APPROPRIATE ASSESSMENT SCREENING FOR AQUACULTURE LICENSE APPLICATION T05/545 AT BALLYMACODA BAY, CO. CORK

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SUMMARY

This report is an Appropriate Assessment Screening Report for aquaculture site T05/545A in respect of the conservation objectives of the Ballymacoda Bay SPA.

There are 16 waterbird species that are listed as Qualifying Interests (QIs) of the Ballymacoda Bay SPA. The wetland habitat in the Ballymacoda Bay SPA is also listed as a QI of the Ballymacoda Bay SPA.

Aquaculture site T05/545 is an 11.2 ha site located to the north-east of the existing area of trestles in the lowermost part of the intertidal zone on Ring Strand. Due to its position, it is probably only exposed on around one-third of low tides. The only aquaculture activity within this site will be cultivation of Pacific Oysters (*Crassostrea gigas*) using bags and trestles (oyster trestle cultivation).

Development of the site will not cause any changes to the permanent area occupied by wetland habitat. Therefore, the Wetlands QIs of the Ballymacoda Bay SPA will not be affected.

The conservation objectives for the waterbird QIs of the Ballymacoda Bay SPA define their favourable conservation condition using two attributes: population trends and distribution. This assessment focuses on assessing the potential impact on the distribution attribute from displacement caused by oyster trestle cultivation. Displacement impacts do not necessarily translate to impacts on population trends, so the distribution attribute is likely to be more sensitive to potential impacts than the population trend attribute.

Two of the waterbird QIs of the Ballymacoda Bay SPA (Turnstone and Redshank) have neutral/positive response to oyster trestle cultivation and will not, therefore, be adversely affected by development of aquaculture site T05/545A.

The potential displacement impacts to the other waterbird QIs from development of this site were assessed using waterbird count data from the winter of 2010/11. The displacement impacts assessed included displacement from the area occupied by the aquaculture site and displacement from adjacent areas due to disturbance from husbandry activity. If waterbird distribution patterns in January and February 2011 are considered representative of typical distribution patterns at Ballymacoda Bay, then development of aquaculture site T05/545A is not likely to cause significant displacement impacts to any of the QI species of the Ballymacoda Bay SPA.

Detailed assessment of the cumulative impact of the development of aquaculture site T05/545A in combination with the existing development of the licensed sites was not possible due to the absence of any baseline data on waterbird distribution patterns prior to the development of the licensed sites. However, based on inference from waterbird distribution patterns in the winter of 2010/11, it is likely that development of the licensed aquaculture sites has caused significant displacement impacts to some of the QI species of the Ballymacoda Bay SPA. Therefore, the cumulative impact of the development of aquaculture site T05/545A in combination with the existing development of the licensed sites is likely to cause increases to already significant displacement impacts to some of the QI species.

1. INTRODUCTION

This report is an Appropriate Assessment Screening Report for aquaculture site T05/545 in respect of the conservation objectives of the Ballymacoda Bay SPA.

The brief was as follows:

> *The AA screening is required to examine displacement of birds of this area based on the percentage occupied by the aquaculture at low tide. In addition detailed consideration needs to be given to disturbance in this area, and the ecology of the species to be impacted on. This must be carried out both for this site alone and also in combination with the three existing licences on the south shore.*

Aquaculture site T05/545 is an application for cultivation of Pacific Oysters (*Crassostrea gigas*) using bags and trestles (referred to hereafter as oyster trestle cultivation). It is located on the lower shore of Ballymacoda Bay adjacent to the three licensed aquaculture sites, which are also used for oyster trestle cultivation (Figure 1.1).

Aquaculture site T05/545 was previously included in an Appropriate Assessment of all aquaculture sites in Ballymacoda Bay. That assessment included separate reports addressing impacts on the Ballymacoda (Clonpriest & Pillmore) SAC (Marine Institute, 2017a) and the Ballymacoda Bay SPA (APEM, 2016), as well as a Concluding Statement (Marine Institute, 2017b).

In carrying out this assessment, I have drawn on my experience of waterbird monitoring, research and assessment in Irish coastal SPAs. This includes designing and carrying out a study of the relationship between waterbird distribution and oyster trestle cultivation (the Trestle Study), preparing reports supporting Appropriate Assessment of aquaculture and shellfisheries in eleven SPAs, monitoring waterbird distribution in relation to oyster trestle cultivation at Dungarvan Harbour over four winters, and various other studies and assessments

This assessment makes use of unpublished data and mapping from Ballymacoda Bay carried out in 2010/11 for the Marine Institute as part of the Trestle Study. Permission to use this material has been granted by the Marine Institute.

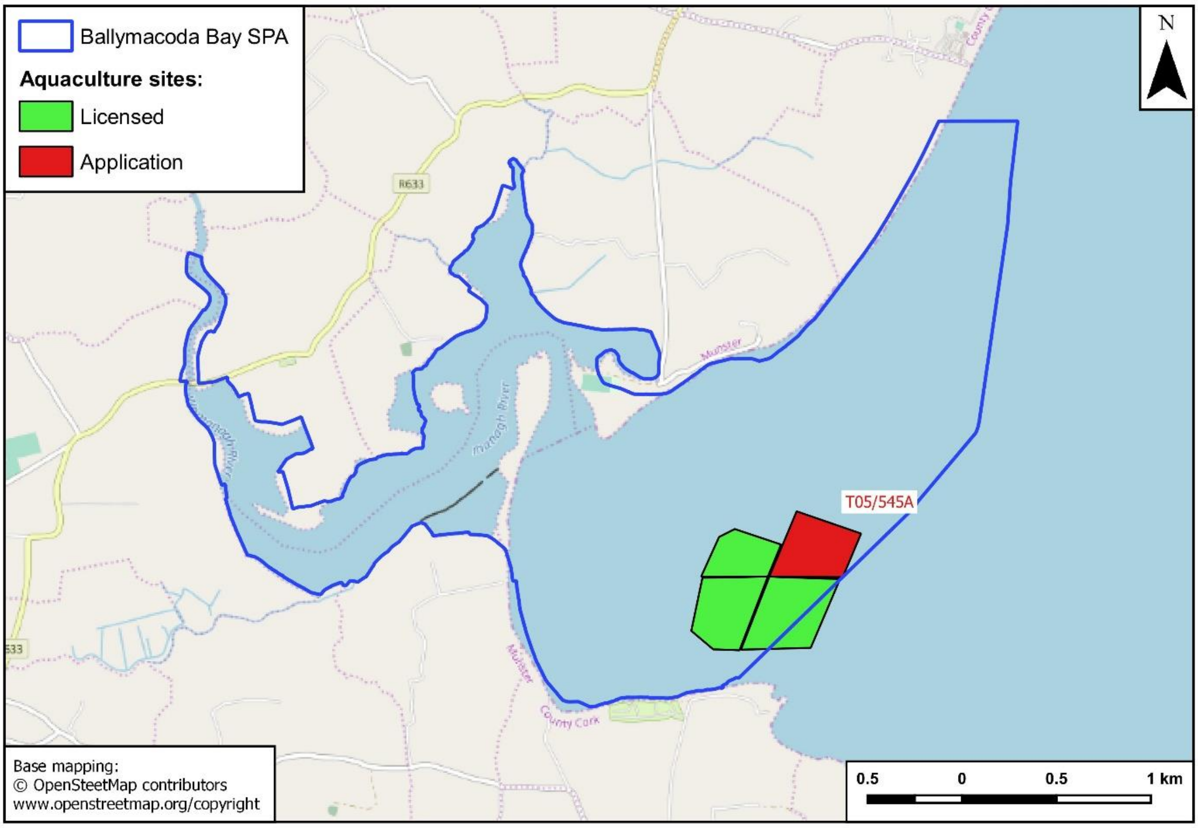

Figure 1.1. Ballymacoda Bay SPA and the aquaculture sites covered by this assessment.

2. METHODOLOGY

2.1. SITE DIVISIONS

The Ballymacoda Bay SPA can be divided into two broad zones: the Estuary Zone and the Bay Zone (Figure 2.1). The Estuary Zone comprises the section of the SPA upstream of Ring Point, which is protected from the open sea by sand dunes along the upper shores of Ring Strand and Pilmore Strand. The intertidal habitat in the Estuary Zone occurs in a band a few 100 m wide around the sinuous channel of the Womanagh River. The Bay Zone comprises the section of the SPA downstream of Ring Point, which is exposed to the open sea. In the southern part of this zone, the intertidal habitat extends out for around 1.5 km, with the width of the intertidal progressively diminishing to the north. The division between the muddier sediments in the Estuary Zone and the sandier sediments in the Bay Zone is reflected in the mapping of marine community types by NPWS (2015a): the Estuary Zone is classified as the *sandy mud with Hediste diversicolor and Tubificoides benedii community* while the Bay Zone classified as the *sand with polychaetes and bivalves community complex*.

The Bay Zone is bisected by the tidal channel of the Womanagh River and can be further subdivided into Ring Strand to the south of the channel and Pilmore Strand to the north of the channel (Figure 2.1). While not mapped by NPWS (2015a), the Pilmore Strand subdivision contains extensive areas of mixed sediment shore habitat (LS5; Fossitt, 2007), which extend out to the lower shore. This comprises a mixture of scattered gravel/cobbles on from muddy sand and denser areas of continuous gravel/cobbles, with the latter holding some mussel beds. Based on mapping carried out by Gittings and O'Donoghue (2012b), around 40% of the intertidal habitat in the Pilmore Strand subdivision comprises mixed sediment shore habitat. There is no significant area of mixed sediment shore habitat in the lower shore of the Ring Strand subdivision.

The licensed aquaculture sites and the application site all occur in the lower part of the intertidal zone on Ring Strand. During some of the waterbird counts that provided data used for this assessment, count sectors were defined that encompassed these aquaculture sites and the remaining intertidal habitat at a similar elevation on Ring Strand. This overall area is referred to as the lower shore zone on Ring Strand (Figure 2.1).

2.2. AQUACULTURE MAPPING AND INFORMATION

The mapping of the aquaculture sites used for this assessment is taken from the *Ballymacoda_2019.shp* shapefile received from the Aquaculture Licences Appeals Board on 1st November 2019.

I mapped the extent of trestles during the Trestle Study counts by GPS on 12th October 2010 and 19th February 2011. A block of trestles in aquaculture site T05/491A was not mapped because it was not exposed on either date.

Details of the proposed aquaculture operations in aquaculture site T05/545A are taken from the Aquaculture Profile report and accompanying spreadsheet (BIM, 2016).

2.3. WATERBIRD DATA

The primary data sources used for this assessment were the 2010/11 NPWS Waterbird Survey Programme counts[1] and waterbird counts carried out for the Marine Institute, also in the winter of 2010/11 (the Trestle Study).

2.3.1. Waterbird Survey Programme counts

Details of the Waterbird Survey Programme (WSP) methodology and results at Ballymacoda Bay are described in Cummins and Crowe (2011) and Lewis and Tierney (2014).

[1] These are referred to as the BWS counts by APEM (2016).

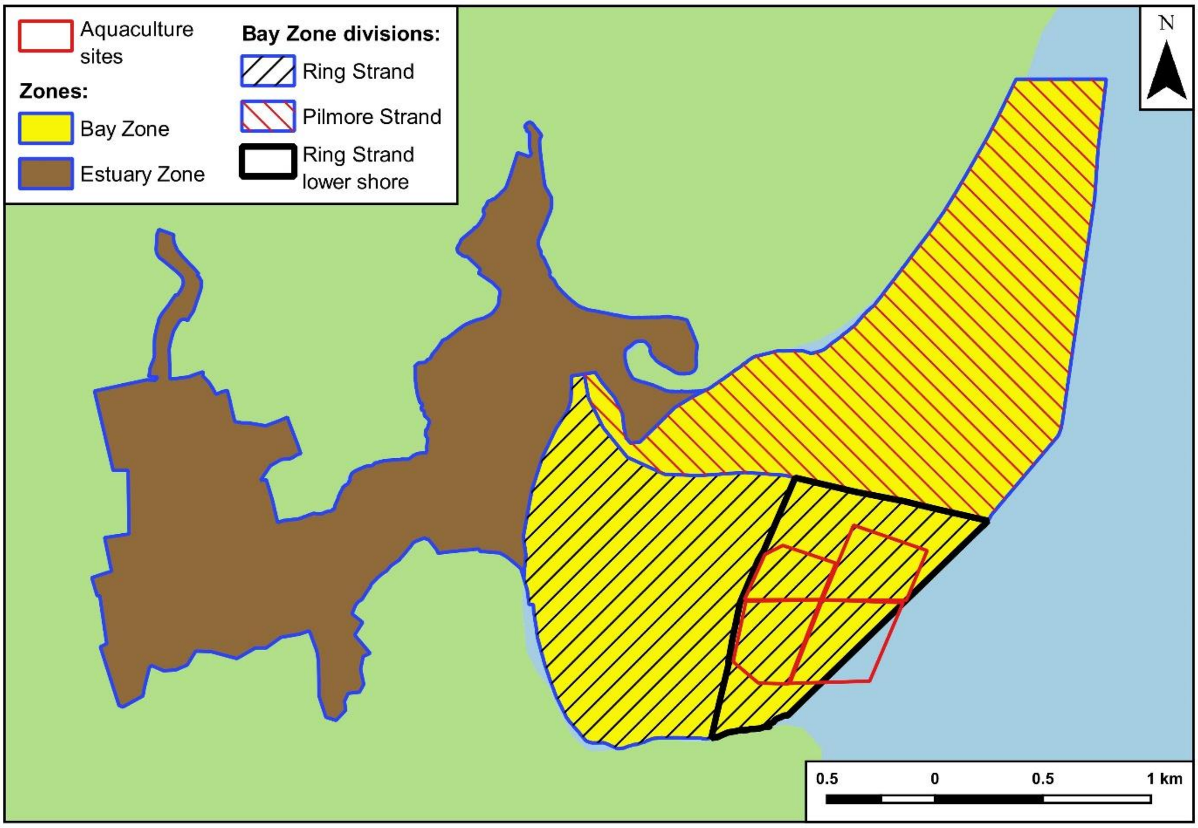

Figure 2.1. Zones and divisions used in this report.

Four low tide counts, and one high tide count, were carried out. The low tide counts were carried out in October, November and December 2011 and February 2012. The high tide count was carried out in January 2011. The counts were carried out by a coordinated team of three professional counters. All the counts were completed in a single day and there was complete coverage on each count (Cummins and Crowe, 2011).

The total area covered was divided into 11 subsites, of which seven covered the Estuary Zone, and four covered the Bay Zone (Figure 2.2). A single subsite (0L572) was used to cover Ring Strand.

The WSP counted feeding and roosting birds separately. However, I 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.

2.3.2. Trestle Study counts

As part of a study of the effects of oyster trestle cultivation on waterbird distribution (Gittings and O'Donoghue, 2012b, 2016), a series of waterbird counts were carried out at Ballymacoda Bay in the winter of 2010/11.

These counts covered the Bay Zone. The survey area was divided into nine count sectors (Figure 2.2). There were five sectors covering Ring Strand. Three sectors covered the lower shore: one containing the existing area of trestles (OY), one covering the area to the south of the trestles (CS1) and one covering the area to the north of the trestles (CS2). The remaining area of Ring Strand was divided into two sectors (CS3 and CS4). The count sectors excluded the rocky zone along the upper edge of the southern shoreline of Ring Strand. The mapped lower boundaries of the count sectors are only indicative. In practice, all birds on the intertidal were counted as far as the tideline, and birds in subtidal habitat just below the tideline were also counted.

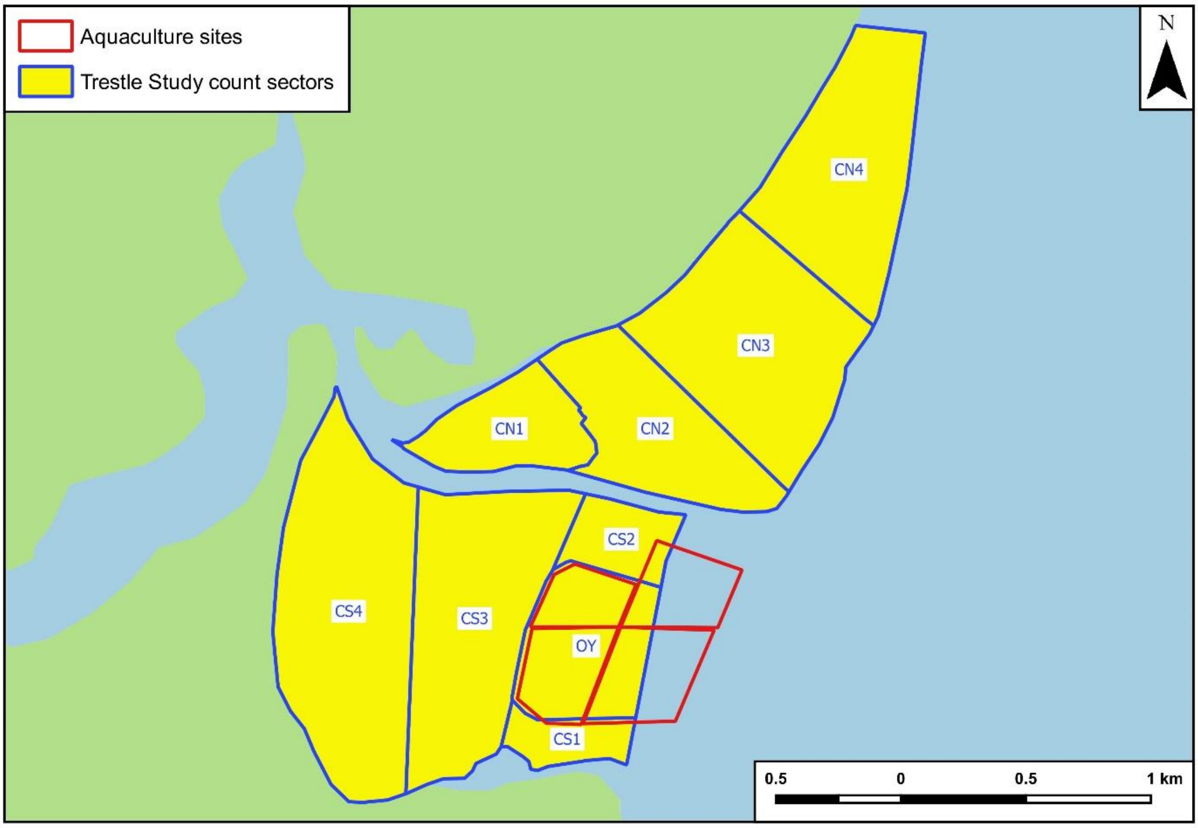

Figure 2.2. Count sectors used for the Trestle Study.

Low tide counts were carried out on four dates in January and February 2011, with two complete counts carried out on each data. The counts were carried out by a coordinated team of two professional counters. The counts were carried out in a four hour window around low tide, corresponding to the period of exposure of the trestles and each count was completed within a period of around two hours.

2.4. TIDELINE MAPPING AND TIDAL DATA

As part of the Trestle Study, the tideline in Ring Strand was mapped at full low tide on two dates: 12th October 2010 and 19th February 2011. I also mapped the tideline for the present assessment on 29th October 2019. On each date, part or all of the tideline was mapped by walking along the tideline with a GPS. On 29th October 2019, I mapped the tideline within the oyster trestles by eye with reference to the configuration of the trestles.

The tidal exposure patterns in the outer part of Ballymacoda Bay appear to be strongly influenced by weather conditions. On two of the dates when tideline mapping was carried out, the tidal exposure was noted to be significantly less than indicated by the predicted astronomical tides. Therefore, to help interpret the tidal exposure patterns, I used tidal monitoring data from Ballycotton Harbour (Irish National Tide Gauge Network; https://bit.ly/2OoPra8). This monitoring station is around 10 km SW of Ballymacoda Bay and is located in a similar east-facing bay. It seems reasonable to assume that weather conditions will be similar here, and will have similar relative influences on tidal heights. Therefore, while the absolute values of the tidal heights may differ, I have assumed that the tidal monitoring data from Ballycotton Harbour can be used an index of variation in tidal heights in Ballymacoda Bay.

2.5. ASSESSMENT METHODOLOGY

2.5.1. Identification of potential impacts

Impact types

The potential impacts of oyster trestle cultivation on waterbirds include displacement of birds from areas occupied by oyster trestles, and disturbance to birds in areas outside the oyster trestles.

Impacts within the aquaculture site

The primary source of information used for the identification of potential impacts within the aquaculture site is the Trestle Study (Gittings and O'Donoghue, 2012b, 2016). This study was carried out in six Irish estuaries with oyster trestle cultivation, including Ballymacoda Bay. The study used the results of counts of waterbirds within oyster trestles and in areas of comparable habitat without trestles, and quantification of the available habitat within and outside the trestles, to analyse the relationship between waterbird distribution patterns and the presence of oyster trestles. The results of the analyses were used to identify consistent patterns of positive or negative association with oyster trestles across the sites studied and categorised species into the following groups: neutral/positive response, negative response, exclusion response, and variable response (response may vary between sites).

In this assessment, species that were classified as having a negative response, exclusion response, or variable response were all assumed to be potentially negatively affected by oyster trestle cultivation. The nature of the potential impacts to these species is the displacement from the aquaculture site of some, or all, individuals that would have otherwise occurred in the aquaculture site.

Disturbance impacts outside the aquaculture site

The Trestle Study did not investigate disturbance impacts from oyster trestle cultivation outside areas occupied by oyster trestles. At sites with large aggregations of aquaculture sites, the potential disturbance impact outside the aquaculture sites will be small relative to the impact within the aquaculture site as most activity will be within the interior of the aquaculture sites. However, aquaculture site T05/545A is a relatively small site on the periphery of the existing area of oyster trestle cultivation, and is located in an area that holds high densities of waterbirds (see Table 3.6). Therefore, it is relevant to consider potential disturbance impacts outside the aquaculture site.

The potential disturbance impacts include: energetic impacts from responses to disturbance and from loss of foraging time; and displacement impacts when sustained disturbance pressure prevents birds from occupying suitable habitat. Various modelling studies indicate that high levels of disturbance (multiple disturbance events per daylight hour) are required to cause significant energetic impacts (e.g., Goss-Custard et al., 2019). This level of disturbance is unlikely to be generated by husbandry activity associated with T05/545A, as such activity will only occur on a minority of low tides. However, the husbandry activity will involve sustained disturbance pressure. Therefore, in this assessment, I focus on the potential displacement impact caused by disturbance pressure preventing birds from occupying habitat adjacent to the aquaculture site (disturbance displacement).

Disturbance impacts will also occur when tractors are being driven to/from the aquaculture site along the access route. However, this access route will only be used a few times on each low tide when husbandry activity occurs. As discussed above, the frequency of its usage will not be sufficient to cause significant energetic impacts. Use of the access route will not involve sustained disturbance pressure so it will not cause displacement impacts. Therefore, the potential disturbance impacts from use of the access route are not likely to be significant and are not considered further in this assessment.

2.5.2. Assessment of impact magnitude

General approach

For each species that was assessed (the target species), I quantified the magnitude of the potential impact of the development of the aquaculture site by calculating the potential displacement as a percentage of the total Ballymacoda Bay population. I carried out separate calculations of the potential impacts from displacement of birds from the aquaculture site (occupancy displacement), and from displacement of birds from adjacent intertidal habitat due to disturbance (disturbance displacement). Each calculation involved using waterbird count data to calculate the percentage of the total Ballymacoda Bay population occurring in the count sector containing the aquaculture site or potentially disturbed area (waterbird occupancy), and multiplying this by the percentage of tidal habitat in this count sector which is occupied by the aquaculture site (trestle occupancy), or which is potentially affected by disturbance from husbandry activity associated with the aquaculture site. Because the aquaculture site is not exposed on every low tide, a correction factor was applied to reflect the proportion of low tides on which the aquaculture site is exposed. For the disturbance displacement, a correction factor was applied to reflect the percentage of birds displaced (as not all birds are displaced by disturbance).

The detailed calculation methods are described below. These calculation methods differ from those used in the Ballymacoda Bay SPA AA report (APEM, 2016) in a number of ways. My calculations use data from the Trestle Study counts to provide finer spatial resolution of waterbird distribution patterns in the Bay Zone, compared to the APEM calculations which used the single WSP subsite covering the whole of Ring Strand. Also, as described above, my calculations take account of the patterns of tidal exposure of the aquaculture site and adjoining intertidal habitat and include potential disturbance impacts outside the aquaculture site. They also differ from the APEM calculations by using waterbird population sizes in 2010/11 as the denominator in calculating percentages, rather than the baseline population sizes from the 1990s used in the APEM calculations. I consider, the former more appropriate as the conservation objectives explicitly refer to waterbird distribution patterns in 2010/11. Also, use of the baseline population sizes result in ecologically ambiguous results where there have been large decreases or increases in populations. For comparison, displacement impacts calculated using the APEM methodology are presented in Appendix 1.

Occupancy displacement calculation method

The intertidal habitat in aquaculture site T05/545A is not exposed on every low tide. Therefore, to calculate the potential displacement impact it is necessary to consider both the occurrence of the target species in the aquaculture site T05/545A and the exposure of intertidal habitat in this aquaculture site.

For each of the target species, I calculated the potential displacement impact using the following formula:

$$D_{OCC} = T_{exp} * T_{545}/T_{CS2} * W_{BZ} * W_{CS2}$$

where T_{exp} = the proportion of low tides during which the intertidal habitat in aquaculture site T05/545A is exposed; T_{545} = the mean area of intertidal habitat exposed in aquaculture site T05/545A on low tides when intertidal habitat is exposed in the aquaculture site; T_{CS2} = the mean area of intertidal habitat exposed in the Trestle Study sector CS2 when intertidal habitat is exposed in T05/545A; W_{BZ} = the proportion of the total Ballymacoda Bay population of the target species that occurs in the Bay Zone at low tide; and W_{CS2} = the proportion of the target species numbers occurring in the Bay Zone which occur within sector CS2.

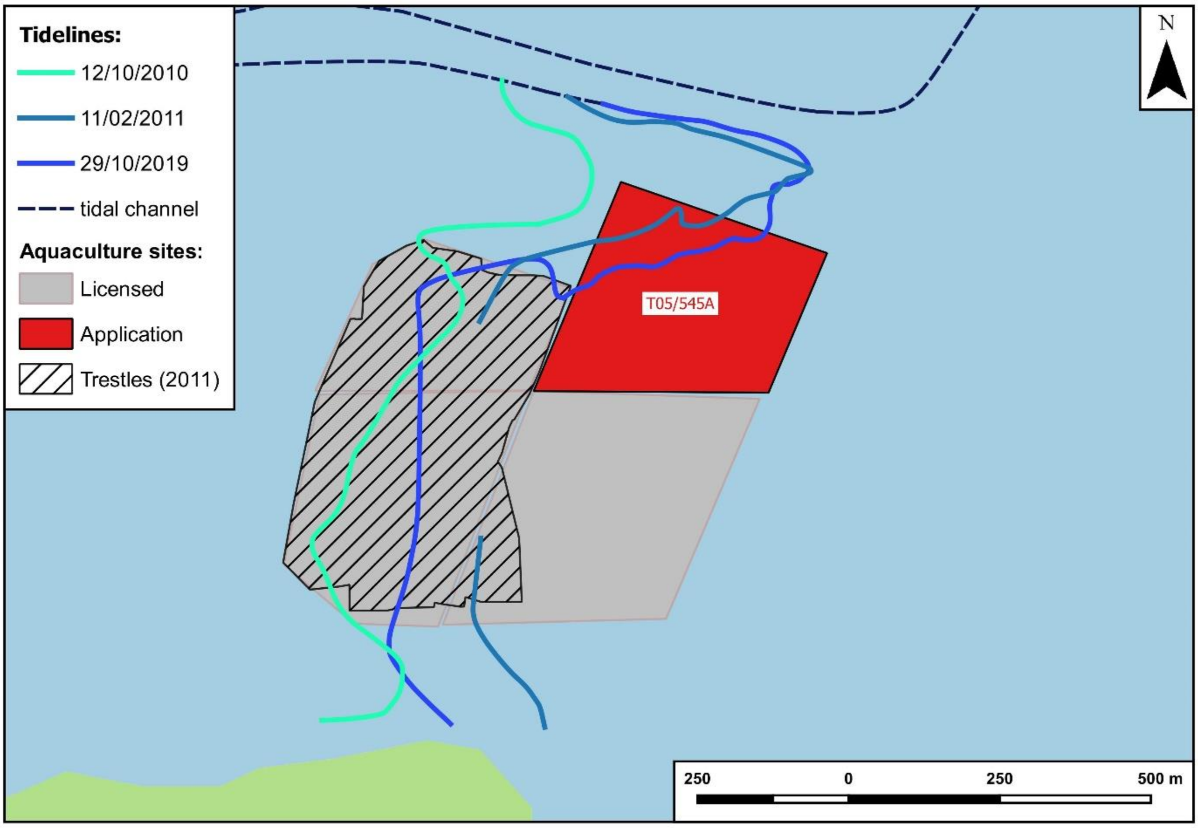

Figure 2.3. Mapped tidelines along the lower edge of Ring Strand at low tide.

I estimated the proportion of low tides during which the intertidal habitat in aquaculture site T05/545A is exposed (T_{exp}) as follows. Intertidal habitat was exposed in this aquaculture site on 19th February 2011 and 29th October 2019, when minimum tidal heights of 0.526 and 0.527 m were recorded at Ballycotton, but was not exposed on 12th October 2011, when a minimum tidal height of 1.096 was recorded at Ballycotton (Figure 2.3). I took the median between these tidal heights (0.811 m) as the threshold tidal height below which intertidal habitat in aquaculture site T05/545A will be exposed. In the tidal monitoring data from Ballycotton, 27.2% of low tides have a minimum tidal height below this threshold. Therefore, I used 0.272 as an estimate of the value of T_{exp}.

I used the tideline mapping from 19th February 2011 and 29th October 2019 to estimate the areas of intertidal habitat exposed in T05/545A (T_{545}), and in sector CS2 (T_{CS2}), on low tides when intertidal habitat is exposed in T05/545A. The ratio of these values is likely to overestimate the mean proportion of intertidal habitat in sector CS2 which occurs in T05/545 on those low tides, as there are more of those low tides in the range 0.528-0.811 m (72%), than in the range < 0.525 m (28%).

To estimate the proportions of the total Ballymacoda Bay population of the target species that occur in the Bay Zone at low tide (W_{BZ}), I used the maximum proportion of the total count that was recorded in the Bay Zone during the WSP low tide counts. I used the maximum, rather than the mean, because of the low number of counts. There were only four low tide counts carried out, and for some of the target species the effective sample size is only three counts, as they were absent, or only present in very low numbers on one of the low tide counts. A sample size of 3-4 counts is too low for calculations of meaningful occupancy levels using the means of the counts. There would be a high risk of any such calculated means underrepresenting the actual mean occupancy levels due to sampling effects. Therefore, as a precautionary measure, I have used the maximum waterbird occupancies for the calculation of displacement impacts.

To estimate the proportions of the Bay Zone numbers of the target species which occur within sector CS2 (W_{CS2}), I used data from the Trestle Study counts. For species which occurred in significant numbers in the Bay Zone on most, or all, of the Trestle Study counts, I used the mean count in CS2 and calculated 95% confidence intervals around this mean, and then divided the mean and upper and lower confidence interval limits by the mean total of the Trestle Study counts. For the other target species, I used the summed total counted in CS2 across all counts as a proportion of the summed totals in all sectors counted across all counts.

Disturbance displacement

A single husbandry worker working on trestles within an aquaculture site represents a point disturbance source. The potential disturbance impact of such a source can by assessed by drawing buffers around the point representing distances at which birds show various levels of response to disturbance. However, in practice, there are usually multiple husbandry workers present in aquaculture sites, while they will move around while they are working.

A typical pattern of husbandry activity is for a group of husbandry workers to be working on two adjacent lines of trestles, with a tractor driving up and down the lane between the trestle lines. Therefore, based on the dimensions in the licence applications, I have used 15 m wide subdivisions of T05/545A to simulate patterns of husbandry activity. Using positions at either end, and in the middle, of each of the upper two trestle blocks in the aquaculture site, I drew buffers around each of the positions representing potential disturbance zones. Based on data from Dungarvan Harbour (Gittings and O'Donoghue, 2018a, 2018b and 2019b), I used buffers of 100 m and 300 m, with 100% exclusion assumed within the 100 m buffer and 25% exclusion assumed within the 300 m buffer (see Section 4.3.3). I then calculated the mean area of intersection of each buffer with the area of sector CS2 exposed (outside the aquaculture site) on the two dates for which I had mapping of the exposed area. An example of the buffers generated from two subdivisions, and their overlap with the intertidal habitat exposed on one of the two dates, is shown in Figure 2.4.

The potential disturbance impact is then given by

$$D_{DIST} = T_{exp} * (DB_{100}/T_{CS2} + DB_{300}/T_{CS2}*0.25) * W_{BZ} * W_{CS2}$$

where DB_{100} = the mean area of intersection between the 100 m disturbance buffers and the mean area of intertidal habitat exposed in T05/545A on low tides when intertidal habitat is exposed in the aquaculture site; and DB_{300} = the mean area of intersection between the 100-300 m disturbance buffers and the mean area of intertidal habitat exposed in T05/545A on low tides when intertidal habitat is exposed in the aquaculture site.

Note that the above calculations assume that husbandry activity only takes place in T05/545A on days when intertidal habitat is exposed within the aquaculture site. Also, I assumed that most husbandry activity will take place in the upper two trestle blocks, because the lower trestle block will only be accessible on the lowest tides. I also assumed that no disturbance impacts would occur to birds on the northern side of the tidal channel, due to the physical barrier of the tidal channel.

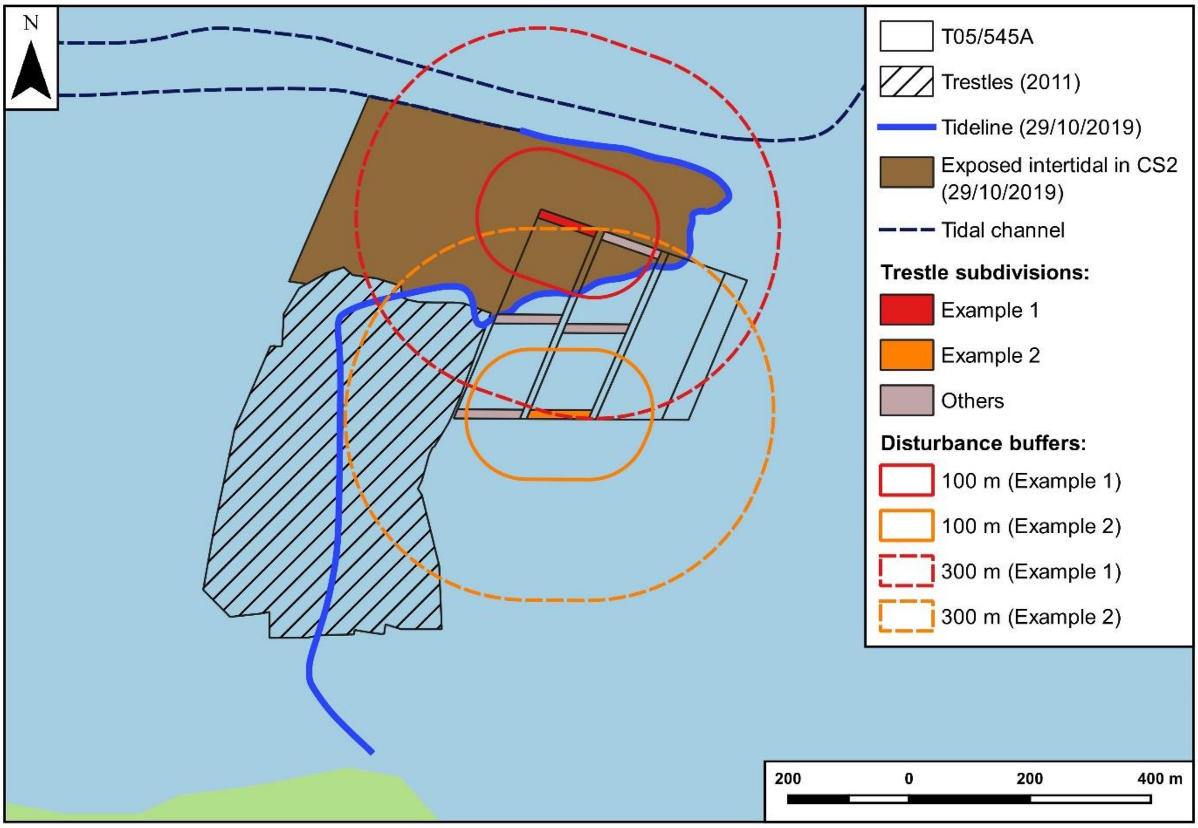

Figure 2.4. Trestle subdivisions used for calculation of potential disturbance impacts with examples of disturbance buffers generated for two of these lanes and their overlap with exposed intertidal habitat on one of the two dates used for the analysis.

2.5.3. Assessment of impact significance

I assessed the potential significance of the predicted impacts with reference to attribute 2 of the conservation objectives for the QI species of the Ballymacoda Bay SPA (NPWS, 2015b). This attribute states that "there should be no significant decrease in the range, timing and intensity of use of areas by … [QI species], other than that occurring from natural patterns of variation" (NPWS, 2015b). NPWS do not provide any guidance on what is considered a significant decrease. However, in a number of AA reports on aquaculture in coastal SPAs that I have co-authored (most recently Gittings and O'Donoghue, 2019a), we have used a 5% displacement level as a threshold for considering a displacement impact to be potentially significant. This 5% threshold was also used in the Ballymacoda Bay SPA AA report (APEM, 2016). This threshold is based on the typical error level in large-scale waterbird counts, which means that population changes of less than 5% are unlikely to be detected, while modelling studies indicate that habitat losses substantially greater than 5% are usually required to cause population-level impacts (see review in Gittings and O'Donoghue, 2019a).

Attribute 1 of the conservation objectives for the QI species of the Ballymacoda Bay SPA states that the long term population trend of the QI species should be stable or increasing. Displacement impacts do not necessarily translate to impacts on population trends as displaced birds will often find suitable alternative habitat within the site. Therefore, impacts on this attribute are only likely to occur if there are high levels of displacement impacts, so the 5% displacement threshold will generally be a conservative threshold in relation to potential impacts on population trends.

3. BALLYMACODA BAY SPA

3.1. QUALIFYING INTERESTS

There are 16 bird species that are listed as Qualifying Interests (QIs) of the Ballymacoda Bay SPA: Wigeon, Teal, Golden Plover, Grey Plover, Lapwing, Ringed Plover, Curlew, Black-tailed Godwit, Bar-tailed Godwit, Turnstone, Sanderling, Dunlin, Redshank, Black-headed Gull, Common Gull and Lesser Black-backed Gull (NPWS, 2015b). While not explicitly stated by NPWS (2015b), these species are all listed for their non-breeding/wintering populations.

The wetland habitat in the Ballymacoda Bay SPA is also listed as a QI of the Ballymacoda Bay SPA.

3.2. CONSERVATION OBJECTIVES

The conservation objectives for the Wigeon, Teal, Golden Plover, Grey Plover, Lapwing, Ringed Plover, Curlew, Black-tailed Godwit, Bar-tailed Godwit, Turnstone, Sanderling, Dunlin, Redshank, Black-headed Gull, Common Gull and Lesser Black-backed Gull QIs of the Ballymacoda Bay SPA are to maintain their favourable conservation condition (NPWS, 2015b).

The favourable conservation conditions of these QIs in the Ballymacoda Bay SPA are defined by various attributes and targets, which are shown in Table 3.1.

Table 3.1. Attributes and targets for the conservation objectives for the Wigeon, Teal, Golden Plover, Grey Plover, Lapwing, Ringed Plover, Curlew, Black-tailed Godwit, Bar-tailed Godwit, Turnstone, Sanderling, Dunlin, Redshank, Black-headed Gull, Common Gull and Lesser Black-backed Gull QIs of the Ballymacoda Bay 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 … [QI 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 (2015b). Attributes are not numbered in NPWS (2015b), but are numbered here for convenience.

The conservation objective for the Wetlands QI of the Ballymacoda Bay SPA is to "maintain the favourable conservation condition of the wetland habitat in Ballymacoda Bay SPA as a resource for the regularly occurring migratory birds that utilise it" (NPWS, 2015b).

The favourable conservation conditions of the Wetlands QI in the Ballymacoda Bay SPA is defined by the attribute and target shown in Table 3.2. Oyster trestle cultivation does not involve any changes to the area occupied by wetland habitat. Therefore, the development of aquaculture site T05/545A will not affect the conservation condition of the Wetlands QI of the Ballymacoda Bay SPA, and this QI is not considered further in this assessment.

Table 3.2. Attribute and target for the conservation objective for the Wetlands QI of the Ballymacoda Bay SPA.

Attribute	Measure	Target	Notes
Habitat area	Hectares	The permanent area occupied by the wetland habitat should be stable and not significantly less than the area of 602 hectares, other than that occurring from natural patterns of variation	The wetland habitat area was estimated as 602 ha using OSi data and relevant orthophotographs. For further information see part three of the Conservation Objectives Supporting Document.

Source: NPWS (2015b).

3.3. WATERBIRD DISTRIBUTION

For most of the QI species the waterbird numbers recorded in the WSP low tide counts were broadly comparable to numbers recorded in recent I-WeBS counts (Table 3.3). However, the numbers of Ringed Plover and Turnstone recorded in the WSP low tide counts were very low compared to peak I-WeBS counts for recent winters (Table 3.3). Therefore, distribution patterns derived from the WSP low tide count data may not be very reliable for Ringed Plover and Turnstone.

The occurrence patterns of the waterbird QIs in the Bay Zone was generally in line with their typical habitat preferences (Table 3.4). Ringed Plover, Bar-tailed Godwit and Sanderling, which are typically associated with sandier sediments all occurred mainly, or exclusively, in the Bay Zone, while species such as Teal, Lapwing, Black-tailed Godwit and Redshank which are typically associated with muddier sediments occurred mainly in the Estuary Zone.

For most of the QI species, the mean Trestle Study count (which only included birds in the Bay Zone) as a percentage of the mean WSP count for the whole site was similar to, or greater than, the mean percentage of the WSP count in the Bay Zone (Table 3.4). This indicates that the numbers recorded in the Trestle Study counts, for these species, were broadly representative of the numbers likely to occur in the Bay Zone over the winter[2]. However, the Trestle Study counts of Ringed Plover and Sanderling as percentages of the WSP counts were low compared to the mean and maximum percentages of the WSP count in the Bay Zone for these species (Table 3.4).

In the Trestle Study counts, Wigeon and Sanderling showed a strong concentration along the tideline, but the other QI species were not concentrated along the tideline (Table 3.5). Apart from Bar-tailed Godwit, overall densities were higher in Ring Strand than Pilmore Strand (Table 3.6). Within Ring Strand, the area to the north of the existing trestles (sector CS2) generally held the highest densities (Table 3.6). Note that the densities are not corrected for tidal exposure but are based on the mapped count sector boundaries. However, these mapped sector boundaries broadly represent the average tidal exposure across the Trestle Study counts.

[2] The much higher percentages in the Trestle Study/WSP comparisons for some species such as Wigeon and Grey Plover reflect the differences in the seasonal timing with the October WSP count occurring before the main arrival of wintering birds.

Table 3.3. Waterbird numbers recorded in Ballymacoda Bay during the WSP low tide counts compared to I-WeBS data.

Species	WSP low tide		I-WeBS counts	
	mean	range	2010/11 peak count	2011/12-2015/16 mean peak count
Wigeon	737	441-1037	82	499
Teal	662	344-1011	107	495
Golden Plover	2630	703-5750	98	6720
Grey Plover	112	35-212	52	231
Lapwing	598	41-1492	4	1150
Ringed Plover	28	4-64	103	219
Curlew	422	253-553	393	453
Black-tailed Godwit	945	327-1945	398	1034
Bar-tailed Godwit	425	181-651	44	591
Turnstone	21	14-27	73	168
Sanderling	105	6-158	114	191
Dunlin	620	310-1005	868	805
Redshank	285	202-371	258	272
Black-headed Gull	301	52-629	286	1302
Common Gull	216	57-418	170	633
Lesser Black-backed Gull	175	30-329	367	3543

I-WeBS: 2010/11 and 2015/16 counts considered poor quality; no counts for 2013/14.

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

Table 3.4. Waterbird occurrence in the Bay Zone.

Species	% of total WSP count in the Bay Zone		TS count as a % of the WSP count	
	mean	range	mean	max
Wigeon	17%	3-35%	43%	85%
Teal	1%	0-3%	0%	1%
Golden Plover	7%	0-13%	6%	9%
Grey Plover	56%	35-97%	123%	118%
Lapwing	2%	0-5%	9%	16%
Ringed Plover	94%	81-100%	28%	36%
Curlew	16%	8-25%	15%	30%
Black-tailed Godwit	17%	0-50%	0%	0%
Bar-tailed Godwit	84%	66-100%	135%	141%
Turnstone	75%	43-100%	65%	141%
Sanderling	100%	100%	52%	70%
Dunlin	41%	31-62%	124%	113%
Redshank	27%	9-34%	20%	24%
Black-headed Gull	40%	18-79%	14%	22%
Common Gull	37%	21-56%	46%	49%
Lesser Black-backed Gull	25%	0-85%	17%	21%

The TS count as a % of the WSP count columns show the mean Trestle Study count as a percentage of the mean WSP count and the maximum Trestle Study count as a % of the maximum WSP count.

Data sources: 2010/11 Waterbird Survey Programme as undertaken by the National Parks & Wildlife Service; and waterbird counts carried out for the Marine Institute (Gittings and O'Donoghue, 2012b).

Table 3.5. Percentage of birds on the tideline during the Trestle Study counts.

Species	Mean	Range	Sum
Wigeon	97%	87-100%	-
Golden Plover	-	-	1%
Grey Plover	14%	1-38%	-
Lapwing	-	-	0%
Ringed Plover	-	-	0%
Curlew	12%	2-26%	-
Bar-tailed Godwit	32%	2-91%	-
Turnstone	-	-	18%
Sanderling	76%	43-100%	-
Dunlin	12%	0-41%	-
Redshank	13%	7-34%	-
Black-headed Gull	35%	4-71%	-
Common Gull	21%	8-38%	-
Lesser Black-backed Gull	6%	4-10%	-

Only counts with totals > 9 included in the calculation of means and ranges. For Golden Plover, Lapwing, Ringed Plover and Turnstone there were too few qualifying counts to calculate means and ranges. Instead the summed numbers across all counts were used to calculate percentages.

Data source: waterbird counts carried out for the Marine Institute (Gittings and O'Donoghue, 2012b).

Table 3.6. Mean densities (birds/km^2) during the Trestle Study counts.

Species	Pilmore Strand	Ring Strand					
		overall	CS1	OY	CS2	CS3	CS4
Wigeon	24	62	16	8	677	7	23
Grey Plover	10	20	9	2	95	31	3
Curlew	3	10	16	1	17	7	15
Bar-tailed Godwit	80	37	54	10	167	59	7
Sanderling	6	12	0	0	66	8	4
Dunlin	58	109	12	1	607	108	69
Redshank	2	9	30	11	6	7	9
Black-headed Gull	1	9	40	18	23	5	2
Common Gull	8	12	82	1	37	12	4
Lesser Black-backed Gull	1	15	11	0	24	5	20

Data source: waterbird counts carried out for the Marine Institute (Gittings and O'Donoghue, 2012b).

4. IMPACT ASSESSMENT

4.1. PROJECT DESCRIPTION

The aquaculture site (T05/545A) that is the subject of this assessment is an 11.2 ha site located to the north-east of the existing area of trestles in the lowermost part of the intertidal zone on Ring Strand (Figure 4.1). The only aquaculture activity within this site will be cultivation of Pacific Oysters (*Crassostrea gigas*) using bags and trestles (oyster trestle cultivation).

There are no trestles currently present in this site, and there is no evidence that this site has ever had any trestles (BIM, 2016).

Based on the map submitted with the application around 85% of the site will be occupied by double rows of trestles (including the 4 m wide lanes between the trestles), 6% will be occupied by 12 m wide interior access lanes between trestles blocks, and 9% will be undeveloped (Figure 4.2). The undeveloped section will be the lowest part of the site along its eastern edge.

The site will be accessed from the southern shoreline of Ring Strand following a route along the edge of, and through, the existing trestle blocks (Figure 4.2).

Information supplied with the aquaculture profile in the *Ballymacoda_Production_overview.xlsx* spreadsheet about husbandry activity combined this site with another application site (T05/482B)[3]. All husbandry activity will take place within a 1.75-4.75 hour window centred around low tide. The numbers of days that would be worked across both sites was stated to be 165 days per year with seed intake from March-May, harvesting from September-April and turning taking place throughout the year. It was also stated that work would take place on night time tides “if required due to weather and work loads”.

4.2. POTENTIAL IMPACTS

The potential impacts of oyster trestle cultivation on waterbirds includes changes to habitat structure, impacts on food resources and disturbance.

4.2.1. Habitat structure

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, it has been hypothesised that trestles may interfere with flocking behaviour causing species that typically occur in large, tightly packed flocks to avoid the trestles, and/or with detection of prey by visual feeders (Gittings and O’Donoghue, 2012b, 2016). Trestles could also interfere with the visibility of potential predators causing increased vigilance and reduced foraging time and cutting off potential escape routes (Kelly et al., 1996; Gittings and O’Donoghue, 2012b, 2016; Burger et al., 2015).

4.2.2. Food resources

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

[3] Note that the spreadsheet does not include licence numbers, but I have deduced this attribution from other information included in the spreadsheet.

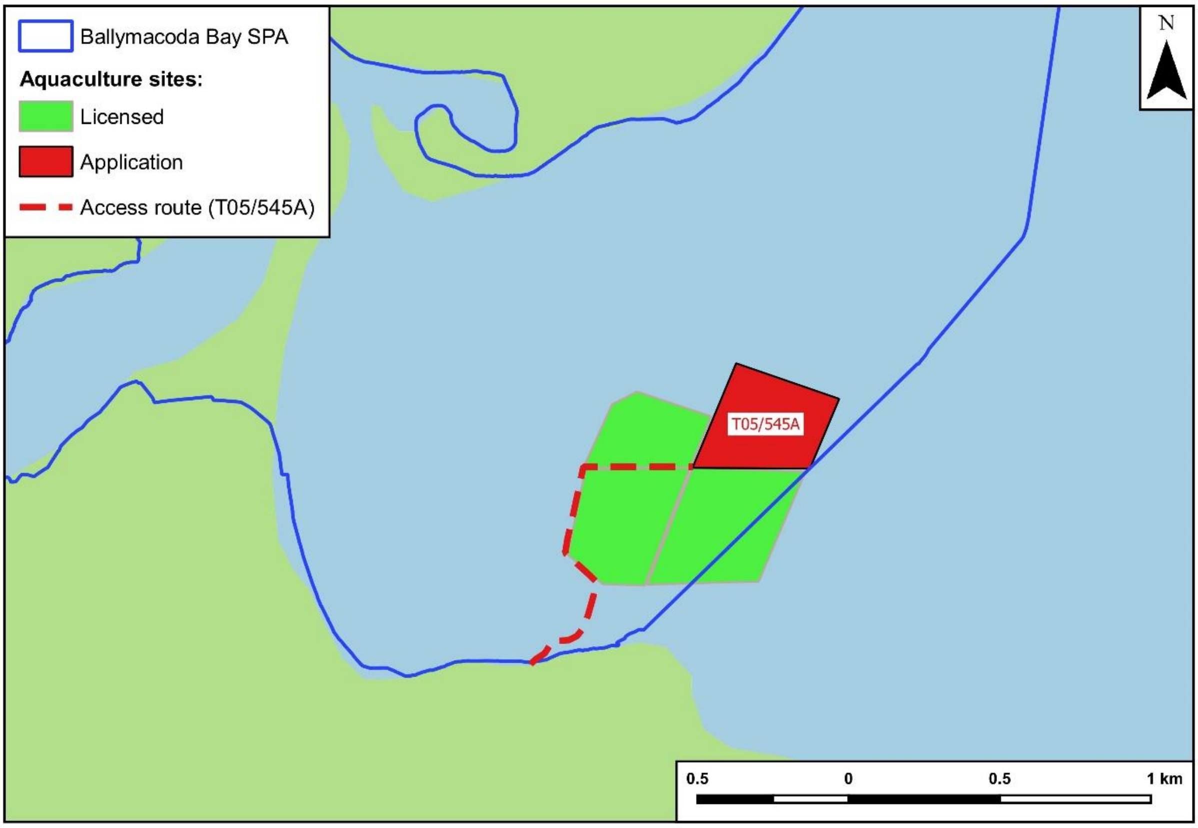

Figure 4.1. Aquaculture site T05/545A and access route.

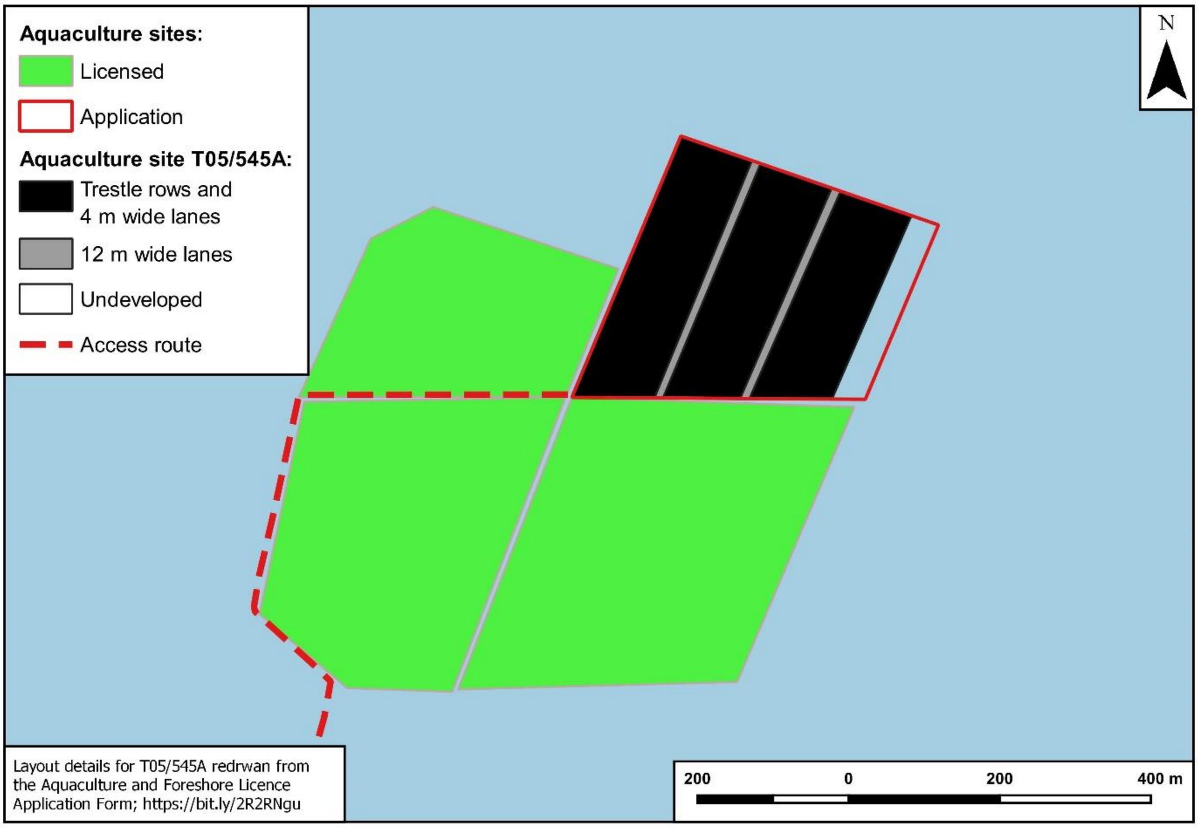

Figure 4.2. Proposed layout of trestles rows and lanes in aquaculture site T05/545A.

The Irish study referred to above was carried out at Dungarvan Harbour (De Grave et al., 1998). This study compared an oyster trestle block with a control site approximately 300 m away. 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.

In more recent work, 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.

4.2.3. Disturbance

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 because no husbandry activity takes place during the high tide period.

4.3. WATERBIRD RESPONSES

4.3.1. Trestle Study

The Trestle Study (Gittings and O'Donoghue, 2012b, 2016) provides data on the nature of the association between oyster trestles and bird distribution patterns for many of the species included in this assessment. The study examined the combined potential effects of habitat alteration and disturbance from husbandry activity within trestle blocks. The sites included in the study included some with very high levels of husbandry activity. Therefore, the responses of waterbirds to oyster trestle cultivation reported by the Trestle Study include the effects of disturbance within the trestle blocks.

Table 4.1 shows site-specific data from the Trestle Study for Ballymacoda Bay. This indicates the nature of the association with oyster trestles using Jacobs Index (D) values (Jacobs, 1974). These D values can vary from +1 (indicating that all birds occur within the trestle blocks) to -1 indicating complete avoidance of the trestle bocks. These analyses were carried out at two scales: all sectors, which included all the Trestle Study count sectors; and close sectors, which only included count sectors OY, CS1, CS2 and, for some species, CS3. Table 4.1 also includes the overall response to oyster trestles as categorised by Gittings and O'Donoghue (2016) using data from all the sites included in the Trestle Study.

Grey Plover appears to be almost 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, 2019b). Grey Plover is a visual feeder which typically occurs at low densities. Each individual bird requires open areas to detect prey at the surface over a wide area, and to allow it to make sudden runs to capture prey (see Pienkowski, 1980). Oyster trestles and other structures are likely to interfere with this behaviour. Therefore, Grey Plover may be particularly sensitive to oyster trestle cultivation, and other similar types of aquaculture activity, due to this foraging behaviour (Connolly and Colwell, 2005; Gittings and O'Donoghue, 2016).

The overall occurrence pattern of Grey Plover at Ballymacoda Bay in the Trestle Study showed as a strong negative association with oyster trestles (Table 4.1). There were only two records of a total of eight Grey Plover, from the trestle blocks out of 74 records of a total of 1273 birds across all counts. Both the records from the trestle blocks were on counts when the tideline was close to the upper edge of the trestles.

Dunlin and Bar-tailed Godwit both showed strong negative patterns of association with oyster trestles in the data from the Trestle Study, but small numbers of both species can occur within trestle blocks. For Bar-tailed Godwit, the negative association with trestles was further supported by subsequent monitoring work at Dungarvan Harbour (Gittings and O'Donoghue, 2015, 2018a, 2018b, 2019b). 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. Both species showed strong negative associations with oyster trestles in the Ballymacoda Bay data (Table 4.1).

Ringed Plover and Sanderling were also classified by the Trestle Study as having a negative response to trestles, but this was based on limited data. Subsequent monitoring work at Dungarvan Harbour (Gittings and O'Donoghue, 2015 and unpublished data) and, for Sanderling, at Donegal Bay (Gittings and O'Donoghue, 2012a; Atkins, 2016) has provided further evidence of strong avoidance of oyster trestles by these species. At Ballymacoda Bay, the Ringed Plover counts during the Trestle Study were too low to allow analysis of patterns of association with trestles, while Sanderling showed a strongly negative pattern of association (Table 4.1). During the WSP low tide counts at Ballymacoda Bay, it was noted that while the subsite covering Ring Strand supported the highest numbers of Sanderling, they "were not recorded in association/near the aquaculture trestles that occur on the lower shore in this subsite" (NPWS, 2014).

Lesser Black-backed Gull was also classified as having a negative response to trestles. However, this was based on limited data and largely reflected apparent avoidance of trestles by roosting flocks, rather than impacts on feeding birds. At Ballymacoda Bay, this species showed a strong negative pattern of association with trestles, although it was only present in the survey area in significant numbers on four counts.

The Trestle Study only produced limited data for Wigeon, with a negative pattern of association at Ballymacoda Bay (Table 4.1), and a neutral/positive pattern at another site. This species can feed on the algae that attaches to the trestle bags. However, during the Trestle Study counts at Ballymacoda Bay it was noted that the trestles were "clean" looking with little algae on the bags.

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[4]. At Ballymacoda Bay, Curlew and Common Gull showed negative patterns of association, while Black-headed Gull showed a neutral/positive pattern of association (Table 4.1). Unlike Lesser Black-backed Gull, most Black-headed Gull and Common Gull recorded at Ballymacoda Bay were feeding rather than roosting.

Turnstone and Redshank were showed an overall neutral/positive pattern of association with oyster trestles in the Trestle Study. Redshank showed neutral/positive pattern of association at Ballymacoda Bay (Table 4.1), while Turnstone were not recorded in sufficient numbers at Ballymacoda Bay for this analysis. For Turnstone, their neutral/positive pattern of association with trestles reflects their habit on feeding on the trestles where they search for prey amongst attached seaweeds.

[4] Curlew was classified as having an overall neutral/positive pattern of association with oyster trestles by Gittings and O'Donoghue (2012b). However, based on further analysis of the dataset by Gittings and O'Donoghue (2016), its response is now classified as variable.

Table 4.1. Summary of patterns of association with oyster trestles at Ballymacoda Bay.

Species	Overall response	Jacobs index (D) values for Ballymacoda Bay							
		All sectors				Close sectors			
		D_{sum}	D_{min}	D_{max}	n	D_{sum}	D_{min}	D_{max}	n
Wigeon	(Variable)	-0.87	-0.61	-1.00	7	-0.96	-	-	-
Grey Plover	Exclusion	-0.83	-1.00	-1.00	3	-0.91	-0.50	-1.00	5
Sanderling	(Negative)	-1.00	-	-	-	-1.00	-1.00	-1.00	3
Dunlin	Negative	-0.99	-0.82	-1.00	8	-0.99	-0.90	-1.00	8
Bar-tailed Godwit	Negative	-0.77	-0.27	-1.00	7	-0.73	-0.25	-1.00	8
Curlew	Variable	-0.70	-	-	-	-0.82	-	-	-
Redshank	Neutral/positive	+0.35	-	-	-	+0.05	+0.18	-0.09	3
Black-headed Gull	Variable	+0.53	-	-	-	+0.05	+0.41	-0.46	3
Common Gull	Variable	-0.85	-	-	-	-0.90	-0.76	-1.00	3
Lesser Black-backed Gull	(Negative)	-1.00	-	-	-	-1.00	-	-	-

D_{sum} values from Gittings and O'Donoghue (2016) and are based on summed data across all counts. D_{min} and D_{max} values show the minimum and maximum D values on individual counts. These were calculated from unpublished data collected during the Trestle Study and are only shown for species where at least three counts had sufficient data for calculating D values. Overall response is based on Table 6 in Gittings and O'Donoghue (2016).

4.3.2. Species not covered by the Trestle Study

The other species included in this assessment are: Teal, Golden Plover, Lapwing and Black-tailed Godwit. 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 Lapwing and Black-tailed Godwit, the Trestle Study found some weak evidence of negative association with trestles, from ordination analyses and/or qualitative assessment of count data (Gittings and O'Donoghue, 2012b).

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).

Black-tailed Godwit is behaviourally and ecologically similar to Bar-tailed Godwit. Therefore, it seems likely that Black-tailed Godwit will show a similarly strong negative response to trestles, as shown by Bar-tailed Godwit.

No evidence is available about the nature of the response of Teal to trestles, so a precautionary classification of a negative response has been made for the purpose of this assessment.

4.3.3. Disturbance responses

The responses of waterbirds to oyster trestle cultivation reported by the Trestle Study and discussed above include the effects of disturbance within the trestle blocks.

The Trestle Study did not investigate disturbance impacts from husbandry activity to waterbirds outside the trestle blocks. However, monitoring work at Dungarvan Harbour collected observations on the disturbance responses of four species (Grey Plover, Bar-tailed Godwit, Knot and Dunlin) to oyster trestle cultivation husbandry activity (Gittings and O'Donoghue, 2018a, 2018b, 2019b). These observations were made in an area from which oyster trestles had been removed (the Bird Corridor) and involved responses to oyster husbandry activity in adjacent areas of oyster trestles, or to movements of tractors travelling to/from areas of oyster trestles past the Bird Corridor. There was an 80% flush response within 100 m of the disturbance source (n = 5 observations), a 23% flush response between 100 and 300 m (n = 30), and a negligible flush response at distances greater than 300 m (n = 84). While this data is limited, I consider it to be broadly representative of typical disturbance responses of these, and other wader species, based on my experience in monitoring waterbirds over five winters at Dungarvan Harbour. However, it should be noted that the disturbance stimuli were activities outside trestle blocks, or at the edges of trestle blocks. Activity within the interior of trestle blocks may have lower disturbance impacts, as the trestle blocks may act as barriers to the disturbance perceived by birds outside the trestle blocks.

4.3.4. Screening

Based on the above review of evidence about species association with trestles, Turnstone and Redshank can be screened out from further assessment as they have an overall neutral/positive pattern of association with trestles across sites and, for Redshank, the site-specific data from Ballymacoda Bay conforms to this pattern.

Black-headed Gull has a variable pattern association with trestles across sites, while the site-specific data indicates a neutral pattern of association at Ballymacoda Bay. However, this species has been retained in the assessment on a precautionary basis.

All the other QI species have negative patterns of association with trestles, or variable patterns of association with evidence of negative patterns at Ballymacoda Bay, or have a precautionary classification of a negative response in the absence of data.

Following this screening, the QI species included in the detailed assessment are: Wigeon, Teal, Golden Plover, Grey Plover, Lapwing, Ringed Plover, Curlew, Black-tailed Godwit, Bar-tailed Godwit, Sanderling, Dunlin, Black-headed Gull, Common Gull and Lesser Black-backed Gull. These species are referred to as the target species.

4.4. PREDICTED IMPACTS

4.4.1. General

The percentage occurrences in the Bay Zone and in sector CS2 that were used in the displacement calculations are shown in Table 4.2.

The predicted displacement impacts for the target species are shown in Table 4.3. The highest predicted displacement impact is for Sanderling with a mean value of 2.8%, while its 95% confidence interval overlaps the 5% threshold. None of the other predicted displacement impacts have confidence intervals that overlap the 5% threshold.

There are a number of important limitations that affect the reliability of the predicted displacement impacts. These include: the limited dataset that was available for analysing waterbird distribution patterns in Ballymacoda Bay, the limited data on tidal exposure patterns in the aquaculture site and adjoining areas; lack of site-specific and species-specific data on disturbance responses to husbandry activity; the representativeness of disturbance responses to activity on the edge of, or outside, trestle blocks in assessing disturbance impacts from activity in the interior of trestle bocks; the assumption that waterbirds occur within the aquaculture site in proportion to the area occupied by the aquaculture site; and the precautionary assumption that all the target species are completely excluded from areas occupied by oyster trestle cultivation. Therefore, the predicted displacement impacts should be interpreted as indicative only.

In particular, the displacement analyses are based on waterbird distribution data for a single winter and mainly from January-February in that winter. This means that the predicted displacement impacts are best interpreted as predicting the displacement that would have occurred from development of the aquaculture site to waterbird distribution in January-February 2011.

It should also be noted that the calculation of disturbance displacement makes no correction for night-time low tides. Most waterbirds in intertidal sites feed to some degree at night. The information supplied with the aquaculture profile indicates that some night-time husbandry activity may occur in T05/545A, but this will presumably be less frequent than day-time activity. Therefore, for each target species, the potential disturbance displacement should be reduced by a factor representing the proportion of night-time low tides on which the species feeds and on which no husbandry activity occurs (restricted to low tides when T05/545A is exposed).

Specific issues affecting the potential reliability of the predicted displacement impacts for individual species are discussed in Section 4.4.2.

Table 4.2. Occurrence of the target species in the Bay Zone and in Trestle Study sector CS2.

Species	Bay Zone %	CS2 mean count	CS2 %
Wigeon	35%	228 (26-431)	63% (7-100%)
Teal	3%	-	50%
Golden Plover	13%	-	0%
Grey Plover	97%	34 (10-57)	25% (7-42%)
Lapwing	5%	-	0%
Ringed Plover	100%	-	10%
Curlew	25%	5 (0-11)	8% (0-16%)
Black-tailed Godwit	50%	-	0%
Bar-tailed Godwit	100%	59 (28-90)	10% (5-16%)
Sanderling	100%	21 (0-43)	34% (0-69%)
Dunlin	62%	215 (0-486)	28% (0-63%)
Black-headed Gull	79%	7 (1-14)	16% (2-29%)
Common Gull	56%	12 (2-22)	12% (2-22%)
Lesser Black-backed Gull	85%	-	11%

The *Bay Zone %* column shows the maximum percentage of the total count that occurred in the Bay Zone during the WSP low tide counts. The CS2 mean count column shows the mean counts (with 95% confidence intervals) in CS2 for species that occurred regularly in significant numbers on the Trestle Study counts. The *CS2 %* column shows the mean (with 95% confidence intervals), or summed, percentages of the total Bay Zone count that occurred in sector CS2 during the Trestle Study counts.

Table 4.3. Predicted displacement impacts due to exclusion of birds from aquaculture site T05/545A (occupancy) and disturbance of birds in adjacent intertidal habitat (disturbance).

Species	Predicted displacement (% of the total Ballymacoda Bay population)		
	Occupancy	Disturbance	Total
Wigeon	0.6% (0.1-1.0%)	1.4% (0.2-2.3%)	2.0% (0.2-3.3%)
Teal	0.0%	0.1%	0.1%
Golden Plover	0.0%	0.0%	0.0%
Grey Plover	0.7% (0.2-1.2%)	1.5% (0.5-2.6%)	2.2% (0.7-3.8%)
Lapwing	0.0%	0.0%	0.0%
Ringed Plover	0.3%	0.6%	0.9%
Curlew	0.1% (0-0.1%)	0.1% (0-0.3%)	0.2% (0-0.4%)
Black-tailed Godwit	0.0%	0.0%	0.0%
Bar-tailed Godwit	0.3% (0.1-0.5%)	0.7% (0.3-1.0%)	1.0% (0.4-1.5%)
Sanderling	1.0% (0.0-2.0%)	2.2% (0.0-4.5%)	3.2% (0.0-6.4%)
Dunlin	0.5% (0.0-1.1%)	1.1% (0.0-2.5%)	1.6% (0.0-3.6%)
Black-headed Gull	0.4% (0.0-0.7%)	0.8% (0.1-1.5%)	1.1% (0.1-2.2%)
Common Gull	0.2% (0.0-0.4%)	0.4% (0.1-0.8%)	0.6% (0.1-1.1%)
Lesser Black-backed Gull	0.3%	0.6%	0.8%

95% confidence intervals are included for the species where the CS2% was calculated using means.

4.4.2. Species Assessments

Sanderling

Peak numbers of Sanderling occur at Ballymacoda Bay in spring and autumn (Smiddy, 1992; Crowe, 2005). The displacement analysis in this assessment is based on data collected outside this period and may not, therefore, represent potential displacement impacts during the peak periods of occurrence.

The high predicted displacement impact reflects the 100% maximum occurrence in the Bay Zone during the WSP counts and the high relative occurrence in sector CS2, and also the variability in numbers occurring in sector CS2 during the Trestle Study count (which caused the wide confidence interval). In fact, the mean occurrence in the Bay Zone during the WSP counts was also 100%. This species is associated with sandy bays, rather than muddy estuaries, so its occurrence in the Estuary Zone may well be negligible. Therefore, despite the small sample, the Bay Zone % used in the displacement analysis may not significantly overestimate its overall occurrence in the Bay Zone.

As with the other species in the assessment, the predicted displacement impact due to disturbance is around twice the magnitude of the predicted displacement impact due to trestle occupancy. Sanderling was not one of the species included in the dataset from which the disturbance responses were derived. When they occur on sandy beaches with regular pedestrian activity they can tolerate close approach without flushing. Studies have reported very low flight distances for Sanderling in responses to human activity with a median flight initiation distance of 12 m (range 10-50 m) reported by Roberts and Evans, (1993) and a mean flight initiation distance of 18 m reported by Møller and Erritzøe (2010). However, Sanderling may be more sensitive to disturbance when they occur on intertidal habitat away from areas with regular pedestrian activity: at Dungarvan Harbour, I have recorded Sanderling flocks being flushed by pedestrian and tractor activity at distances of over 100 m.

The 95% confidence interval for the predicted displacement impact exceeded the 5% threshold. However, as the analyses are likely to overestimate displacement due to disturbance in general, and, as Sanderling are likely to be less sensitive to disturbance than the species used to derive the disturbance responses, it is likely that the actual displacement impact will be below the 5% threshold.

Grey Plover

Grey Plover had the second highest predicted displacement impact of 2.1%, but the upper limit of the 95% confidence interval was below the 5% threshold.

Peak numbers of Grey Plover occur at Ballymacoda Bay in late winter (Smiddy, 1992; Crowe, 2005). The displacement analysis in this assessment is based on data collected that overlaps this period of maximum occurrence.

Wintering Grey Plover populations use both open sandflat and muddy estuarine habitat. The maximum occurrence of 97% in the Bay Zone during the WSP low tide counts was substantially greater than the mean occurrence of 56%. Therefore, the use of the maximum value in the displacement analysis is likely to overestimate the displacement impact.

Grey Plover is one of the species included in the dataset from which the disturbance responses were derived. Studies in the literature have reported a wide range of apparent disturbance sensitivity, with mean flight initiation distances of 23-124 m tabulated in the review by Livezey et al. (2016). This again may reflect differences in habituation, with low flight initiation distances being likely to occur when disturbance responses are recorded at sandy beaches with regular pedestrian activity.

Wigeon

Wigeon had the third highest predicted displacement impact of 2.0%, but the upper limit of the 95% confidence interval was below the 5% threshold.

Peak numbers of Wigeon occur at Ballymacoda Bay in mid-winter (Smiddy, 1992; Crowe, 2005). The displacement analysis in this assessment is based on data collected that overlaps this period of maximum occurrence.

Coastal wintering populations of Wigeon are generally associated with saltmarsh and muddy estuarine habitats and do not typically occur on open sandflats. However, at Ballymacoda Bay, high numbers were recorded in the Bay Zone during the Trestle Study counts. These birds appeared to have a strong association with the tidal channel with 76% of the all birds recorded in the Trestle Study counts occurring in sectors CS2 or CN1, and with 90% of the birds in those sectors feeding.

As Wigeon feed in shallow subtidal habitat, as well as in the intertidal zone, the displacement calculations may underestimate the potential impact. As a quarry species with a relatively large body size, Wigeon may also be more sensitive to disturbance (as measured by flight initiation distances) than the species from which the disturbance responses used in this assessment were derived (see Laursen et al., 2005).

Conversely, Wigeon may not always have a negative response to oyster trestle cultivation and may exploit algae attached to oyster bags as a food resource. The Trestle Study counts were carried out during a period when it was noted that trestles were “clean” looking with little algae on the bags. At other times, the trestles may be more attractive to Wigeon. At Dungarvan Harbour, Light-bellied Brent Goose mainly exploit the oyster trestle areas on the ebb and flood tides when the trestles are just covered by the tide, presumably making it easier to feed on the attached algae easier, and when there is little or no husbandry activity, and Wigeon are likely to show similar patterns in sites where they feed on trestles. The Trestle Study counts did not cover the ebb and flood tide periods.

Other species

All the other species covered by this assessment had predicted displacement impacts of less than 2%.

Ringed Plover, Bar-tailed Godwit and Dunlin are all species with documented negative responses to oyster trestle cultivation and had predicted displacement impacts of 0.9-1.6%. However, Bar-tailed Godwit and Dunlin are not completely excluded by trestles, but, instead, occur in reduced densities within trestle blocks compared to comparable habitat outside trestle blocks. Peak numbers of Ringed Plover in Ballymacoda Bay occur mainly in autumn (Smiddy, 1992; Crowe, 2005). Based on its typical habitat preferences, Ringed Plover would be expected to occur mainly in the Bay Zone, but the numbers recorded in the Trestle Study counts were very low. Therefore, the displacement analysis for this species is not likely to be reliable. The maximum Bay Zone occurrence value of 100% used for Bar-tailed Godwit is likely to significantly overestimate its typical occurrence patterns in the Bay Zone, so the displacement impact predicted for Bar-tailed Godwit is likely to be a significant overestimate.

Teal, Golden Plover, Lapwing, Curlew and Black-tailed Godwit all had zero, or very low, predicted displacement impacts. Teal and Lapwing are mainly associated with muddy estuarine habitats and occurred in very low numbers in the Bay Zone. Black-tailed Godwit is also typically associated with muddy estuarine habitats. At Ballymacoda Bay, it did occur in significant numbers in the Bay Zone but was never recorded in sector CS2 during the Trestle Study counts. Golden Plover uses intertidal habitats for roosting and generally occurs in large dense flocks on extensive intertidal flats. Curlew usually occurs as dispersed individuals rather than in compact flocks, so relatively small areas of habitat (such as in sector CS2) are unlikely to hold large concentrations of this species. Curlew may also not always be negatively affected by oyster trestle cultivation.

The three gull species had predicted displacement impacts of 0.6-1.1%. Black-headed Gull and Common Gull have a variable response to oyster trestle cultivation. At Ballymacoda Bay, Black-headed Gull did not appear to be negatively affected by oyster trestle cultivation during the Trestle Study counts. Foraging gulls are also generally not very sensitive to disturbance impacts and can often congregate around husbandry workers, although roosting flocks are sensitive to such impacts.

4.5. CUMULATIVE DISPLACEMENT IMPACTS

This section considers the potential cumulative displacement impact from the development of aquaculture site T05/545A in combination with the licensed aquaculture sites.

Two of the licensed aquaculture sites are more or less fully occupied by trestles, and were similarly occupied during the WSP and Trestle Study counts. The third aquaculture site lies below these sites in the extreme lower part of the intertidal zone. Intertidal habitat will be rarely exposed in this site, and there was no exposure of intertidal habitat in this site during the Trestle Study counts. Therefore, most of the potential impact from the development of the licensed aquaculture sites will already have occurred before the Trestle Study counts. This means that there is no available baseline data that can be used to assess the displacement impacts that have occurred as a result of the development of the licensed aquaculture sites.

On the three dates when the intertidal habitat was mapped, the intertidal habitat within the licensed aquaculture sites comprised around 35-40% of the total area of intertidal habitat in the lower shore section of Ring Strand (Table 3.1). If this is representative of the typical exposure patterns in this area, and if the target species were uniformly distributed across this intertidal habitat before development of the aquaculture sites, then the development will have displaced around 35-40% of the numbers occurring in this zone. However, the data from the Trestle Study (Table 4.5) shows that, in the remaining areas of trestle-free habitat, the target species generally occur in much greater numbers in the northern part (sector CS2), compared to the southern part (sector CS1), even allowing for the differences in areas. This may reflect an association with the tidal channel, which runs along the northern edge of sector CS2. In the absence of any trestles, there would presumably be a gradient of decreasing densities of most of the target species from north to south over sector OY.

The licensed aquaculture sites extend higher up the shore than the T05/545A, so the intertidal habitat in these sites will be exposed on more low tides. Therefore, while it is not possible to make quantitative assessments, given the relative numbers recorded in sector CS2, the relative amount of intertidal habitat exposed in the sectors, and the fact that all the exposed habitat in the OY sector is occupied by trestles, it seems likely that development of the licensed aquaculture sites has caused significant displacement impacts to some of the target species.

If some of the birds in sector CS2 are birds displaced from the licensed aquaculture sites (i.e., they would occur in sector OY if no trestles were present), then further displacement due to development of T05/545A would not represent a cumulative impact (as their displacement has already been counted as part of the impact of the development of the licensed sites). However, in the absence of any specific evidence to support this interpretation, and in line with the precautionary principle, I have assumed that any displacement impacts from development of T05/545A will be additive to displacement impacts that have already occurred from development of the licensed sites.

The development of the licensed sites is likely to have caused significant displacement impacts to some of the target species, and development of T05/545A is likely to cause measurable displacement impacts to these species. Therefore, the cumulative impact of the development of aquaculture site T05/545A in combination with the existing development of the licensed sites is likely to cause increases to already significant displacement impacts to some of the QI species.

Table 4.4. Exposure of intertidal habitat in the three Trestle Study sectors on the lower shore of Ring Strand

Date	Total area exposed	% in OY sector	% in CS1 sector	% in CS2 sector
12/10/2010	16.7 ha	35%	28%	37%
19/02/2011	27.2 ha	37%	14%	49%
29/10/2019	39.9 ha	41%	19%	40%

Data sources: tideline mapping carried out for the Marine Institute (Gittings and O'Donoghue, 2012b) and for this assessment.

Table 4.5. Percentage occurrence in sectors CS1, CS2 and OY during the Trestle Study counts.

Species	CS1	OY	CS2
Wigeon	0%	1%	46%
Teal	0%	0%	50%
Golden Plover	0%	0%	0%
Grey Plover	2%	1%	23%
Lapwing	0%	0%	0%
Ringed Plover	6%	0%	10%
Curlew	11%	1%	7%
Black-tailed Godwit	0%	0%	0%
Bar-tailed Godwit	3%	1%	10%
Sanderling	0%	0%	31%
Dunlin	0%	0%	25%
Black-headed Gull	15%	18%	20%
Common Gull	12%	1%	15%
Lesser Black-backed Gull	4%	0%	11%

Data source: waterbird counts carried out for the Marine Institute (Gittings and O'Donoghue, 2012b).

5. CONCLUSIONS

5.1. CONCLUSIONS OF THE ASSESSMENT

The displacement analyses in this assessment are based on waterbird distribution patterns in January and February 2011. The degree to which these are representative of typical distribution patterns at Ballymacoda Bay is not known. However, the broad distribution patterns recorded in January and February 2011 are generally in line with distribution patterns that would be expected based on my knowledge of the species' ecology and habitat associations in Irish estuaries and bays.

The highest predicted impact is to Sanderling, with a calculated displacement impact of 3.2%, and with an upper 95% confidence limit of 6.4%. However, as the calculation method is likely to overestimate disturbance displacement for Sanderling, I consider that it is unlikely that the actual displacement impact for Sanderling would exceed the 5% threshold that I have used for assessing significance.

None of the other species assessed have displacement impacts close to or, or exceeding the 5% threshold. Therefore, development of aquaculture site T05/545A, by itself, is not likely to cause significant displacement impacts to any of the QI species of the Ballymacoda Bay SPA.

Development of the existing licensed sites is likely to have caused significant displacement impacts to some of the QI species of the Ballymacoda Bay SPA. Therefore, the cumulative impact of the development of aquaculture site T05/545A in combination with the existing development of the licensed sites is likely to cause increases to already significant displacement impacts to some of the QI species.

5.2. SCREENING CONCLUSION AND STATEMENT

The conclusions of the Appropriate Assessment Screening of aquaculture site T05/545A are as follows:

1. The development of aquaculture site T05/545A is likely to cause increased impacts to Qualifying Interests of the Ballymacoda Bay SPA which have already been subject to significant impacts from the licensed aquaculture sites.
2. Therefore, the development of aquaculture site T05/545A, in combination with the impacts from the existing licensed sites, may have significant effects on the Conservation Objectives of the Ballymacoda Bay SPA.
3. A Stage 2 Appropriate Assessment is required.

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Appendix 1 Displacement calculations carried out using the APEM method

INTRODUCTION

This appendix presents the results of displacement calculations carried out using the methods used by APEM (2016). These are presented for comparative purposes. The rationale for using a different calculation method in the present assessment is discussed in Section 2.5.2 above.

METHODS

I used the following formula to calculate displacement impacts based on the APEM method:

$$D_{APEM} = W_{572\text{-}573}/W_{BL} * A_{545}/A_{572\text{-}573}$$

where $W_{572\text{-}573}$ = the maximum total count in subsites 0L572 and 0L573 during the WSP low tide counts; W_{BL} = the baseline population as given by NPWS (2014); A_{545} = the total area of aquaculture site T05/545A (11.24 ha); and $A_{572\text{-}573}$ = the total area of subsites 0L572 and 0L573 (298 ha).

RESULTS

The results of the calculations are shown in Table A1.1.

The predicted displacement impact for Sanderling using the APEM method exceeds the 5% threshold due to the increase in Sanderling numbers that have occurred since the winters used for setting the baseline population.

The second highest predicted displacement impact using the APEM method is for Black-tailed Godwit, while the predicted displacement impact for this species from the calculation methods used in the present assessment was zero. This discrepancy reflects the fact that a relatively high number of Black-tailed Godwit occurred in subsite 0L572 during the WSP counts but no Black-tailed Godwit were recorded in count sector CS2 during the Trestle Study counts. Note that the flock mapping data for the WSP counts indicates that the Black-tailed Godwit that occurred in subsite 0L572 were above the lower shore zone and there were no mapped Black-tailed Godwit flocks in the area corresponding to Trestle Study count sector CS2.

Table A1.1. Predicted displacement impacts from development of aquaculture site T05/545A calculated using the APEM method, and the waterbird data used in the calculations.

Species	Baseline population	0L572-573 max	% of baseline population in 0L572-573	Displacement
Wigeon	907	278	31%	1.2%
Teal	887	31	3%	0.1%
Golden Plover	10,920	700	6%	0.2%
Grey Plover	535	156	29%	1.1%
Lapwing	4,063	56	1%	0.1%
Ringed Plover	153	58	38%	1.4%
Curlew	1,145	114	10%	0.4%
Black-tailed Godwit	765	401	52%	2.0%
Bar-tailed Godwit	581	106	18%	0.7%
Sanderling	98	174	178%	6.7%
Dunlin	3,192	367	11%	0.4%
Black-headed Gull	1,560	177	11%	0.4%
Common Gull	1,120	155	14%	0.5%
Lesser Black-backed Gull	5,051	94	2%	0.1%

Data sources: 2010/11 Waterbird Survey Programme as undertaken by the National Parks & Wildlife Service, and NPWS (2014).