprises a tiny fraction of the total extent of intertidal and shallow subtidal habitat in the West Harbour zone. Apart from Cormorant and Common Tern, these areas are unlikely to support significant numbers of SCI species at low tide. High tide roost usage will not be affected by development of the aquaculture sites as husbandry activities will only take place at low tide and the trestles will be flooded at high tide.

7.51 The Cormorant day roost on the western shoreline of Spike Island typically holds around 20 birds during the autumn/early winter period, which is around 15% of the mapped Cormorant day roost capacity in the West Harbour. This roost can be occupied at low tide when birds move down to exposed rocks lower down the foreshore. It is also possible that Cormorant day roosts occur on the northern and/or eastern shorelines of Spike Island, which were not covered by the mapping exercise. Cormorant routinely roost on artificial structures in Cork Harbour and we have observed Cormorant roosting on trestles in Dungarvan Harbour. Therefore, the presence of the trestles would not necessarily deter terns from roosting on the Spike Island shoreline. However, husbandry activity would be likely to flush the birds. There are a total of 37 mapped Cormorant day roosts in Cork Harbour, and there are likely to be additional unmapped day roosts. Cormorants are a mobile species and are frequently observed flying around the harbour. In general, Cormorants disturbed from one day roost are likely to be able to resettle on another day roost nearby. As husbandry activity will be limited to a few low tides per month, any disturbance impact is unlikely to be significant.

7.52 Common Tern roosts may occur on the Spike Island shoreline during the spring and post-breeding/autumn migration period and these roosts may occur at low tide. Terns routinely roost on artificial structures in Cork Harbour (such as the naval college slipway and the jetty at Ballybricken Point, so the presence of the trestles would not necessarily deter terns from roosting on the Spike Island shoreline. However, husbandry activity would be likely to flush the terns. Common Tern tend to roost in large concentrations in a small number of sites, so, unlike Cormorant, disturbance to a single roost site has the potential to cause significant impacts. There are several alternative roost sites available nearby, although these are all probably subject to higher levels of disturbance than the Spike Island roost sites. Overall, due to the small size of the aquaculture sites on Spike Island, and the presumed low intensity of husbandry activity, it seems unlikely that development of these aquaculture sites would cause significant disturbance impact to roosting Common Terns during the post-breeding/autumn migration period. However, further information about the usage of the Spike Island shoreline by roosting Common Tern (particularly the northern shoreline) and about the intensity of husbandry activity that would result from the development of the aquaculture sites, would be required to definitively assess this potential impact.

7.53 No information has been provided about the routes that would be used to access the aquaculture sites. We presume that the sites will have to be accessed by boat. Any such access routes would have the potential to cause disturbance to Red-breasted Mergansers, Cormorants and Great Crested Grebes. Red-breasted Mergansers are currently rare during the day in the East Harbour and West Harbour zones, while their night time roost sites occur away from any likely access routes. However, in the event of a recovery of the Red-breasted Merganser population, boat disturbance in the East Harbour and West Harbour zones may become a significant factor limiting their usage of these areas. Cormorants and Great Crested Grebes are generally not very sensitive to boat disturbance while foraging, and the Great Crested Grebe roost sites occur away from any likely access routes. Overall, due to the presumed low intensity of husbandry activity associated with these aquaculture sites, it seems unlikely that boat access to the sites would cause significant disturbance impacts to the Cork Harbour Red-breasted Merganser, Cormorant and Great Crested Grebe populations. However, further information about the intensity of husbandry activity would be required to definitively assess these potential impacts.

Conclusions

7.54 The small scale of the oyster trestle cultivation activity covered by this assessment, and the location of three of the five sites in areas of the harbour that do not hold high concentrations of intertidal/shallow subtidal waterbirds, mean that no significant displacement impacts are likely to occur.

7.55 There is a possibility of disturbance impacts to Common Tern roosts on Spike Island. Any such impacts are unlikely to be significant, but further information about Common Tern usage of the Spike Island and about the intensity of husbandry activity, would be required to definitively assess this potential impact.

8. Assessment of bottom mussel cultivation

Introduction

8.1 This chapter assesses the likely impact of bottom mussel cultivation in sites T05/522A and T05/522B (Figure 6.2), which are referred to as Sites A and B, hereafter.

8.2 The assessment is based on the information supplied about the spatial extent and timing of the proposed activities associated with the cultivation of these sites (see Chapter 6).

8.3 For the assessment of potential disturbance impacts from fishing activity within the bottom mussel cultivation sites it was necessary to consider the spatial configuration of the individual plots that will be fished. The size of an individual plot that will be fished on any one day will be around 5 ha (see paragraph 6.12). Therefore, to assess the potential displacement impact from fishing activity in the bottom mussel cultivation sites, we divided the sites into 5 ha plots (Figure 8.1). The dimensions of the plots in different sections of the sites were adjusted to fit into the dimensions of the sites, while maintaining an area of 5 ha. Plots were not included if they would contain more than 50% intertidal/shallow subtidal habitat (see paragraph 6.9), and plots were not included in the northern arm of Site B as this has not been identified as one of the target areas for mussel plots (see paragraph 6.12). The plots were divided into three categories to represent the target areas identified by the operator: Site A, the deepwater channel and margins in Site B, and the area around the oyster bed in Site B. These plots do not necessarily represent the exact position of the plots that will be fished, but they provide representative scenarios that can be used to assess how the potential disturbance and displacement impacts will vary depending upon which sections of the sites are fished.

Potential impacts

Habitat alteration impacts

8.4 Bottom culture of mussels can be disturbing to certain subtidal biotopes, due to extirpation of the characteristic infaunal species from the area covered by mussels, and, in some cases, the sensitivity of characteristic species to organic enrichment, smothering and/or physical disturbance from dredging (Marine Institute, 2013).

8.5 From a review of the literature (Appendix B), the following general patterns can be identified. Mussel culture beds can increase the diversity and abundance of epibenthic fauna by providing an additional food resource for species that predate on the mussels themselves or other species that may be attracted to the mussel bed to predate on the species that are attracted to the mussel beds for refuge. This change in epibenthic fauna contrasts with a reduction in diversity of infaunal species as increased organic rich sediments deposited by the mussels changes the characteristics of the sediments beneath the culture plot (assuming that deposition rates are high; Francis O'Beirn, Marine Institute, pers. comm.). There is disagreement as to the nature of the effect of mussel beds on the abundance of other filter feeding benthic species: a positive effect, by providing an additional habitat for larvae to establish; or a negative effect, by consuming the larvae of other species that may otherwise occupy the area. In general, it appears the effects of bottom mussel culture have been found to be localised in extent but may persist in time depending on the biotic and abiotic processes operating in the area.

8.6 Increasing the density of mussels has been demonstrated to cause reduced abundance and diversity of invertebrates. This is due to complete dominance of mussels in terms of space and quite likely filtration (competitive exclusion). There is very little reference to fishes in mussel literature and speculation might lead us to assume that tightly packed mussels will result in homogeneous habitat and little provision of refugia for fishes. This scenario would be more likely to refer to natural seed beds found intertidally which would not have been subject to any erosion or stratification due to aging of the mussels in the beds and which would be uniform in terms of age and size. However, if an area comprises patches of mussels (of varying densities) among sandy/muddy habitat then this could provide sufficient complexity of habitat to support a diverse fish assemblage. This scenario is more likely to apply to cultivated mussel beds (Francis O'Beirn, Marine Institute, pers. comm.).

8.7 In Wexford Harbour, which has the most intensive development of this activity in Ireland, analysis of aerial imagery indicates that the second scenario applies to the cultivated mussel beds (Gittings and O'Donoghue, 2016c). Furthermore, the SAC assessment for Wexford Harbour (Marine Institute, 2016) states that: "*in Wexford Harbour, mussel culture practices result in a mottled distribution of mussels on the seabed forming in a heterogeneous habitat structure" and that "such a structural arrangement is likely to benefit overall system diversity*" in line with the conclusions of other studies "*that mussel reef systems (on sedimentary habitats), as found in Wexford, enhance habitat heterogeneity and species diversity at the ecosystem level*".

8.8 If the patterns of bottom mussel cultivation in Wexford Harbour are typical of the likely development of this activity in Cork Harbour, it can be concluded that bottom culture of mussels is unlikely to reduce food resources for benthic invertebrate eating, and/or fish-eating, species.

Disturbance

8.9 Subtidal bottom mussel cultivation could cause impacts to waterbirds using moderately deep, or deep, subtidal habitat, and/or using high tide shallow subtidal or shoreline roosts, through disturbance associated with husbandry activities and/or travel to/from the sites. Disturbance impacts to waterbirds using intertidal and shallow subtidal habitats at on ebb/flood tides are also possible.

8.10 Disturbance impacts can affect bird populations in two ways. If disturbance levels are intense enough, birds may completely abandon an area and the displacement impact is, therefore, analogous to habitat loss. At lower disturbance intensities, birds may continue to use an area but may suffer energetic impacts due to loss of foraging time and energy expended in evasive behaviour.

8.11 For disturbance to cause displacement impacts, the disturbance pressure will have to operate over a wide area (relative to the size of the site) and be more or less continuous. For disturbance to cause significant energetic impacts, birds must be disturbed with sufficient frequency, and/or forced to engage in energetically expensive evasive behaviour (e.g., long flights, or extended interruption of feeding). Various modelling studies have indicated that multiple disturbance events per daylight hour are required to cause impacts on wader survival rates (Goss-Custard *et al.*, 2006; West *et al.*, 2007; Durell *et al.*, 2008).

Species responses

8.12 No information is available on the responses of species associated with subtidal habitat to habitat alteration caused by bottom mussel culture. However, there is some evidence that mussel dredging activity associated with bottom mussel culture in Wexford Harbour may cause significant disturbance impacts to Red-breasted Mergansers and possibly some other species (Gittings and O'Donoghue, 2016a, 2016c). This evidence is discussed further in the relevant species accounts below.

Assessments

Red-breasted Merganser

Occurrence in the bottom mussel cultivation sites

8.13 The East Harbour zone contains suitable subtidal habitat for Red-breasted Mergansers and used to support significant numbers of mergansers. However, in recent years, only small numbers have been recorded here during the day (mean of 5% of the total I-WeBS count; 2010/11-2019/20). These birds mainly occur in the eastern part of the zone, east of Aghada Pier, or in Whitegate Bay.

8.14 Mergansers from the North Channel commute down the East Ferry Channel in the evening and a regular nocturnal roosting flock of around 20 birds occurs in the East Harbour. The main roost location is off the south-eastern shore of Great Island. However, some mergansers often initially gather to the east of Aghada Pier and then swim west towards dusk. The exact extent and position of the main roosting area has not been mapped.

Habitat impacts

8.15 Red-breasted Mergansers are fish-eating birds. In general bottom mussel cultivation is likely to either have no effect on, or increase local abundances of fish (see paragraphs 8.5-8.8). Therefore, development of bottom mussel culture in the East Harbour is not likely to have negative effects on the availability of food resources for the Red-breasted Merganser SCI of the Cork Harbour SPA.

Disturbance response of Red-breasted Merganser to marine traffic

8.16 Observations that we made during survey work in Wexford Harbour indicate that Red-breasted Mergansers can be very sensitive to disturbance from marine traffic (Gittings and O'Donoghue, 2016a, 2016c). A disturbance response was noted in 32 out of the 45 interactions between mergansers and boats that we observed, with birds being flushed on 22 occasions. The disturbance response was related to the lateral distance of the birds from the path of the boat, with 90% of observations within 250 m showing a disturbance response, compared to only 29% of the observations at distances of over 500 m from the path of the boat. Overall 84% of observations within 500 m showed a disturbance response. The birds that did show a response often flushed at long distances from the boat, with some birds flushing at distances of over 1 km, but these were mainly birds that were close to the path of the boat (i.e., the boat was heading straight towards them). While our dataset includes responses to three types of boat (a cot, small inshore potting vessels and dredgers), there was no detectable difference in the responses to these boat types (although our analysis was constrained by limited data for the disturbance response to cots at large lateral distances).

8.17 This high sensitivity is also indicated by other research into disturbance by marine traffic. In Orkney, Jarrett *et al*. (2018) classified Red-breasted Merganser as having very high sensitivity to disturbance based on observations from vantage point surveys, focal flock watches and ferry surveys. In the latter surveys, they reported mean disturbance responses of around 60% within 0-50 m, 30% within 50-100 m, and 20% within 100-300 m, of ferry routes. These are lateral distances so are directly comparable within our observations from Wexford Harbour. The apparently lower sensitivity to disturbance in Jarrett *et al*.'s study, compared to our study, may indicate habituation to predictable patterns of marine traffic along regular ferry routes. They also noted that Red-breasted Merganser appeared to be particularly sensitive to noise, often flushing when sudden loud noises were caused by ferries reversing on arrival at a pier.

8.18 Fliessbach *et al*., (2019), carried out research into disturbance by ship traffic in the German North and Baltic Seas. They reported mean escape distances for Red-breasted Merganser of 1,178 m (individuals) and 681 m (groups)[8], which were the third (individuals), or fourth (groups) highest escape distances of the 22 seabird taxa in their study. Note that these escape distances are straight line distances and are, therefore, not directly comparable with the lateral distances that we reported from Wexford Harbour.

8.19 Changes in Red-breasted Merganser distribution patterns in Cork Harbour (see paragraph 5.28) may also indicate sensitivity to disturbance from marine traffic. The areas with the largest declines (the East Harbour and the West Harbour zones) are the areas with the highest levels of marine traffic, while the North Channel (moderate decline) and the Fota Channel (no apparent decline) have very little, if any, marine traffic during the mid-winter period. Furthermore, the decline in the North Channel occurred in the late 1990s when the North Channel oyster fishery was still open, while no further decline appears to have occurred since closure of the fishery in 2002.

Assessment of potential disturbance impact to foraging Red-breasted Merganser from travel to/from the bottom mussel cultivation sites

8.20 Travel to/from the bottom mussel cultivation sites will cause potential disturbance impacts to foraging Red-breasted Merganser but will not cause long-term displacement impacts.

8.21 The most significant potential energetic impact will occur when birds are flushed by boats, as flying is energetically expensive. The energetic cost of flying in Red-breasted Mergansers has been estimated at between 60-79 J/sec (depending upon the age and sex of the bird), compared to a resting metabolic rate of around 8-11 J/sec (Platteeuw and van Eerden, 1997). The mean flight duration that we recorded for mergansers that were flushed by boats in Wexford Harbour was 86 seconds (n = 9). This would equate to an energetic cost of around 5-7 kJ. The daily energy expenditure (DEE) of Red-breasted Mergansers in two Dutch wintering populations has been estimated as ranging from around 1200-2500 kJ (but this was considered to represent extreme conditions; Platteeuw and van Eerden, 1997), while the DEE for a British wintering population of the closely-related Goosander has been estimated as ranging from 669-887 kJ (Newson and Hughes, 1998). Therefore, a single disturbance incident that results in a merganser being flushed might have an energetic cost of around 1% of its daily energy expenditure. This suggests that multiple disturbance events per bird per day would be required to cause significant energetic impacts to the Cork Harbour Red-breasted Merganser population.

8.22 We assessed the potential impact from boats travelling through the North Channel to/from the bottom mussel cultivation sites. Red-breasted Merganser do not occur in the East Ferry Channel and only occur irregularly in very low numbers during the day in the East Harbour zone. We used the observed *any disturbance response* rates from Wexford Harbour as a precautionary assumption to allow for potential site-specific variability in disturbance responses: we assumed flush rates of 90% of birds within 250 m of the boat's path, 73% within 250-500 m, and 29% within 500-1000 m. We calculated the area of foraging habitat within these distance bands from the boat's path. We included all shallow and moderately deep subtidal habitat as well as 50% of the intertidal habitat (to reflect the fact that the boat will usually be travelling at mid tide). We used the mean mid-winter (December-February) I-WeBS count for the North Channel over the last five winters to calculate the density of Red-breasted Merganser in the North Channel.

8.23 The results of these calculations indicate that, on average 11.7 Red-breasted Merganser would be flushed during a single trip during the peak seasonal occurrence period of Red-breasted

[8] The difference between the two parameters is that the individual mean counts escape distances for each individual in a group separately, while the group mean only counts a single escape distance for each group.

Merganser in Cork Harbour (Table 8.1), or 23.4 Red-breasted Merganser per fishing day (as there would be two trips each fishing day). This amounts to around 45% of the total Cork Harbour population. As multiple disturbance events per bird per day are likely to be required to cause significant energetic impact, the scale of this potential impact, even if it happened every day, is below the level that would be required for a significant impact.

Table 8.1 – Calculations of number of mean number of Red-breasted Merganser likely to be flushed during a single boat trip from the mooring in the North Channel to the start of the East Ferry Channel.

Section	Buffer	Habitat area (ha)	Birds flushed
North Channel	0-250 m	118	6.1
	250-500 m	61	2.6
	500-1000 m	173	2.9

See text for details of calculation method and assumptions.

Assessment of potential displacement impact to foraging Red-breasted Merganser from fishing activity in the bottom mussel cultivation sites

8.24 Fishing activity in the mussel plots in the bottom mussel cultivation sites will caused sustained disturbance impacts and could result in displacement of Red-breasted Merganser from the area around the plot being fished. However, the mean Red-breasted Merganser mid-winter count in the East Harbour (excluding Whitegate Bay) over the last five winters is 1.4, which represents around 2.8% of the Cork Harbour population. Therefore, given that fishing will only take place on 4-5 days per month, it is clear that any potential displacement impacts to Red-breasted Merganser will not be significant.

Assessment of disturbance impacts to roosts

8.25 Mussel fishing will not take place at night. However, based on an eight hour fishing day with 37-52 minutes travel time each way to/from the North Channel mooring, all fishing days in November-January would involve fishing activity/travel close to dawn and dusk. Depending on the timing of the high tide, fishing days in September-October and February-March could also involve fishing activity/travel close to dawn and/or dusk.

8.26 While few Red-breasted Merganser occur during the day in the East Harbour, significant numbers of Red-breasted Merganser regularly commute to the East Harbour from the North Channel to roost. The East Harbour roost is occupied from around 30-60 minutes before sunset and probably holds 25-33% of the Cork Harbour population. The main roosting area appears to be located off the south-eastern shore of Great Island, but the exact location and extent of this area has not been mapped. As we have only observed the roost from viewpoints on the southern shore, it is not clear how close the roosting area is to the Great Island shoreline, although the mergansers generally appear to roost closer to the shoreline than the Great Crested Grebes. Some, or all of the mergansers often initially assemble to the east of Aghada Pier, before swimming west towards the roosting area as dusk approaches. Therefore, most routes from plots within the bottom mussel cultivation sites to the mouth of the East Ferry Channel may involve travel towards merganser flocks.

8.27 Some Red-breasted Merganser may remain in the North Channel at night, roosting in the bay next to Ballintubbrid. The boat route to the mooring site in the North Channel will pass the roost, with the distance from the roost depending on the exact route taken by the boat. However, as the boat turns out of the East Ferry Channel into the North Channel it may be perceived by the mergansers as heading directly towards the roost.

8.28 As mergansers are very sensitive to marine activity, it is likely that any travel in the general direction of the merganser flocks would flush the birds, and may cause them to abandon the roost for the night. It is also possible that birds will be flushed twice: i.e., if birds flushed from the East Harbour roost move to the North Channel roost and then are flushed again when the boat passes that roost. However, it is also possible that birds flushed from the East Harbour roost may settle on open water further west and then return to the roost after the boat has passed.

8.29 The energetic impact of disturbance to roosting Red-breasted Merganser may be greater than disturbance to foraging birds as birds may have to fly further to alternative roost sites, and may also be more agitated resulting in longer flight durations. However, as fishing will only take place on 4-5 days per month, it seems unlikely that the energetic impact would be significant at a population scale, although energetic impacts on a sequence of four or five consecutive nights could potentially by more significant if birds are already energetically stressed.

Cormorant

Occurrence in the bottom mussel cultivation sites

8.30 Feeding Cormorants are widely distributed across subtidal habitat throughout Cork Harbour and appear to occur at more or less uniform densities (see paragraph 5.31). The bottom mussel cultivation sites contain around 5% of the total extent of Cormorant habitat within Cork Harbour, so they would be expected to support around 5% of the Cormorant population. There are five mapped Cormorant day roosts along the shorelines around the bottom mussel cultivation sites and these support around 10% of the estimated Cormorant day roost capacity in Cork Harbour. However, some birds that forage in the waters around the bottom mussel cultivation sites may commute to more distant daytime roosts (e.g., on Spike Island or on the Spitbank Lighthouse). Nocturnal Cormorant roosts occur at Siddon's Tower next to the eastern edge of Site B, and (in recent winters) on the ESB platform to the west of the south-western edge of Site B. These support around 9% of the Cork Harbour population but, again, some birds that feed in the in the waters around the bottom mussel cultivation sites during the day may commute to other nocturnal roosts.

Impact to Cormorant foraging habitat

8.31 Cormorant are fish-eating birds. In general bottom mussel cultivation is likely to either have no effect on, or increase local abundances of fish (see paragraphs 8.5-8.8). Therefore, development of bottom mussel culture in Sites A and B is not likely to have negative effects on the availability of food resources for the Cork Harbour Cormorant population.

Disturbance impact to foraging birds from travel to/from the bottom mussel cultivation sites

8.32 In Cork Harbour, we observed disturbance responses from Cormorant on 8-15% of occasions during 102 observations of interactions with shipping at Roches Point, including 19-30% of observations involving lateral response distances of up to 200 m[9]. These disturbance responses mainly involved birds flushing and flying out of the area. These observations mainly involved large commercial vessels travelling at speeds of around 10 knots. In Wexford Harbour, Cormorants appeared to be relatively tolerant of disturbance by marine traffic in Wexford Harbour (Gittings and

[9] The ranges are from observation classified as confirmed disturbance responses (based on the behaviour of the bird) to all observations with a possible disturbance responses. The latter are likely to include coincidental movements which were not disturbance responses.

O'Donoghue, 2016c). We observed numerous instances of boats travelling past Cormorants within a few hundred metres without any discernible response from the birds.

8.33 To assess the potential impact from boats travelling to/from the bottom mussel cultivation sites, we assumed that all Cormorant within 50 m of the boat's path would be flushed, and that 30% of Cormorant within 50-200 m would also be flushed, with the latter representing the maximum observed disturbance response from Cormorant at Roches Point. We then calculated the area of Cormorant foraging habitat within these distance bands from the boat's path. We included all subtidal habitat as well as 50% of the intertidal habitat (to reflect the fact that the boat will usually be travelling at mid tide). The analysis of the WSP count data suggests that feeding Cormorant occur at more or less uniform densities across Cork Harbour. The densities of foraging Cormorant recorded in the WSP counts across Cork Harbour ranged from 1.2-2.8 birds/km^2, while inference from Cormorant roost counts using time budget data from literature sources suggest a mean density of feeding Cormorant in Cork Harbour during the peak months (October-December) of 1.2-3.1 birds/km^2. Based on this we used a precautionary density figure of 4.0 birds/km^2 to estimate the number of feeding Cormorant likely to be encountered during a single boat trip.

8.34 The results of these calculations indicate that, on average 4.7 Cormorant would be flushed during a single trip during the peak seasonal occurrence period (September-November) of Cormorant in Cork Harbour (Table 8.2), or 9.4 Cormorant per fishing day (as there would be two trips each fishing day). This amounts to less than 2% of the total Cormorant population of Cork Harbour, as represented by the mean roost count in Table 5.4. On days when more than one plot was being fished or inspected, some additional Cormorant would be flushed by the boat moving between the plots but the numbers involved would be small as the mean length of journeys between plots ranges from 0.7 km (95% CI 0.65-0.73 km) for journeys between separate channel plots in Site B to 2.7 km (95% CI 2.6-2.8 km) for journeys between a plot in Site A and a channel plot in Site B (see paragraph 8.3 for details about how the plots were defined). These distances are much shorter than the 6.4-8.9 km journey to/from the North Channel. At other times of the year, smaller numbers of Cormorant would be flushed but the numbers flushed would remain the same percentage of the total Cork Harbour population (if the assumptions used in these calculations hold). Multiple disturbance events per day are likely to be required to cause significant energetic impacts, the scale of this potential impact, even if it happened every day, is orders of magnitude lower than the level that would be required for a significant impact.

Table 8.2 – Calculations of number of mean number of Cormorant likely to be flushed during a single boat trip from the mooring in the North Channel to the most distant plot in the East Harbour.

Section	Buffer	Habitat area	Birds flushed
North Channel	0-50 m	31	0.9
	50-200 m	85	0.8
East Ferry Channel	0-50 m	26	0.8
	50-200 m	39	0.4
East Harbour	0-50 m	32	1.0
	50-200 m	96	0.9
All	0-50 m	89	2.7
	50-200 m	73	2.0

See text for details of calculation method and assumptions.

8.35 The above assessment is based on the typical widely dispersed distribution pattern of Cormorant. However, large rafts of feeding Cormorant can occur in Cork Harbour. These mainly seem to occur on fast running tides over deep water channels. There has been no systematic survey or mapping of these rafts, but they appear to be of very rare occurrence in the East Harbour. However, they may be of quite regular occurrence in the deep water channel where the North

Channel turns into the East Ferry Channel. This is directly on the boat route. If a raft of 100 birds was flushed from this location on every trip, this would represent a daily impact of 0.4 flushes/bird to the Cork Harbour population on fishing days and a monthly impact of less than 0.1 flushes/bird to the Cork Harbour population. Therefore, even under this unrealistic worst-case scenario the likely impact level would be well below the level likely to cause energetic impacts to the Cork Harbour population.

Disturbance impact to foraging birds from fishing activity in the bottom mussel cultivation sites

8.36 Sustained fishing activity in one location is likely to cause complete exclusion of Cormorant from the area around the fishing activity and may affect birds over a wider area than a single passage of a boat. However, the spatial scale of this impact is difficult to assess. In Wexford Harbour, we observed foraging Cormorant within 400-500 m of mussel dredging. In Cork Harbour we have observed, foraging Cormorant within a few hundred metres of potting vessels.

8.37 For this assessment, we assessed two scenarios: one using a displacement distance of 200 m, based on the observed maximum response distance of Cormorant to vessel movements in Cork Harbour; and one using a precautionary doubling of this distance to 400 m. We calculated the areas of Cormorant foraging habitat in 200 m and 400 m buffers around each plot (see paragraph 8.3 for details about how the plots were defined). We included all subtidal habitat as well as all the intertidal habitat (to reflect the fact that fishing will take place around high tide). We then calculated the percentages that these habitat areas represent of the total area of Cormorant foraging habitat in Cork Harbour. This represents the percentage of foraging Cormorant likely to be displaced, assuming that foraging Cormorant occur at more or less uniform density throughout Cork Harbour (see paragraph 5.31). The results of these calculations indicate that, with a 200 m displacement distance, fishing activity would be likely to displace less than 1% of the foraging Cormorant within the SPA, while with a 400 m displacement distance the figure would rise to around 1.5% (Table 8.3). As fishing will only take place of 4-5 days per month, the mean displacement impact across the month would be around 0.1-0.2%. Therefore, mussel fishing activity is not likely to cause significant displacement of foraging Cormorant.

Table 8.3 – Calculations of potential displacement impacts to Cormorant from fishing activity in the aquaculture sites.

Buffer	Location	Habitat affected	
		Habitat area (ha) (95% confidence intervals)	% of Cork Harbour
200 m	Site A	35.5 (34.6-36.3)	0.6%
	Site B (channel)	36.1 (35.9-36.3)	0.6%
	Site B (oyster bed)	36.5 (35.6-37.3)	0.6%
400 m	Site A	84.9 (80.9-89.0)	1.4%
	Site B (channel)	91.9 (91.2-92.6)	1.5%
	Site B (oyster bed)	90.5 (86.0-95.0)	1.5%

See text for details of calculation method and assumptions.

Disturbance impact to Cormorant day roosts

8.38 Chatwin *et al.* (2013) reported the probability of agitation due to approach by motorboats and kayaks for roosting Double-Crested Cormorant on Vancouver Island ranging from 2.5% at a distance of 70 m to 15% at a distance of 30 m. In Wexford Harbour, Cormorants roosting on the training walls along the navigation channel generally showed no disturbance response to marine traffic (Gittings and O'Donoghue, 2016c). In Cork Harbour, Cormorants roosting on the Cow Rock at Roches Point appear to tolerate kayaks and small boats passing within 50-100 m on the outer side of the rock but will flush at a distance of around 50 m if a kayak passes along the narrow channel between the rock and the headland. During a boat survey in Cork Harbour covering most of the East Harbour, West Harbour and Inner Harbour zones in August 2016 (using a small cabin cruiser), birds flushed from all the Cormorant day roosts that we passed, usually at distances of around 50-100 m. The variations in the responses in the above locations may reflect differences in habituation to vessel activity. As mussel fishing activity is unlikely to be sufficiently predictable for birds to develop high levels of habituation, fishing close to the roost sites is likely to flush the roosting birds.

8.39 There are five regularly used Cormorant day roosts in the vicinity of the bottom mussel cultivation sites (Figure 8.2). Three of these are more than 300 m from the nearest section of the sites (Table 8.4). The other two are within 150-190 m of the nearest sections of the sites, but 270-450 m from the nearest section of permanent subtidal in the sites (Table 8.4). As the mussel fishing activity will only occur in the permanent subtidal habitat, these distances mean that no disturbance impacts from fishing activity to Cormorant day roosts are likely to occur.

Table 8.4 – Distances from the bottom mussel cultivation sites to Cormorant day roosts.

Site	Map reference	Roost	Distance (m) from nearest section	
			of site	permanent subtidal in site
Site A	D1	Cuskinny Bay (D1)	500	500
Site B	D2	ESB platform	500	500
Site B	D3	Old Pier	310	310
Site B	D4	Rostellan rocks	190	270
Site B	D5	Saleen lagoon	150	450

See Figure 8.2 for location of roosts.

8.40 The regularly used Cormorant day roosts in the North Channel occur along the northern shore (Figure 8.2). The boat route will only pass two of these roosts, and while the exact distance will depend on the exact route of the boat it is likely to be greater than 250 m. Therefore, disturbance impacts to these Cormorant day roosts are not likely to occur.

Disturbance impact to Cormorant night roosts

8.41 There does not appear to be any information in the literature on the potential disturbance impact from marine traffic to Cormorants roosting in trees at night. However, as some birds in the night roosts occur in branches low down over the water, it is likely that vessel activity close to the roost would flush at least some of the birds. In the Owenboy Estuary, kayaking activity has been observed to cause abandonment of the Drake's Pool roost site.

8.42 The Siddon's Tower roost is adjacent to Site B, while the Bagwell's Hill roosts are close to the boat route as it passes round the northern end of the East Ferry Channel (Figure 8.2). These roosts are not normally occupied during the day but the build-up of the night roost can begin from more than 100 minutes before dusk (Text Figure 8.1). Therefore, fishing activity close to dusk could cause disturbance of these roosts. Based on an eight hour fishing day with 37-52 minutes travel time each way to/from the North Channel mooring, all fishing days in November-January would involve fishing activity/travel close to dawn and dusk. Depending on the timing of the high tide, fishing days in September-October and February-March could also involve fishing activity/travel close to dawn and/or dusk.

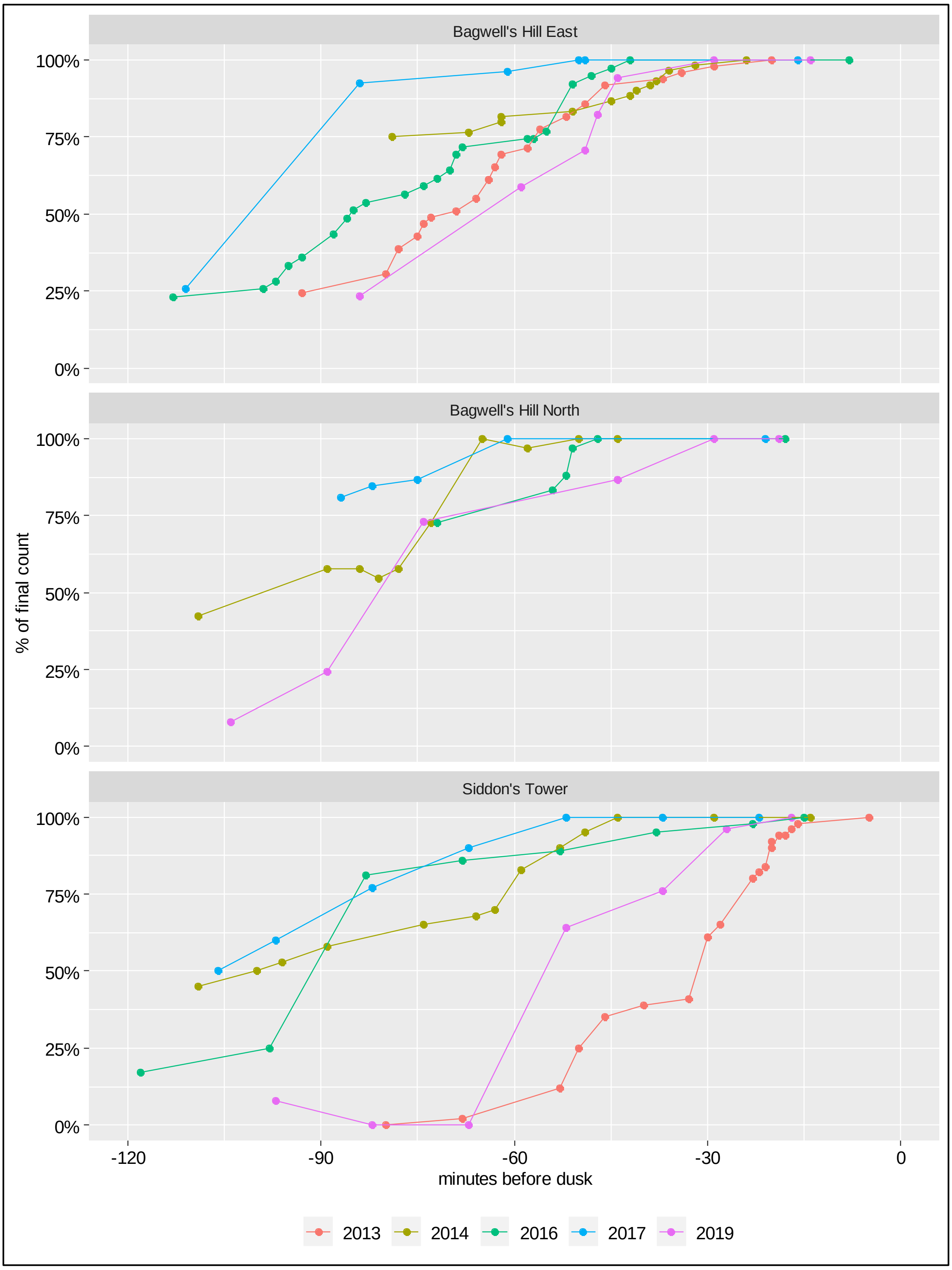
8.43 The Siddon's Tower and Bagwell's Hill roosts are within around 200 m of the bottom mussel cultivation sites or boat route (Table 8.5). There is no data available on the distances over which Cormorant are disturbed from night roosts by boat traffic. However, given the sensitivity of night roosts, and the fact that these roosts all occur in areas where there is very little boat traffic in winter, we consider that there is a significant risk that some disturbance impacts will occur to these roosts from boat traffic at these distances. Impacts to the Siddon's Tower roost would only occur if a plot is located at the eastern end of Site B and could be managed by restricting the timing of fishing activity in this plot. However, impacts to the Bagwell's Hill roosts could occur on every fishing day in mid-winter. Disturbance could also occur on the morning trip to the bottom mussel cultivation sites, although the impact would presumably be lower as the birds would soon be departing the roost anyway.

8.44 The nearest alternative night roost sites to Bagwell's Hill are the Siddon's Tower roost, around 3.8-4.9 km away, the ESB Platform roost around 5.3-6.3 km away (although this may have limited capacity), and the Fota Island roost around 7.2-8.3 km away. The typical speed of a flying Cormorant is 15.2 m/sec (Alerstam *et al.*, 2007), so these flight would take around 4-9 minutes. Based on the figures in Gremillet *et al.* (2003), a 2-5% increase in daily food consumption would be required to offset the additional energy expenditure involved in flights of these lengths. However, birds disturbed from the roost would be unlikely to fly directly to the alternative roost site, but would, instead, probably circle around several times before departing, while there may also be additional flight time required the following morning. Also, if there is a mass departure, there may not be spare capacity at the alternative roosts to accommodate all the birds displaced from the Bagwell's Hill roosts: it is common to observe during roost counts birds circling around several times before finding a suitable perch to roost on with, occasionally, birds departing without settling at the roost. Therefore, the actual impact of disturbance to the Bagwell's Hill roosts could require a significantly greater than 2-5% increase in daily food consumption. The sequencing of the fishing days may also affect the significance of the disturbance impact. Four or five trips consecutive fishing days could result in cumulative energetic impacts if the birds are already stressed and could cause a longer term abandonment of the roosts than the same number of fishing days spread out across the course of a month.

Table 8.5 – Cormorant night roosts.

Site/route	Map reference	Roost	Distance (m) from nearest section:	
			of the site/route	permanent subtidal in site/ along route
Site B	N1	Siddon's Tower	0	150
	N2	Rostellan Lake	390	750
	N3	ESB Platform	500	500
Boat route	N3	Bagwell's Hill East	120	120
	N4	Bagwell's Hill North	200	200

See Figure 8.2 for location of roosts. Distances to the Bagwell's Hill roosts are based on the indicative mapped boat route, which follows the mid channel along the East Ferry Channel and then takes a straight line to the mooring through the North Channel. The actual route taken may be closer to, or farther away from, the roosts.



Text Figure 8.1 – Build-up pattern of the Siddon's Tower and Bagwell's Hill Cormorant nocturnal roosts.

Great Crested Grebe

Occurrence in the bottom mussel cultivation sites

8.45 The East Harbour zone has traditionally been the most important part of the harbour for Great Crested Grebes. During the grebe roost study in 2014/15-2016/17, it supported around half of the total population within the harbour, although in recent winters there appears to have been a shift to the West Harbour. The grebes disperse widely during the day to feed, but assemble at night into communal roosts in specific areas within the East Harbour zone. These roosts may also be occupied irregularly during the day.

8.46 The bottom mussel cultivation sites holds around 20% of the grebe habitat within the East Harbour zone. However, a large part of the western half of Site B is occupied by deep subtidal habitat, which is too deep for feeding grebes. The two principal grebe roosts in the East Harbour zone occur within the aquaculture site: in the open water off Aghada Pier (mainly occupied in the early part of the winter); and in the open water around the Fair Rock (mainly occupied in mid and late winter). These roosting areas were mapped by triangulation from the shoreline, so the general positions are reasonably accurate although the mapped extent of each area is approximate (see Gittings, 2017).

Disturbance impact to foraging birds from travel to/from the bottom mussel cultivation sites

8.47 Foraging Great Crested Grebes appear to be generally very tolerant of vessel activity. In Wexford Harbour, we observed numerous instances of boats travelling past foraging grebes within a few hundred metres without any discernible response from the grebes, although we did observe one instance of feeding grebes flushed by a boat when the boat drove through an area with grebes directly in its path (Gittings and O'Donoghue, 2016c). In Cork Harbour, we have also observed occasional instances of Great Crested Grebe being flushed, or swimming away, when directly in the path of an approaching boat. While we do not have quantitative data on disturbance responses, based on these observations, we consider that most birds directly in the path of the boat will flush, or swim away, and a proportion of birds up to 100-200 m away will also flush, or swim away. Therefore, the disturbance response for Cormorant seems a reasonable scenario to apply to Great Crested Grebe as well: all Great Crested Grebe within 50 m of the boat's path would be flushed and 30% of Great Crested Grebe within 50-200 m would also be flushed, or swim away.

8.48 The East Harbour has traditionally been considered to hold the major concentration of wintering Great Crested Grebe. In roost count study carried out in 2014/15-2016/17, the East Harbour held a mean of 53% of the total Cork Harbour population (see Table 5.5). While in more recent winters there appears to have been a shift in distribution to the West Harbour, for this assessment we have used the figure of 53% to represent the likely distribution of Great Crested Grebe in the East Harbour. We used the mean of coordinated February roost counts (203 birds) to represent the total Cork Harbour population (although this is purely for illustrative purposes as the percentage impact will remain the same whatever figure is used). We assumed that all birds were foraging. Roosting flocks can occur during the day, but are of irregular occurrence.

8.49 We then calculated the area of Great Crested Grebe foraging habitat within the relevant distance bands from the boat's path. We included all shallow and moderately deep subtidal habitat as well as 50% of the intertidal habitat (to reflect the fact that the boat will usually be travelling at mid tide).

8.50 The results of these calculations indicate that, on average 8.2 Great Crested Grebe would be flushed during a single trip during the peak seasonal occurrence period of Great Crested Grebe in

Cork Harbour (Table 8.2), or 16.4 Great Crested Grebe per fishing day (as there would be two trips each fishing day). This amounts to around 16% of the total Great Crested Grebe population of Cork Harbour, as represented by the mean roost count in Table 5.7. On days when more than one plot was being fished or inspected, some additional Great Crested Grebe would be flushed by the boat moving between the plots. The mean length of journeys between plots ranges from 0.7 km (95% CI 0.65-0.73 km) for journeys between separate channel plots in Site B to 2.7 km (95% CI 2.6-2.8 km) for journeys between a plot in Site A and a channel plot in Site B (see paragraph 8.3 for details about how the plots were defined). This compares with the 3.8-6.3 km journey to/from the North Channel (excluding the East Ferry Channel). Therefore, the birds flushed would represent a less than doubling of the impact in Table 5.7. At other times of the year, smaller numbers of Great Crested Grebe would be flushed but the numbers flushed would remain the same percentage of the total Cork Harbour population (if the assumptions used in these calculations hold). As multiple disturbance events per bird per day are likely to be required to cause significant energetic impacts, the scale of this potential impact, even if it happened every day, is at least an order of magnitude lower than the level that would be required for a significant impact.

Table 8.6 – Calculations of number of mean number of Great Crested Grebe likely to be flushed during a single boat trip from the mooring in the North Channel to the most distant plot in the East Harbour.

Section	Buffer	Habitat area (ha)	Grebe density (birds/km^2)	Birds flushed
North Channel	0-50 m	27	4.4	1.2
	50-200 m	72	4.4	0.9
East Harbour	0-50 m	29	11.1	3.2
	50-200 m	86	11.1	2.9
All	0-50 m	56	-	4.4
	50-200 m	158	-	3.8

See text for details of calculation method and assumptions.

Disturbance impact to foraging birds from fishing activity in the bottom mussel cultivation sites

8.51 While foraging Great Crested Grebes appear to be generally very tolerant of vessel movements, they may be more sensitive to sustained activity in one location. In Wexford Harbour, across 11 hours 45 minutes of watching boats dredging or fishing for starfish, we only made two observations of grebes within around 500 m from the boats (Gittings and O'Donoghue, 2016c). On subsequent visits to Wexford Harbour on days when no fishing activity was taking place, we have seen concentrations of Great Crested Grebe in the same areas. Therefore, while Great Crested Grebes appear to be able to tolerate close approach while the boats are travelling to/from mussel plots, it is possible that sustained dredging/fishing activity in one area may cause exclusion of grebes from within a few 100 m of the dredging/fishing activity.

8.52 Based on the above observations, we consider the displacement scenarios assessed for Cormorant (see paragraph 8.33) to provide a reasonable approach for assessing potential displacement impacts to Great Crested Grebe. These scenarios assume complete displacement within buffers of 200 m, and 400 m, around the plot being fished. We calculated the areas of Great Crested Grebe foraging habitat in 200 m and 400 m buffers around each plot (see paragraph 8.3 for details about how the plots were defined). We included intertidal, shallow subtidal and moderately deep subtidal habitat in the calculations (the intertidal habitat was included because the fishing will take place around high tide, while Great Crested Grebe do not feed in deep subtidal habitat). We then calculated the percentage that these habitat areas represent of the total area of Great Crested Grebe foraging habitat in the East Harbour grebe sector and multiplied by the estimated mid-winter population of this sector (mean of coordinated roost counts in Table 5.7 multiplied by the mean percentage in the East Harbour sector from Table 5.6). The results of these calculations indicate that, with a 200 m displacement distance, fishing activity would be likely to displace 2-3 grebes, which would represent around 1-2% of the mid-winter Cork Harbour Great Crested Grebe population, while with a 400 m displacement distance the figure would rise to 8-9 grebes, representing around 4% of the mid-winter Cork Harbour Great Crested Grebe population (Table 8.3). As fishing will only take place on 4-5 days per month, the mean displacement impact across the month would be around 0.2-0.8%.

Table 8.7 – Calculations of potential displacement impacts to Great Crested Grebe from fishing activity in the bottom mussel cultivation sites.

Buffer	Location	Grebe habitat affected		Grebe displacement	
		Habitat area (ha) (95% CI)	% of East Harbour sector	birds displaced	% of Cork Harbour population
200 m	Site A	35.5 (34.6-36.3)	3.1%	3.3	1.6%
	Site B (channel)	20 (17.3-22.7)	1.7%	1.9	0.9%
	Site B (oyster bed)	35.4 (33.7-37.1)	3.1%	3.3	1.6%
400 m	Site A	84.9 (80.9-89.0)	7.4%	8.0	3.9%
	Site B (channel)	91.9 (91.2-92.6)	8.0%	8.6	4.3%
	Site B (oyster bed)	90.5 (86.0-95.0)	7.9%	8.5	4.2%

See text for details of calculation method and assumptions.

Disturbance impacts (roosting birds)

8.53 Great Crested Grebe roosting flocks appear to be much more sensitive to disturbance than birds foraging individually. We have observed ten instances of flocks being apparently disturbed by vessel activity in Cork Harbour (Table 8.8). These mainly occurred when boats were heading on routes that would pass within a few hundred metres of the roosting flock and the birds could respond at distances of more than 1.5 km from the boat. The disturbance caused the roosting flocks to break up, with birds swimming rapidly away looking alert and looking around behind them, and with some birds diving and/or flapping their wings. Usually the grebes swam into the shore. We also observed a few instances of flocks breaking up and birds dispersing when there was no obvious disturbance source, which may be analogous to the way that roosting flocks of waders can “spook” for no apparent reason. However, we have also observed four incidences of boats passing within around 500 m of roosting flocks without any apparent disturbance response.

8.54 The typical response of roosting grebes to disturbance is for the flock to break up with birds dispersing into the shore, and the roosting flock appears to be able to reassemble within a relatively short period of time (Table 8.8). Therefore, occasional disturbances are unlikely to cause abandonment of the roost. However, sustained disturbance (e.g. regular evening/night fishing) might have a more long-term impact. The Lough Mahon roosting area may be particularly vulnerable to disturbance impacts as it is often used during the day.

8.55 The reason why grebes roost communally at night, and the significance of the particular areas that they choose, is not known. It is possible that the birds select areas in relation to factors such as tidal-related currents: e.g., the grebes could choose areas with relatively slack tidal currents. If this is the case, disturbance by mussel fishing activity could displace birds into less favourable roosting locations. Any disturbance by mussel fishing activity would be limited to a short period of time at the start of the roosting period as there will not be any significant amount of mussel fishing activity after it gets dark. Therefore, such disturbance may not have significant effects on the use of the roosts. However, it is possible that repeated disturbance close to dusk could disrupt their behaviour patterns and cause abandonment of the roosts.

8.56 Grebes will also incur an energetic cost in responding to disturbance of their roosts as this will cause additional swimming activity. The East Harbour roosts can hold around half of the Cork Harbour Great Crested Grebe population. Therefore, frequent disturbance of the East Harbour roosts could result in significant negative impacts to the Cork Harbour Great Crested Grebe population, if birds are energetically stressed and/or of food resources are limited.

8.57 The night roosts generally build up from around two hours before dusk (Text Figure 8.2) but appear to disperse rapidly shortly after dawn (Gittings, 2017). The roosts may also be occupied during the day, but usually by smaller numbers of birds. Therefore any evening/night fishing or boat movement is likely to cause disturbance to the roosts, while daytime fishing may also cause some disturbance. All fishing days in November-January would involve fishing activity/travel close to dawn and dusk. Depending on the timing of the high tide, fishing days in September-October and February-March could also involve fishing activity/travel close to dawn and/or dusk.

8.58 The bottom mussel cultivation sites partly overlap two of the Great Crested Grebe roosts in the East Harbour sector (Figure 8.3). Of these, the E2 roost is the main roost used at the start of the season, with birds gradually switching to the E1 roost as the winter progresses (Text Figure 8.3). The boat route also passes close to the main North Channel roost. The potential disturbance impact may depend more on the direction of the boat movement, rather than its distance from the roost. For instance a route from a plot at the western end of Site B could cause a disturbance impact to roost E2 if the birds perceive the boat as heading in their direction, even if the boat turned away towards the East Ferry Channel before reaching the roost (Figure 8.3); this is analogous to the observation on 07/01/2017 (Table 8.8).

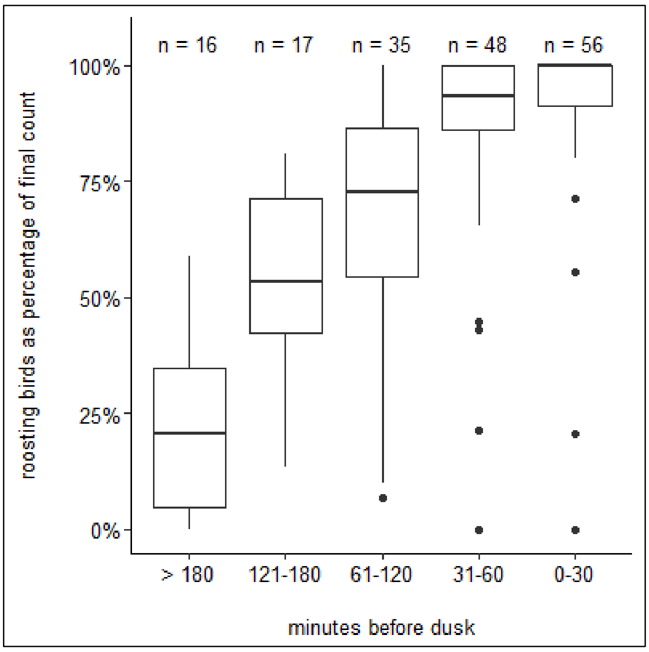
8.59 Roost E2 is likely to be particularly vulnerable to disturbance impacts, as boat routes from most of the plots in Site B could involve travel in the direction of the roost. However, this roost is mainly occupied in the early part of the winter (October/November; Text Figure 8.3) so the overlap between high usage of this roost and potential disturbance impacts from fishing activity/boat movements close to dusk will be reduced. Roost N1 may also be vulnerable to disturbance impacts as the boat may be perceived as heading towards the roost as it turns into the North Channel from the East Ferry Channel. However, this roost only holds a small proportion of the Cork Harbour population. Roost E1 is likely to be less vulnerable to disturbance impacts as most possible boat movements in the evening will not involve travel in the direction of the roost.

8.60 As the roosts cover large areas of open water, in contrast to the very localised nature of the Cormorant night roosts, it seems unlikely that the relatively low frequency of the potential disturbance (4-5 nights per month, at most) would cause significant long-term impacts. However, it is possible that four or five trips consecutive fishing days could result in cumulative energetic impacts if the birds are already stressed and could cause a longer term abandonment of the roosts than the same number of fishing days spread out across the course of a month.

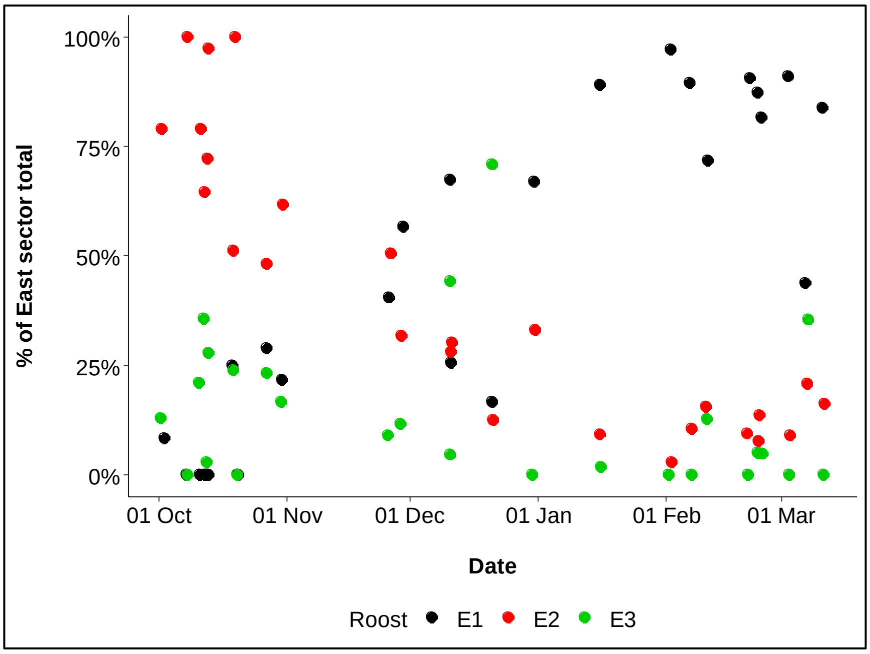
Table 8.8 - Observations of disturbance to Great Crested Grebe roosting flocks by vessel activity In Cork Harbour.

Date	Time	Location	Vessel type	Flock size	Disturbance response
03/10/2015	19:41	Inner Harbour	Large ship	28	Flock close to navigation channel, broke up and swam into shore as ship approached.
12/10/2015	18:56	East Harbour	RIB	54	Flock reacted to noise of boat when boat was over 1 km from flock and not visible to flock. Flock scattered with birds swimming rapidly away.
31/10/2015	15:50	East Harbour	RIB	24	Flock broke up and swam into shore.
31/10/2015	17:27	East Harbour	Cabin cruiser	68	Flock broke up and swam into shore. The flock then gradually re-coalesced over a period of 10-20 minutes.
13/02/2016	16:37	West Harbour	Inshore potting vessel	13	Flock broke up and swam into shore when boat was over 1.5 km from flock. The flock then re-coalesced over a period of 20 minutes.
28/02/2016	15:10	Inner Harbour	Currach	9	Flock close to navigation channel disturbed by rowers and flew in towards the Little Island shore.
19/11/2016	14:45	Inner Harbour	Small ship	24	Flock close to navigation channel broke up and swam in towards another flock which was further away from the navigation channel.
19/11/2016	15:45	Inner Harbour	Trawler	35	Flock some distance from the navigation channel reacted to passage of vessel by becoming alert and swimming around, and a few diving, but flock not breaking up.
19/11/2016	16:40	Inner Harbour	Small ship and trawler	40	Flock close to navigation channel broke up broke up and became widely dispersed with the flock not reforming in the next 35 minutes before dusk.
07/01/2017	16:40	West Harbour	Small boat	23	Flock began spreading out and some diving when hit by wake of boat going into Crosshaven.

Adapted from Gittings (2017).



Text Figure 8.2 – Boxplot showing build-up of dusk roosts of Great Crested Grebes, as percentages of roosting birds in dusk roost locations in five time periods relative to dusk. Data is only included from counts where a final count was taken in the 0-30 minutes before dusk time period and another count was taken in at least one other time period. Adapted from Gittings (2017).



Text Figure 8.3 – Occupancy of the three roost sites in the East sector of Cork Harbour. Combined data from 2014/15-2016/17; only includes dates with total counts of 35 or more grebes. Adapted from Gittings (2017).

Dabbling ducks

8.61 Five of the six dabbling duck SCI species regularly occur within the East Harbour zone (Table 8.9). The sixth species (Pintail) only occurs very occasionally (five records of 1-3 birds during I-WeBS counts; 2011/12-2017/18). The Saleen subsite generally holds the largest high tide numbers of dabbling ducks in the East Harbour zone (Table 8.10) and these ducks mainly roost in the creek. However, some Mallard and, occasionally, Wigeon roost in the open water outside the creek (SA1; Figure 8.4), while small Wigeon roosts also occur around the rocks opposite Rostellan village (AG1; Figure 8.4), and next to the ESB Generating Station (AG2; Figure 8.4). At low tide, the Shelduck and Teal mainly remain within the creek, while the Wigeon and Mallard move out to the shallow subtidal habitat outside the creek extending into the Aghada subsite.

Table 8.9 – Mean percentages of the total Cork Harbour count recorded in the East Harbour zone during the I-WeBS counts and the WSP low tide counts, and percentage of total Cork Harbour high tide roost capacity occurring within the East Harbour zone.

Species	I-WeBS	WSP	Roost capacity
Shelduck	5% (3-7%)	14%	5%
Wigeon	11% (9-14%)	15%	5%
Teal	11% (9-12%)	14%	4%
Mallard	31% (26-36%)	27%	21%
Pintail	9% (0-24%)	0%	-
Shoveler	47% (27-67%)	60%	-

I-WeBS data from 2011/12-2017/18. 95% confidence intervals for the I-WeBS percentages are shown in parentheses. The WSP analyses exclude data from the Outer Harbour zone.

Table 8.10 – Mean high tide I-WeBS counts in the four subsites of the East Harbour zone, 2011/12-2017/18.

Species	Months	Saleen	Rostellan Lake	Aghada	Whitegate
Shelduck	Dec-Feb	17 (12-22)	0	0	32 (13-51)
Wigeon	Dec-Feb	65 (45-84)	8 (2-15)	32 (13-51)	14 (7-22)
Teal	Dec-Feb	104 (81-127)	6 (0-12)	3 (0-8)	1 (0-2)
Mallard	Sep-Jan	33 (21-45)	11 (3-19)	3 (1-4)	25 (16-33)
Shoveler	Nov-Feb	1 (0-2)	1 (0-3)	1 (0-2)	3 (1-5)

Months included in the analyses represent the period of peak occurrence of the species in Cork Harbour. Sample sizes: Dec-Feb = 19; Sep-Jan = 30; Nov-Feb = 27; 95% confidence intervals for the mean counts are shown in parentheses.

8.62 The distances of the open water duck roosts that are occupied by SCI species along the shorelines around the aquaculture sites from the nearest sections of the aquaculture sites are shown in Table 8.11. The roost on the shoreline to the east of Aghada Generating Station (AG2) is too far from the nearest section of Site B for any disturbance effects to be likely, but the other two roosts are within potential disturbance zones from fishing activity in Site B. The roost in the outer part of Saleen Creek (SA1) overlaps Site B and extends out to near the edge of the permanent subtidal zone. This roost holds around 13% of the East Harbour roost capacity for Wigeon, and around 8% of the East Harbour roost capacity for Mallard. Fishing activity in the northern section of Site B would be likely to cause disturbance to this roost. The roost around the rocks opposite Rostellan village (AG1) is around 170 m from the nearest permanent subtidal habitat within in Site B. This is probably within the distance where disturbance effects are possible but not certain. This roost holds around 12% of the East Harbour roost capacity for Wigeon.

8.63 The East Harbour zone holds around 5% of the calculated Wigeon roost capacity, and 21% of the calculated Mallard roost capacity, in Cork Harbour, but 11-15% of the Cork Harbour Wigeon population, and 27-31% of the Cork Harbour Mallard population, based on the count data. These discrepancies probably reflect the approximations involved in the calculations of the roost capacity. Given the scale of the plots, fishing activity on most days could only affect one of the roosts (as the plan is, on most days, to fish a single plot). Therefore, the maximum potential disturbance impacts would affect around 2% of the Cork Harbour Wigeon population, and 2.5% of the Cork Harbour Mallard population. As the aquaculture sites will only be fished on 4-5 days per month, and individual plots will be fished less frequently than this, any disturbance to these roosts will have a negligible impact on the total Wigeon and Mallard roost capacities in the East Harbour zone, or in Cork Harbour overall.

Table 8.11 - Distances from the aquaculture sites to open water duck roosts.

Site	Roost	Distance (m) from nearest section	
		of site	permanent subtidal in site
Site B	AG1	150 m	170 m
Site B	AG2	310 m	310 m
Site B	SA1	0 m	40 m

See Figure 8.4 for location of roosts. Note distances are approximate as the spatial extent of roosts are poorly defined.

8.64 At mid tide (at the start and end of the fishing period) there is little exposure of intertidal habitat along the shoreline around the eastern side of Site B (as represented by the tideline mapped on 20/03/2020; Figure 8.4) and the dabbling ducks will generally not have spread out from their high tide roosting areas.

Waders

Occurrence around the bottom mussel cultivation sites

8.65 Five SCI wader species regularly occur in significant numbers in the East Harbour zone, and around 5-12% of the total roost capacity in the harbour for these species occurs in the East Harbour zone. The main concentrations of these roosting waders occur in Saleen Creek and Whitegate Bay with a few minor roosts along the Aghada shoreline and in Cuskinny Bay (Table 8.14).

Table 8.12 – Mean percentages of the total Cork Harbour count recorded in the East Harbour zone during the I-WeBS counts and the WSP low tide counts, and percentage of total Cork Harbour high tide roost capacity occurring within the East Harbour zone.

Species	I-WeBS	WSP	Roost capacity
Oystercatcher	16% (14-19%)	16%	11%
Golden Plover	0% (0-0%)	0%	0%
Grey Plover	0% (0-0%)	0%	0%
Lapwing	4% (0-7%)	11%	0%
Curlew	10% (8-11%)	12%	6%
Black-tailed Godwit	6% (4-8%)	6%	5%
Bar-tailed Godwit	1% (0-4%)	0%	0%
Dunlin	12% (9-16%)	1%	8%
Redshank	15% (14-17%)	12%	12%

I-WeBS data from 2011/12-2017/18. 95% confidence intervals for the I-WeBS percentages are shown in parentheses. The WSP analyses exclude data from the Outer Harbour zone.

Table 8.13 – Mean high tide I-WeBS counts in the four subsites of the East Harbour zone, 2011/12-2017/18.

Species	Months	Saleen	Rostellan Lake	Aghada	Whitegate
Oystercatcher	Sep-Feb	73 (59-87)	0	17 (9-24)	37 (30-44)
Curlew	Sep-Feb	41 (32-50)	1 (0-3)	3 (0-8)	37 (28-45)
Black-tailed Godwit	Sep-Mar	59 (44-74)	3 (0-6)	0 (0-1)	31 (14-48)
Dunlin	Dec-Feb	64 (37-90)	0	27 (2-51)	230 (140-322)
Redshank	Sep-Feb	97 (86-108)	0	3 (2-4)	101 (84-118)

Months included in the analyses represent the period of peak occurrence of the species in Cork Harbour. Sample sizes: Sep-Feb = 33; Sep-Mar = 37; Nov-Feb = 27; 95% confidence intervals for the mean counts are shown in parentheses.

Table 8.14 – Distribution of high tide wader roost capacity in the East Harbour zone.

Species	WG	SA_{inner}	SA_{outer}	CU	AG	Total
Oystercatcher	44	35	59	53	8	198
Curlew	26	79	0	0	0	105
Black-tailed Godwit	61	96	0	0	0	158
Dunlin	413	53	0	0	35	500
Redshank	178	141	0	0	0	319

WG = Whitegate Bay; SA_{inner} = Saleen Creek (inner); SA_{outer} = Saleen Creek (outer); CU = Cuskinny Bay; AG = Aghada.

8.66 The roosts in Whitegate Bay are outside the aquaculture site and too distant from it to be affected by any activity within the site. The other roosts are adjacent to, or close to the aquaculture site. The main roosting area in Saleen Creek is on the inner side of the shingle bank at the mouth of the creek, while Oystercatcher also roost on at two locations on the northern shoreline to the west of the mouth of the creek (SA1 and SA2; Figure 8.5). In Cuskinny Bay, an Oystercatcher roost occurs on the western side of the bay (CU; Figure 8.5), while a small, while an infrequently used Oystercatcher roost occurs along the southern shoreline adjacent to the Aghada Generating Station (AG1; Figure 8.5). A Dunlin roost occurs on the shingle bank adjacent to Aghada Pier (AG2; Figure 8.5). This roost normally holds small numbers of birds but occasionally 100 or more Dunlin can occur here.

8.67 At low tide, some of the waders roosting in Saleen Creek move out to the intertidal habitat in the outer part of the Saleen subsite and may also move to intertidal areas within the Aghada subsite. A concentration of Oystercatcher usually occurs in a mussel bed just outside the mouth of Saleen Creek while, on spring low tides, sizeable numbers of Black-tailed Godwit and Dunlin can feed in in the intertidal area along the southern shoreline of the Aghada subsite between Rostellan village and Aghada Pier.

Disturbance impact

8.68 There is little published information on the potential disturbance impact from watercraft to waterbirds using intertidal and shallow subtidal habitat. Smit and Visser (1993) cite the work of Koepff and Dietrich (1986), who studied the effects of kayaks and windsurfers on roosting waders and Shelduck in the Jadebusen, which is a large tidal bay in the German Wadden Sea. They reported mean flight distances due to kayak and windsurfer disturbances ranging from around 50-150 m for Oystercatcher to 240-400 m for Curlew. The flight distances caused by windsurfers were generally considerably larger than those caused by kayakers. Liley *et al.* (2010) studied the effects of disturbance on waterbirds in the Solent in southern England. They found that water-based activity generally caused stronger disturbance effects than land-based activity. For mixed water-based activity, they reported response distances for five wader species of ranging from 30 m for Turnstone to 124 m for Dunlin and displacement distances ranging from 155 m for Turnstone to 287 m for Redshank. Scarton (2018) reported mean flight initiation distances ranging from 75 m for Common Sandpiper to 219 m for Curlew, including 124 m for Oystercatcher, in response to experimental disturbance by a 7 m fibreglass boat travelling at 8-10 km/hr in Venice lagoon.

8.69 In Cork Harbour, kayaking and small boat activity has been observed to cause disturbance to wader roosts at distances of around 50-100 m from the roost. The consequences of the disturbance can result in short-term abandonment of the entire area and potentially significant energy expenditure: e.g., in August 2016, kayakers flushed the Curlew roost in Saleen Creek and all the birds in the roost abandoned the area and flew over 5 km to roost sites in Whitegate Bay.

8.70 The distances of the wader roosts that are occupied by SCI species along the shorelines around the bottom mussel cultivation sites from the nearest sections of the bottom mussel cultivation sites are shown in Table 8.15. Roosts CU1, AG1 and AG2 are all too distant for any disturbance effects to be likely. The two roosts in the outer part of Saleen Creek (SA1 and SA2) are within 70-150 m of Site B. However, the nearest section of Site B contains an extensive area of intertidal and shallow subtidal habitat (Figure 8.5). Taking this into account, roost SA2 is not likely to be affected by disturbance from fishing activity. The distance of roost SA1 to the nearest area of permanent subtidal habitat is within the potential range at which disturbance effects are possible. This roost is used by Oystercatcher as a secondary roost, probably when birds are disturbed at roost SA1. It holds 8% of the Oystercatcher roost capacity in the East Harbour zone and 1% of the total Oystercatcher roost capacity in Cork Harbour. Any disturbance to this roost will only occur if a plot is fished at the northern end of Site B. As the aquaculture sites will only be fished on 4-5 days per month, and individual plots will be fished less frequently than this, any disturbance to this roost will have a negligible impact on the total Oystercatcher roost capacity in the East Harbour zone, or in Cork Harbour overall.

Table 8.15 – Distances from the aquaculture sites to high tide wader roosts.

Site	Roost	Distance (m) from nearest section	
		of site	permanent subtidal in site
Site A	CU1	500	500
Site B	AG1	410	410
Site B	AG2	380	380
Site B	SA1	70	150
Site B	SA2	150	450

See Figure 8.5 for location of roosts.

8.71 The boat trips to/from the aquaculture sites will generally be made outside the main high tide period. Therefore, they are unlikely to cause significant disturbance impacts to high tide roosts.

8.72 The start and end of the mussel fishing period may extend to four hours before/after high tide and, therefore, overlap with exposure of intertidal habitat causing a risk of disturbance to foraging waders.

8.73 Due to the tidal constraints, mussel fishing activity will generally take place on days with high tide in the middle of the day. In Cork Harbour, these coincide with neap high tides. The tidal exposure four hours after high tide on a moderate neap tide (low tide of 1.0 m) is shown in Figure 8.5. There was a narrow band of intertidal habitat exposed along the eastern shoreline of Site B, with more extensive exposure at the mouth of Saleen Creek extending into the corner of Site B. The 100 m and 200 m buffers show the potential disturbance zones. While there is some overlap, any potential disturbance impacts will only occur for a short period at the start and finish of the fishing period. Given the factors already discussed above, and the lower potential sensitivity of feeding waders, compared to waders at high tide roosts, any disturbance impacts from mussel fishing to waders feeding in intertidal habitat along the eastern side of Site B will be negligible.

Other species

8.74 The other SCI species that occur in the East Harbour zone are Grey Heron, Little Grebe, Black-headed Gull, Common Gull, Lesser Black-backed Gull and Common Tern. Grey Heron are thinly distributed throughout the zone, with a nocturnal roost in Marloag Woods. Little Grebe mainly occur on Rostellan Lake with small numbers also occurring in the mouth of Saleen Creek. The main high tide gull roosts occur around Rostellan village with birds distributed between the south-eastern corner of the Aghada subsite and Rostellan Lake, and in Whitegate Bay with a smaller roost at the mouth of Saleen Creek. A large nocturnal gull roost, holding thousands of gulls, occurs in the open water between Aghada Pier and the East Ferry Channel. At low tide, the gulls feed in the intertidal areas, while, in some years, large numbers also feed in the subtidal water in the middle of the zone. No Common Tern breeding colonies or regular post-breeding/autumn roost sites occur in the East Harbour zone, although they probably feed regularly within the zone during the summer months.

Table 8.16 – Mean percentages of the total Cork Harbour count recorded in the East Harbour zone during the I-WeBS counts and the WSP low tide counts, and percentage of total Cork Harbour high tide roost capacity occurring within the East Harbour zone.

Species	I-WeBS	WSP
Grey Heron	14% (11-17%)	25%
Little Grebe	35% (28-43%)	26%
Black-headed Gull	17% (12-22%)	22%
Common Gull	30% (19-40%)	39%
Lesser Black-backed Gull	3% (1-5%)	6%

95% confidence intervals for the I-WeBS percentages are shown in parentheses. The WSP analyses exclude data from the Outer Harbour zone.

Table 8.17 – Mean high tide I-WeBS counts in the four subsites of the East Harbour zone, 2011/12-2017/18.

Species	Months	Saleen	Rostellan Lake	Aghada	Whitegate
Grey Heron	Sep-Feb	2 (1-2)	1 (0-2)	2 (1-2)	3 (2-5)
Little Grebe	Sep-Feb	3 (2-4)	10 (8-13)	0	0
Black-headed Gull	Sep-Mar	51 (26-75)	26 (13-38)	197 (125-269)	92 (17-167)
Common Gull	Jan-Mar	4 (0-8)	0 (0-1)	25 (9-41)	10 (3-17)
Lesser Black-backed Gull	Nov-Feb	1 (0-2)	0 (0-1)	0	0 (0-1)

Data for the winters of 2011/12 and 2012/13 are not included for Black-headed Gull, Common Gull and Lesser Black-backed Gull. Months included in the analyses represent the period of peak occurrence of the species in Cork Harbour. Sample sizes: Grey Heron and Little Grebe = 33; Black-headed Gull and Lesser Black-backed Gull = 25; Common Gull = 12; 95% confidence intervals for the mean counts are shown in parentheses.

8.75 General observations of heron behaviour in the harbour indicates that they are unlikely to be very sensitive to disturbance from mussel fishing activity. Herons feed widely around the shoreline of the harbour and generally tolerate close approach by pedestrians. When they are disturbed, they usually fly short distances and then resume feeding. Nocturnal roosts are unlikely to be affected by mussel fishing activity as the birds appear to move into the trees, away from the water, at night.

8.76 The Little Grebes in Saleen Creek generally do not occur within around 300-400 m of permanent subtidal habitat. Therefore, they are unlikely to be disturbed by mussel fishing activity.

8.77 Gulls are generally regarded as being very tolerant of human disturbance, often exploiting highly disturbed habitats and feeding in large numbers in very close proximity to human activity. However, flocks of gulls on intertidal habitats will flush in response to disturbance. Laursen *et al.* (2005) reported escape distances (EDs) for Black-headed Gulls in the Danish Wadden Sea of 116 m (95% C.I.: 98-137 m), which were comparable to the EDs shown by some of the wader species in that study, but their study was carried out in an area with a very low level of human activity, and with ample undisturbed habitat for birds to move to, so the birds would not have been habituated to disturbance, and the costs of moving would have been low. Burger *et al.* (2007) found that Laughing Gulls on a New Jersey beach recovered very quickly after disturbance events, with birds returning within 30 seconds, and numbers reaching the pre-disturbance levels within five minutes, in contrast to the wader species, whose numbers still had not reached the pre-disturbance levels after ten minutes.

8.78 In Cork Harbour, the main Black-headed Gull and Lesser Black-backed Gull nocturnal roost occurs in Lough Mahon around the shipping channel into Tivoli Docks. We have observed the passage of large ships through this roost without any significant disturbance effects. Daytime gull roosts can occur both on shoreline areas (usually in association with high tide wader roosts) and on open water. The gulls will flush when disturbed but will usually resettle nearby. For example, a typical pattern would be for gulls flushed from a shoreline roost to resettle on open water nearby.

8.79 Due to their tolerance of human disturbance, mussel fishing activity is unlikely to result in any disturbance responses from gulls foraging in subtidal habitat. Mussel fishing may result in disturbance responses from roosting flocks of gulls. However, as discussed above, any such disturbance responses are only likely to cause short distance local movements and are, therefore, unlikely to cause significant energetic impacts, or to cause gulls to be displaced from an area.

8.80 Foraging Common Terns are generally tolerant of human disturbance and Furness *et al.* (2013) gave Common Tern a low vulnerability score for disturbance by ship traffic, referencing “slight avoidance at short range”. In Irish coastal waters they often feed in very close proximity to human activity.

Conclusions

8.81 The proposed bottom mussel cultivation in the East Harbour, and the associated boat access to/from the North Channel, will cause disturbance to Red-breasted Merganser, Cormorant and Great Crested Grebe on the days when fishing activity takes place. However, the proposed scale of the operation, which will involve a maximum of five fishing days per month mean that the overall disturbance impact on these species will be low and will not be likely to have a significant effect on their conservation condition within Cork Harbour.

8.82 The potential disturbance to Cormorant night roosts, and to a lesser extent, to Red-breasted Merganser and Great Crested Grebe night roosts, are the most sensitive potential impacts. While these are not likely to be significant, due to the limited scale of the operation, there may be potential for these to contribute to more significant cumulative impacts in combination with other activities (see Chapter 9).

8.83 The above conclusions only apply to the scale of the proposed operation described in Chapter 6. Any intensification of the operation may require further assessment.

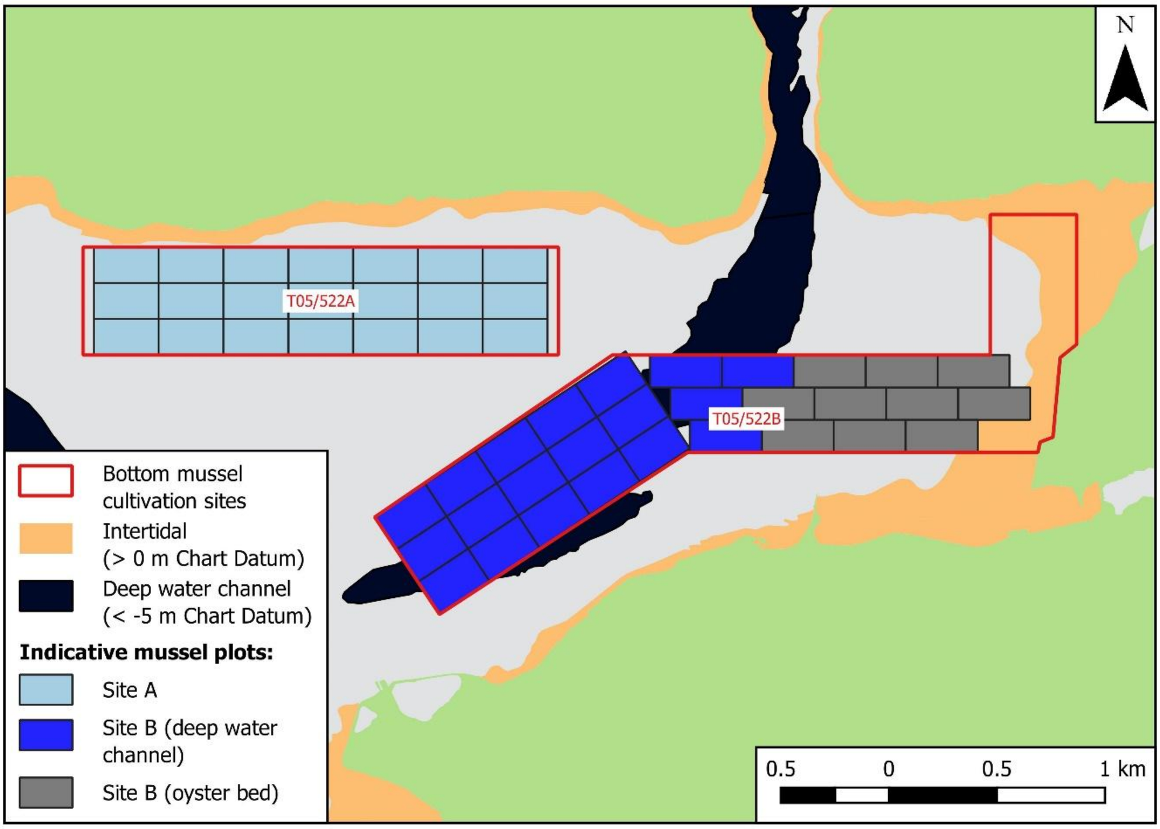


Figure 8.1 – Indicative arrangement of mussel plots used to assess potential displacement impacts to Cormorant and Great Crested Grebe.

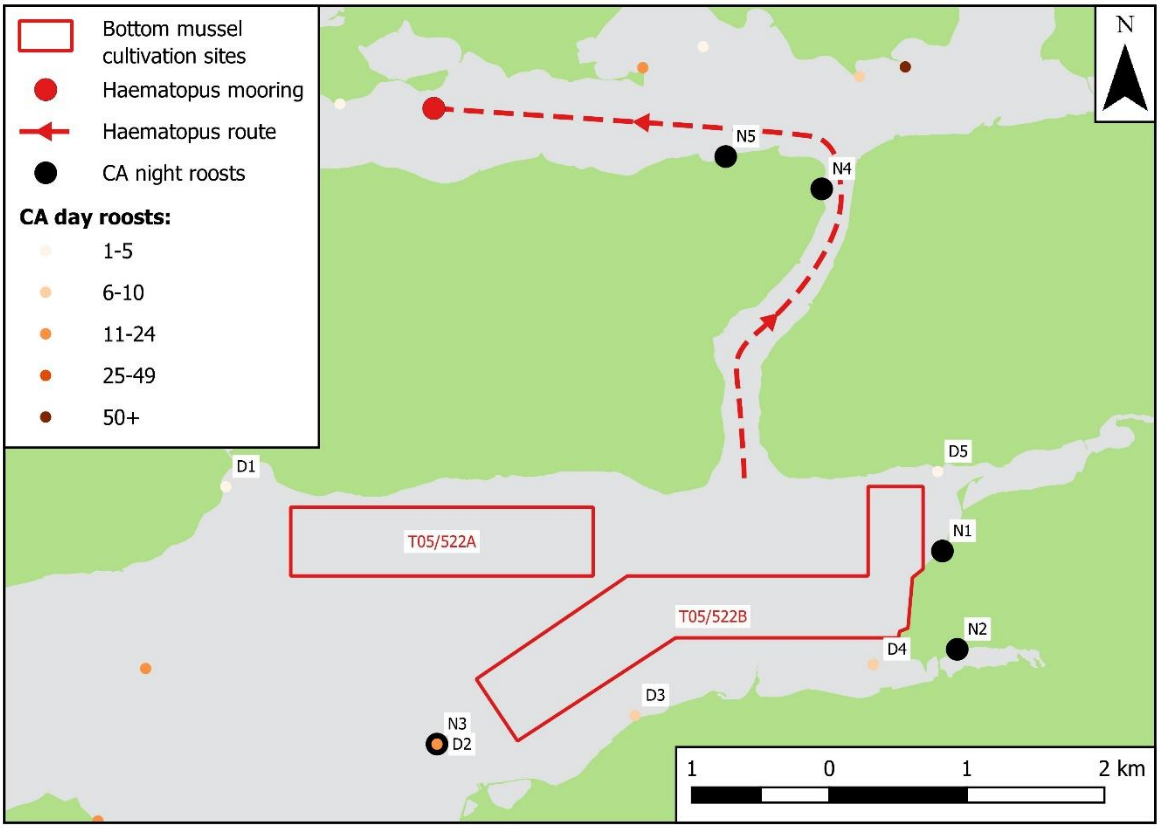


Figure 8.2 – Cormorant roosts in the vicinity of the bottom mussel cultivation sites and boat access route.

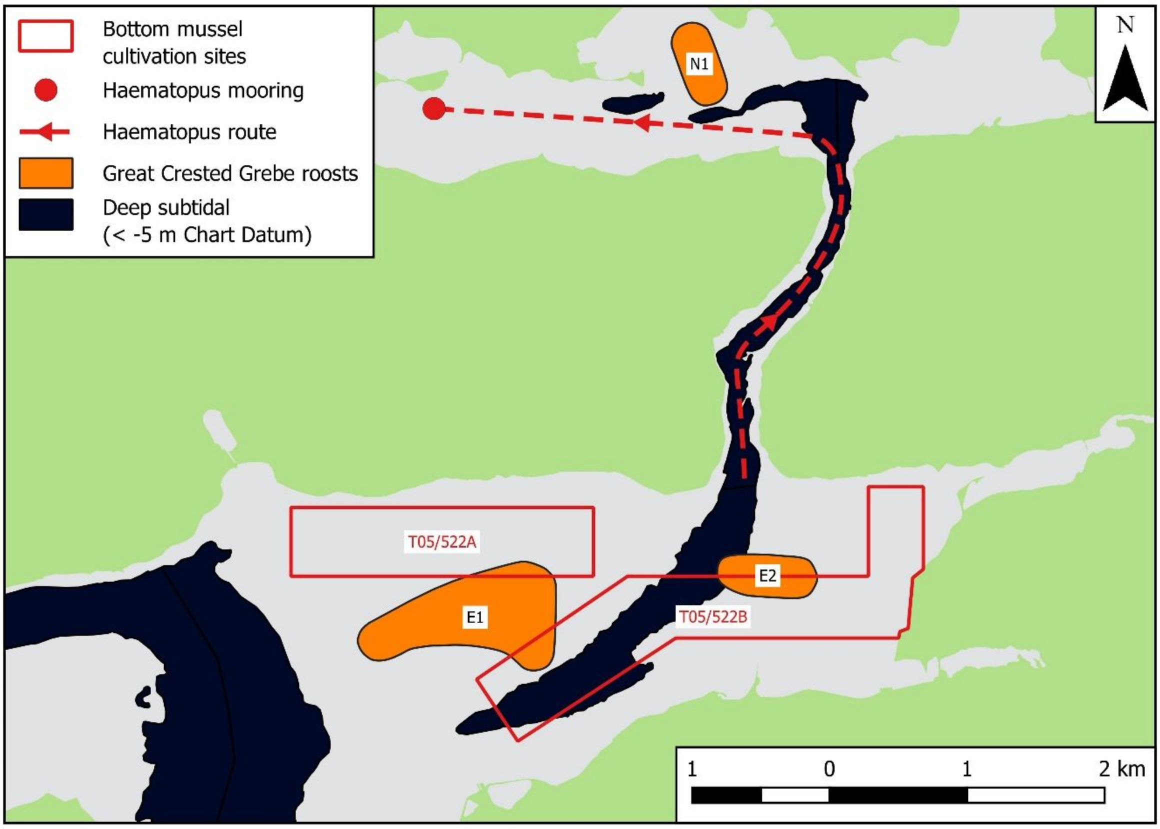


Figure 8.3 – Great Crested Grebe roosts in the vicinity of the bottom mussel cultivation sites and boat access route.

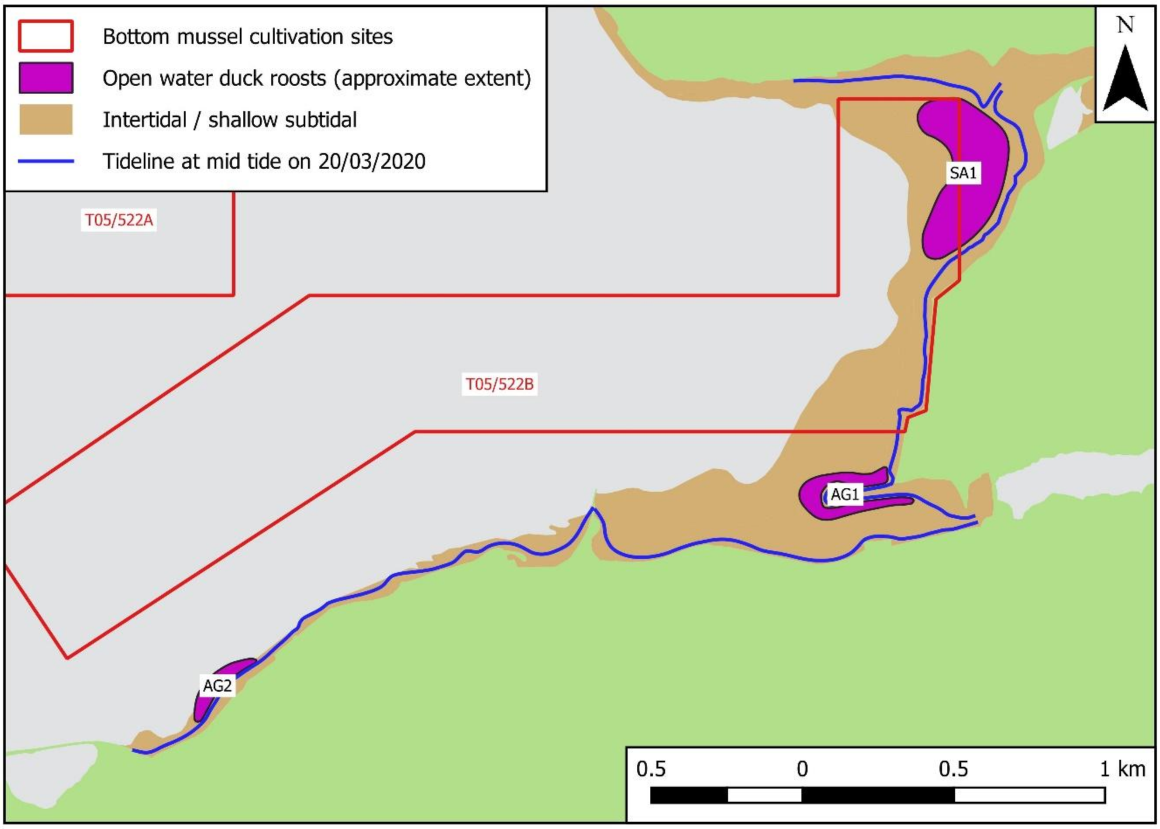


Figure 8.4 – Open water duck roosts in the vicinity of the bottom mussel cultivation sites.

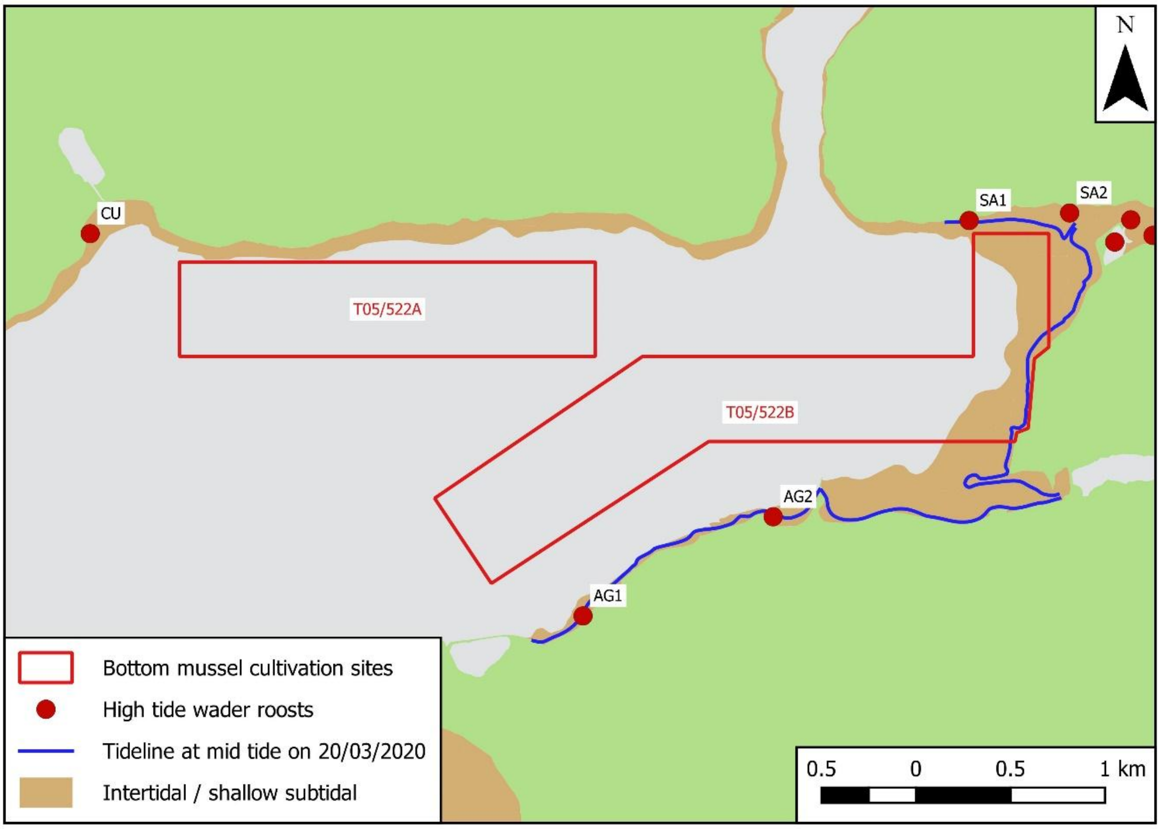


Figure 8.5 – High tide wader roosts in the vicinity of the bottom mussel cultivation sites.

9. Assessment of cumulative impacts

Introduction

9.1 This chapter examines the potential for cumulative impacts from the aquaculture activities covered by this assessment in combination with other relevant activities. The chapter first considers Fishery Orders, which permit additional aquaculture development and shell fishing activity in Cork Harbour. The chapter then reviews a wide range of other activities that occur in Cork Harbour and which have potential for impacts on waterbird populations.

9.2 We only considered potential for cumulative impacts to species for which the assessments in Chapters 7 and 8 have identified potential for significant, or non-significant but not negligible, impacts. This means that the cumulative assessment is limited to Red-breasted Merganser, Cormorant and Great Crested Grebe.

Fishery Orders

Aquaculture activities

9.3 There are four Fishery Orders within Cork Harbour (Figure 9.1).

9.4 Two Fishery Orders occur in the North Channel. The Rossmore Fishery Order overlaps the aquaculture sites and covers the section of the North Channel between Weir Island and Rossmore. This fishery order appears to have been used for oyster trestle cultivation as there are old trestles outside the currently licensed sites. The Brick Island Fishery Order covers the section of the North Channel between Brick Island and Brown Island, including the bay behind Brick Island. This Fishery Order has been used for bottom cultivation of Native and Pacific Oysters using seed from the hatchery on Brick Island. However, the fishery has been closed since 2002, although oysters are still held here for shellfish testing purposes.

9.5 There is one large Fishery Order covering most of the East Harbour zone outside Whitegate Bay. This Fishery Order has been used for bottom cultivation of Native and Pacific Oysters, with oyster trestle cultivation along the shoreline between Saleen Creek and Rostellan. As in the North Channel, the oyster fishery was closed in 2002. However, fishing recommenced in 2020 to take up stock that had been held here. The oyster bed is located in the south-eastern part of the Fishery Order (Figure 9.1). The trestles have not been actively worked for many years.

9.6 There is also a Fishery Order in the Owenboy Estuary. However, no information has been provided about the activities (if any) in this Fishery Order, so it is not considered further in this assessment.

Potential in-combination effects

Oyster trestle cultivation

9.7 No potential non-negligible impacts were identified from the development of the aquaculture sites considered in this assessment to SCI species that are potentially sensitive to negative impacts from oyster trestle cultivation. Therefore, it is not necessary to consider potential in-combination effects from oyster trestle cultivation in the Fishery Orders.

9.8 Development of oyster trestle cultivation in the East Harbour Fishery Order may have negative impacts on SCI species, but these impacts would not have the potential to cause significant impacts in combination with impacts from the aquaculture sites considered in this assessment.

East Harbour oyster fishery

9.9 The East Harbour oyster fishery is operated by the same operator as the applicant for the bottom mussel cultivation sites.

9.10 The oyster bed in the East Harbour occupies an area of around 27 ha and currently holds around 10 tonnes of Pacific Oyster[10]. The bed is being fished in 2020, subject to COVID restrictions, to fish up the stock, but the future plans are not clear.

9.11 Assuming that the fishing effort per unit area is similar to that required for mussels, full development of this fishery would more than double the number of fishing days per month to around 10-12 days per month. Based on the impact assessments in Chapter 8, this would not be enough to cause significant energetic or displacement impacts to foraging Red-breasted Merganser, Cormorant or Great Crested Grebe

9.12 If the oyster fishery required return travel to the North Channel close to dusk, then it could potentially double the days on which nocturnal roosts of Red-breasted Merganser, Cormorant and Great Crested Grebe are disturbed. This could cause disturbance of the roosts on one out of every three evenings. This level of disturbance may be sufficient to cause longer-term abandonment of roosts, particularly for Cormorant.

Brick Island Oyster fishery

9.13 The Brick Island Fishery Order is located in the central area of Red-breasted Merganser distribution within the North Channel. Red-breasted Merganser appear to be very sensitive to boat activity and there is currently very little boat activity in this area in winter. Therefore, the North Channel is currently a disturbance refuge for Red-breasted Merganser in Cork Harbour and any development that increases boat activity in winter in this area may have very significant negative impacts on the Cork Harbour Red-breasted Merganser population. It is notable that the decline in the North Channel Red-breasted Merganser population occurred in the late 1990s when the Brick Island Fishery Order was still open, while there does not seem to have been any subsequent decline during the period when the fishery has been closed, in contrast to ongoing declines in the East Harbour and West Harbour zones (see paragraph 5.28). Therefore, reopening of the oyster fishery in the Brick Island Fishery Order would have the potential to cause significant disturbance impacts to the Cork Harbour Red-breasted Merganser population, depending on the scale and intensity of the fishery. Reopening this fishery would also cause some disturbance impacts to Cormorant and Great Crested Grebe. However, given that the potential disturbance impacts to foraging Red-breasted Merganser, Cormorant and Great Crested Grebe from the proposed bottom mussel cultivation are very limited, they would probably not make a significant contribution to any cumulative impacts in-combination with the impacts from the Brick Island oyster fishery.

Other activities

9.14 Locations with concentrations of watercraft activity in the East Harbour and North Channel are shown in Figure 9.2. The East Ferry Marina on the western side of the East Ferry Channel has 80 berths and hosts a sailing school, while there is a pier on the opposite side of the channel. Aghada Pier on the south side of the East Harbour is used by a variety of watercraft and hosts a

[10] Tristan Hugh-Jones, Atlantic Shellfish, *pers. comm*., 18/03/2020.

kayaking school during summer. In the North Channel, there are slips on the northern shore of Great Island and at Rathcoursey, while small aggregations of moorings occur at the mouth of the East Ferry Channel and at Ballynacorra. There is probably daily activity at Aghada Pier and the East Ferry Marina/Pier throughout the year, but powered watercraft activity in the North Channel during winter appears to be very limited. However, in recent winters, kayaking activity in the eastern end of the North Channel has been observed on several occasions during I-WeBS counts (Gittings, 2018).

9.15 There have been large declines in the Cork Harbour populations of Red-breasted Merganser and Great Crested Grebe and comparison with national trends indicate that these declines may be linked to site-specific factors (see paragraph 5.4). There also have been significant differences between different sections of the harbour in the population trends (see Text Figure 5.1). In the case of Red-breasted Merganser, disturbance from boat traffic and recreational watercraft may well be influencing the current distribution patterns, resulting in the concentration of birds in the Fota Channel and North Channel, which are areas with very low levels of marine activity in winter. The Great Crested Grebe roosting areas in the Inner Harbour, East Harbour and West Harbour zones are all in areas with relatively high levels of marine activity, although the impact on the roosting grebes is mitigated by the fact that the roosts are mainly occupied at night when there is relatively little activity.

9.16 The population trend for Cormorant shows evidence of a decline up to around 2010 but with some recovery since then (see paragraph 5.5). Cormorant are widely distributed throughout the harbour, including in areas with high levels of marine activity. The nocturnal roost at Drakes Pool in the Owenboy Estuary is in an area with a high level of marine activity, and disturbance to this roost has been observed (see paragraph 8.40), while the nocturnal roosts at Siddon’s Tower and Bagwell’s Hill are also potentially vulnerable to disturbance from marine activity.

9.17 The potential cumulative impacts from other marine activity in combination with bottom mussel cultivation are difficult to assess due to the lack of detailed data on seasonal and daily patterns of marine activity in Cork Harbour. However, in the case of disturbance to foraging birds, the potential energetic and displacement impacts from bottom mussel cultivation are very small to they would not be likely to make a significant contribution to any cumulative impacts. Disturbance to the East Harbour and North Channel nocturnal roosts from other marine traffic in winter is probably very limited due to the small scale of the activity. In particular, there is probably very little marine traffic in the East Harbour east of Aghada Pier, in the East Ferry Channel above the East Ferry Marina, or in the North Channel, during winter, so disturbance to the Cormorant roosts at Siddon’s Tower and Bagwell’s Hill are probably very rare events.

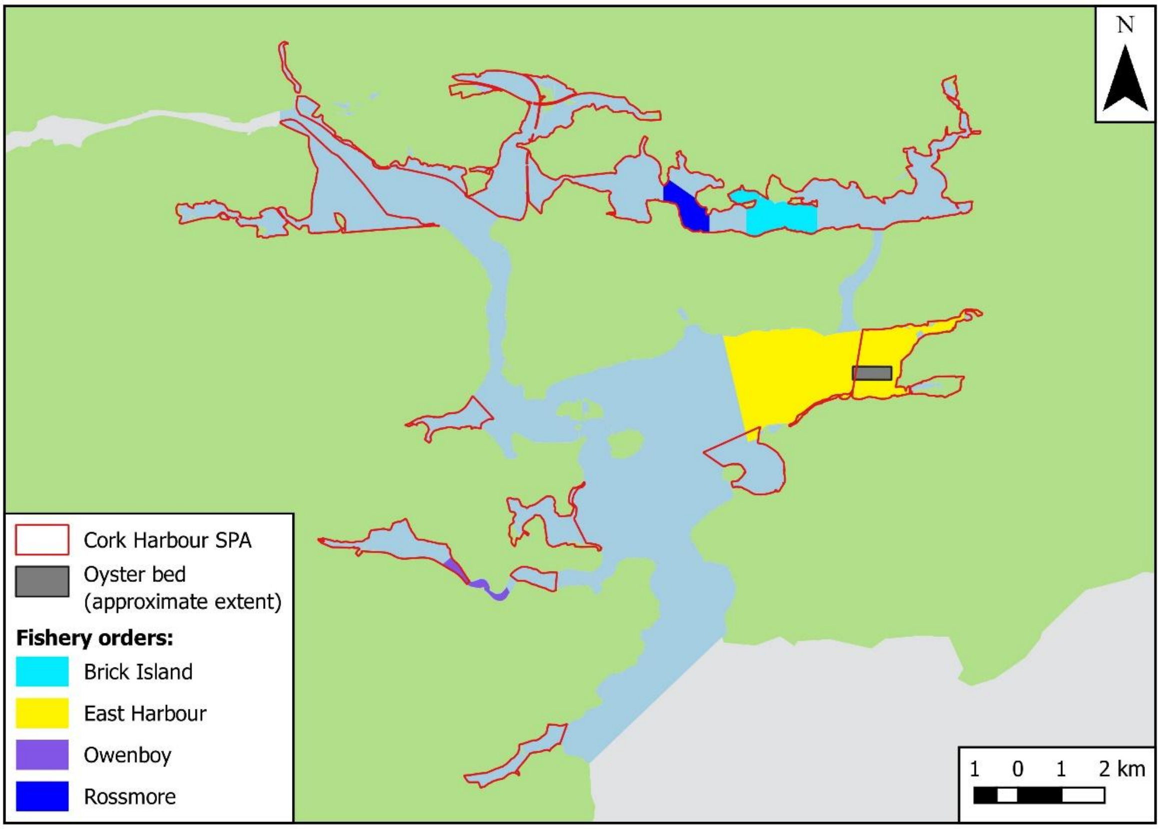


Figure 9.1 – Fishery Orders.

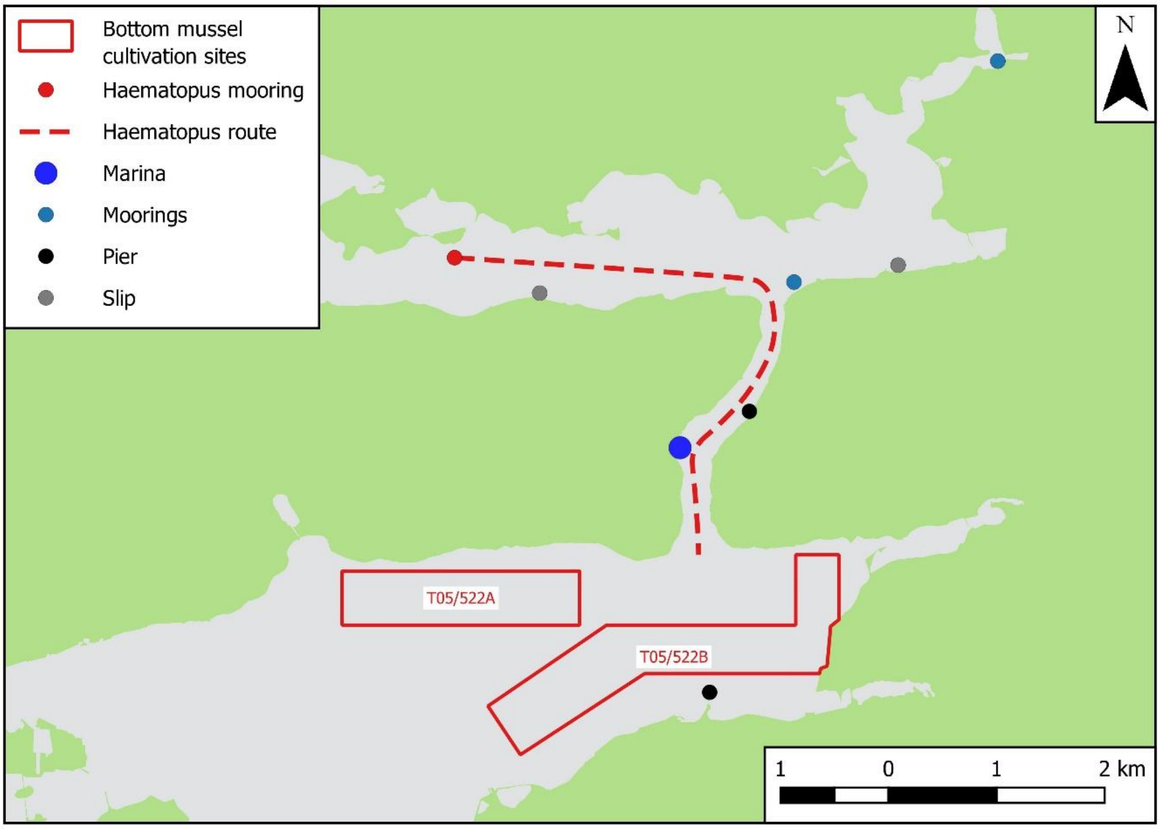


Figure 9.2 – Marinas, moorings, piers and slips in the East Harbour and North Channel.

10. Conclusions

Introduction

10.1 The implications of the potentially significant impacts identified in this assessment for the achievement of the conservation objectives of the relevant SCIs are discussed in this chapter.

10.2 This chapter also includes recommendations for managing and monitoring aquaculture activities where there is uncertainty about the potential impacts.

10.3 These conclusions only apply to the scale of the proposed operations described in Chapter 6. Any intensification of the proposed operations may require further assessment.

Cork Harbour SPA

Red-breasted Merganser, Cormorant and Great Crested Grebe

10.4 Bottom mussel cultivation is not predicted to cause significant disturbance impacts to foraging Red-breasted Merganser, Cormorant or Great Crested Grebe during the day. There is potential for bottom mussel cultivation to cause disturbance impacts to the nocturnal roosts of these species when the boat is returning to the North Channel in the evening. While the number of nights on which this would occur would be limited to 4-5 nights per month, the potential significance is difficult to evaluate as the behavioural consequences of disturbance to nocturnal roosts in these species are poorly understood. Oyster fishing activity in the East Harbour Fishery Order, and other boat traffic and recreational watercraft activity in Cork Harbour, could have additional cumulative disturbance impacts on these roosts in combination with the impact from the bottom mussel culture activity.

10.5 Regular displacement of birds from these roost sites would have a negative impact on attribute 2 (distribution) of the conservation objectives for these SCIs. The energetic costs of disturbance could have impacts on survival rates in which case they could have a negative impact on attribute 1 (population trend) of the conservation objectives for these SCIs.

10.6 Potential disturbance impacts to these roost sites could be minimised by not carrying out any fishing activity within two hours of dusk[11]. This would allow time for the boat to return to the North Channel, past the Bagwell's Hill roosts before significant numbers of Cormorant had gathered there. It would also avoid disturbance impacts to the Cormorant roost at Siddon's Tower, and the Red-breasted Merganser and Great Crested Grebe roosts in the East Harbour, as the boat would have left the East Harbour well before these roosts would usually have started to assemble.

10.7 Alternatively, if this restriction on fishing time would be too limiting, a combination of spatial exclusion zones and monitoring could be used as an adaptive strategy to manage the potential disturbance impacts to the roosts. The spatial exclusion would involve avoiding fishing close to the Siddon's Tower roost within 1.5 hours of dusk, and taking a route along the eastern side of the East Ferry Channel and then straight out into the middle of the North Channel when returning to the North Channel mooring. Monitoring of the disturbance impacts to the Cormorant Bagwell's Hill East, and the Red-breasted Merganser and Great Crested Grebe roosts would be carried out to assess whether any disturbance impacts were occurring. As disturbance impacts would only

[11] Dusk is defined here as the time of civil twilight and is around 30-40 minutes after sunset.

become potentially significant if repeated over a period of time, this strategy would allow the impact to be managed before it became potentially significant.

Other SCIs

10.8 No potentially significant impacts to any of the other SCIs of the Cork Harbour SPA have been identified in this assessment.

The Gearagh SPA

10.9 No potentially significant impacts the Cork Harbour Mallard population have been identified in this assessment. Therefore, even if there is significant population interchange between Cork Harbour and The Gearagh, the development of the aquaculture sites in Cork Harbour will not have significant impacts on the Mallard SCI of The Gearagh SPA.

The Sovereign Islands SPA

10.10 Breeding Cormorant from the Sovereign Islands SPA could potentially forage in the areas around the bottom mussel cultivation sites. However, there will be very limited mussel cultivation activity during the Cormorant breeding season. Also, these birds will not use the nocturnal roosts while they are breeding and will not, therefore, be affected by potential disturbance impacts to these roosts. Therefore, the development of the aquaculture sites in Cork Harbour will not have significant impacts on the Cormorant SCI of the Sovereign Islands SPA.

Other SPAs

10.11 Red-breasted Merganser is an SCI of the Courtmacsherry Bay SPA and has unknown site fidelity (NPWS, 2014c). Therefore, if there is significant population interchange between Cork Harbour and Courtmacsherry Bay, any significant impacts from bottom mussel culture in Cork Harbour could have a negative impact on attribute 1 (population trends) of the conservation objective for this SCI.

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Appendix A

Scientific names

Common name	Scientific names	BTO code
Bar-tailed Godwit	*Limosa lapponica*	BA
Black-headed Gull	*Chroicocephalus ridibundus*	BH
Black-tailed Godwit	*Limosa limosa*	BW
Coot	*Fulica atra*	CO
Common Gull	*Larus canus*	CM
Common Tern	*Sterna hirundo*	CN
Cormorant	*Phalacrocorax carbo*	CA
Curlew	*Numenius arquata*	CU
Double-Crested Cormorant	*Phalacrocorax auritus*	-
Dunlin	*Calidris alpina*	DN
Golden Plover	*Pluvialis apricaria*	GP
Great Crested Grebe	*Podiceps cristatus*	GG
Great Northern Diver	*Gavia immer*	ND
Grey Heron	*Ardea cinerea*	H.
Grey Plover	*Pluvialis squatarola*	GV
Guillemot	*Uria aalge*	GU
Herring Gull	*Larus argentatus*	HG
Kittiwake	*Rissa tridactyla*	KI
Lapwing	*Vanellus vanellus*	L.
Lesser Black-backed Gull	*Larus fuscus*	LB
Light-bellied Brent Goose	*Branta bernicla hrota*	PB
Little Grebe	*Tachybaptus ruficollis*	LG
Mallard	*Anas platyrhynchos*	MA
Oystercatcher	*Haematopus ostralegus*	OC
Pintail	*Anas acuta*	PT
Red-breasted Merganser	*Mergus serrator*	RM
Redshank	*Tringa totanus*	RK
Ringed Plover	*Charadrius hiaticula*	RP
Sanderling	*Calidris alba*	SS
Shelduck	*Tadorna tadorna*	SU
Shoveler	*Anas clypeata*	SV
Teal	*Anas crecca*	T.
Turnstone	*Arenaria interpres*	TT
Whooper Swan	*Cygnus cygnus*	WS
Wigeon	*Anas penelope*	WN

Appendix B

Literature review - Impacts of bottom mussel culture on benthic fauna

B.1 Review

B.1.1 Bottom culture accounts for about half of all mussels produced in Ireland (Heffernan, 1999). In 1995, 5,570 tonnes were produced. Bottom cultivation involves the location, collection and transplantation of wild mussel spat into richer, shallower waters using a dredger. Successful on-growing of re-laid spat requires sandy shallow beds. When the mussels reach commercial size (9-18 months later), they are harvested by dredger (Joyce, 1992 cited in Heffernan, 1999). This method is practised successfully on a large scale in Wexford Harbour and also in Carlingford Lough (Heffernan, 1999).

B.1.2 Heffernan (1999) could not find any literature on the impact of bottom culture on benthic fauna and it was presumed that the culture beds were analogous to natural mussel beds. In the intervening years, a number of studies have been undertaken to assess the impacts of bottom mussel culture on benthic fauna.

B.1.3 Smith and Shackley (2004) investigated the development of bottom mussel culture in inner Swansea Bay, Wales. The area was a shallow, sublittoral and high tidal energy environment. The results of this study found that the establishment of bottom mussel culture led to a reduction in the number and abundance of species due to habitat change and regular harvesting. There was an increase in abundance in carnivorous and deposit feeding species. In addition, the study found that the mussels reduced the chance of other filter feeding benthic species from becoming established by filtering their larvae or by physically smothering them. Smith and Shackley (2004) predicted that the establishment of bottom mussel culture at the Swansea site would lead to a change in benthic fauna and as a result, potentially impact the availability of prey species of juvenile flatfish that use the area as a nursery. Furthermore, an increased number of mussels in the area may reduce the potential food source of other filter feeding species in the area.

B.1.4 These finding are in contrast to those of Dolmer (2002) who reported that there is a positive relationship between mussel abundance and the number of associated species due to the increased complexity of the substratum in mussel beds compared to the surrounding sediments. In effect, the mussels become ‘ecosystem engineers’ (Jones *et al.* 1994; 1997). The presence of mussel beds can control the benthic environment directly by providing habitat and indirectly by enhancing larval settlement (Dolmer, 2002), providing shelter from predation, trapping sediment and altering water flow (Gutiérrez *et al.* 2003).

B.1.5 At study sites in western Sweden, Norling *et al.* (2015) examined the effects of blue mussel plots, one containing live mussels and the other with post mortem shells, on the epifaunal and infaunal assemblages. Notably, this study included the effect on fish species which were not considered in some of the other studies. This study supported previous studies which found that the ecosystem engineering effects of plots containing live mussels and dead shells both had an increase in epibenthic species richness, total abundance and biomass compared to the control plot which consisted of bare sand. Notably, small crustaceans were positively affected by the presence of blue mussel plots whereas fish species were positively affected by the presence of oyster plots which were also studied.

B.1.6 Ysebaert *et al.* (2009), made a comparison study between bottom mussel culture at sites in Denmark (a shallow, wind dominated, mixed water environment with microtidal range and low current conditions) and the Netherlands (a deeper, marine dominated environment with greater tidal range and currents). They reported the change in the habitat due the presence of bottom culture mussels had a positive effect on the benthic community, especially in the Netherlands site where an increase in the number of epibenthic species was seen.

B.1.7 However, it is important to consider the impact of biodeposition on the benthic fauna, in particular the infaunal assemblages. The presence of bottom culture mussel beds means the habitat is dominated by single species on the seabed. This may lead to the transformation of an infaunal dominated community to an epifaunal dominated community and also cause alteration of sediment type and chemistry due to the production of mussel mud (Marine Institute, 2013). Relaid mussels lead to the development of mussel mud (a mix of dead shells, silt and faeces/pseudofaeces) beneath the mussel beds as the filtration and feeding activities of the mussels increase the sedimentation rate (Kaiser *et al.*, 1998). The effects of this were observed by Beadman *et al.* (2004) who noted that an increase in the abundance of mussels resulted in a decrease of both infaunal diversity and abundance through provision of a complex habitat, input of organically rich material and larval removal through filter feeding at a study site in Bangor Pier, north Wales. However, these impacts were local in nature (0 to 10 m) and were not detectable at greater distances.

B.1.8 Ysebaert *et al.* (2009) also found that the influence of bottom cultures on the sedimentary environment and on the macrobenthic community was found to be very local. Kaiser *et al.* (1998) argue that although local in extent, these changes may persist in time following the removal of mussel beds as although the fine sediments are reworked, the remaining shell material effectively creates a new benthic habitat that may have more long term effects on the composition of benthic fauna in the area.

B.1.9 In contrast, Van der Zee *et al.* (2012) reported that mixed blue mussel and oyster beds can have large scale effects (>100 m) as the beds have effects on consumer-resource interactions far beyond their own physical spatial boundaries in intertidal soft-sediment systems. This is a result of increasing organic matter in the sediment, increasing the silt fraction in the sediment and decreasing the redox potential all of which can influence the distribution of benthic species (Norling *et al.*, 2015).

B.1.10 In relation to the effects on surrounding sediment, Norling *et al.* (2015) again reported that the presence of live blue mussels on the seabed significantly increased the organic content in the surrounding sediment by both excreting organic-rich particles and also by trapping passing organic rich particles due to the heterogeneous structure of the mussel bed compared to the surround sandy seabed. However, no significant effects on infaunal species richness or abundance were found during this study though there was a trend towards reduced infaunal abundance in both oyster and blue mussel plots (both alive and dead). Dittmann (1990) reported that blue mussel beds reduce macroinfauna abundances compared to the surrounding sandflats with a change in the composition of the assemblages from Polychaeta in the sandflats to Oligochaeta in the mussel beds. Kochmann *et al.* (2008) report that the presence of mussel beds on the seabed results in a change in the species composition but not in richness. Species which are more tolerant to the changing organic content in the sediment move into the mussel beds whereas less tolerant species remain in the bare sand. The abundances of infaunal species increased under the mussel beds, possibly due to the cover provided by the mussels from predators.

B.1.11 With respect to fish species, Norling *et al.* (2015) found that live blue mussel beds had a positive effect on the fish assemblages with an increase in species richness, abundance and total biomass particularly for oyster beds but also to a lesser degree for live blue mussel beds. Similar positive relationships between blue mussel beds and fish in the Baltic Sea (Jansson *et al.*, 1985). However, the other studies cited in Norling *et al.* (2015) of observations of an increases in fish diversity and abundance over bivalve beds made by Norling *et al.* (2015) were all based on oyster beds (Breitburg, 1999; Posey *et al.*, 1999; Trolley and Volety, 2005) and in the United States by Peterson *et al.*, (2003). In particular the differences in physical structure of oyster beds compared to blue mussel beds to attract different suites of species, the ability of oyster beds to form reefs and so persist for much longer and the lack of information relating to use of fish on dead blue mussel beds are all factors that need to be considered when evaluating the impact of bivalve plots on benthic fauna.

B.1.12 The use of dredges to harvest the mussel beds had an impact on the non-target infaunal benthic fauna at a site in Denmark with polychaetes associated with mussel beds having a reduced density after dredging. In addition, gastropods and bivalves were also reduced in number after dredging. These impacts are reported to be short term in nature (Dolmer *et al.* 2002). The invasion of scavenging brown shrimps into the dredged area accelerates the transport of energy to higher trophic levels, and thereby changes the trophic structure of the ecosystem. (Dolmer *et al.* 2002).

B.1.13 Hoffmann and Dolmer (2000) found that the use of dredges had no long-term effects on the epifauna composition, however further studies suggest that taxa such as sponges, echinoderms, anthozoans, molluscs, crustaceans and ascideans occurred at reduced density or were not observed at all 4 months after an area had been fished, indicating that the fishery has a short-term effect on the epifauna (P. Dolmer, unpublished results). In contrast, harvesting, as well as habitat change, was proposed as an explanation for a decrease in the number of species and in the total number of individuals in their study site (Smith and Shakley, 2004).

B.1.14 In summary, it appears that mussel culture beds can increase the diversity and abundance of epibenthic fauna by providing an additional food resource for species that predate on the mussels themselves or other species that may be attracted to the mussel bed to predate on the species that are attracted to the mussel beds for refuge. This change in epibenthic fauna is contrasted with a change of infaunal species as increased organic rich sediments deposited by the mussels changes the characteristics of the sediments beneath the culture plot. There is disagreement as to the effectiveness of mussel beds to increase or decrease the abundance of other filter feeding benthic species positively by providing an additional habitat for larvae to establish or negatively by consuming the larvae of other species that may otherwise occupy the area. Local site specific factors may play an important role in determining the impact of bottom mussel plots on benthic fauna.

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