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Annex II

Marine Institute Bird Studies

Bannow Bay Special Protection Area: Appropriate Assessment of Aquaculture

Revision: February 2017

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Executive Summary

Introduction

This report contains the Appropriate Assessment of aquaculture in Bannow Bay. The aquaculture sites are within Bannow Bay SPA (site code 004033) and this SPA is the primary focus of this assessment. Following a screening exercise, Special Conservation Interests (SCIs) from three other SPAs are included in this assessment. These SPAs are: Ballyteige Burrows SPA (004020), Keeragh Islands SPA (004118) and Saltee Islands SPA (004002).

The only aquaculture activity in Bannow Bay is suspended oyster and mussel cultivation using bags and trestles in the intertidal zone (referred to as intertidal oyster and mussel cultivation hereafter). The subject of the assessment are areas that have either already been licensed for intertidal mussel and oyster cultivation, 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 Marine.

The history and oyster cultivation in Bannow Bay and a description of current activities is set out in Chapter 6.0 of the assessment. Within the Bannow Bay SPA, there are currently eight sites licensed for intertidal oyster cultivation, and these sites cover a total area of 18.9 ha. There are an additional 17 sites with applications for licenses for intertidal oyster cultivation, and these sites cover a total area of 73.8 ha. One of the application sites (89A) also includes an application for mussel cultivation. All the application and licensed sites are in the middle part of Bannow Bay, spanning the estuary between Saintkierans/Taulaght on the western side of the bay and Newtown on the eastern side of the bay.

This assessment is based on a desktop review of existing information combined with a limited number of site visits. Where relevant, it identifies information gaps that may affect the reliability of the conclusions of this assessment. As the waterbird data available for Bannow Bay is limited, the conclusions derived from the analysis of this data are subject to caveats, which are discussed in the relevant sections of this report. Furthermore, 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* (Gittings and O'Donoghue, 2012). This report, and additional unpublished data from this project, are referred to within the assessment as the *trestle study*. One of the SCIs of the Bannow Bay SPA is Pintail. This species no longer occurs in Bannow Bay, and there is no information available on its distribution within the bay when it did occur.

Methodology

Information on the development and current practices of intertidal oyster cultivation activities in Bannow Bay was obtained from the aquaculture profile document compiled by Bord Iascaigh Mhara in December 2015 (O'Loan, 2015), interviews with major producers in March 2016, and information from the Bannow Bay CLAMS report (CLAMS, 2002). Consultation was also undertaken with National Parks and Wildlife Services.

Most of the analyses of the likely impacts of activities covered in this assessment are based on calculations of spatial overlap between the SCI species distribution and the spatial extent of the activities. These analyses focus on distribution patterns of feeding, or potentially feeding birds, as the main potential impacts will be to the availability and/or quality of feeding habitat, although we have included assessment of potential impacts on roosting birds, where relevant. The distribution of waterbird was analysed using data from the Irish Wetland Bird Survey (I-WeBS) counts of Bannow Bay (mainly using data from 1994/95-2014/15); bird usage counts carried out by NPWS in 1998 and 1999; the National Parks and Wildlife Service (NPWS) Baseline Waterbird Survey (BWS) low tide counts (carried out in 2009/10); data collected during the 2011 trestle study; as well as general observations from 2011 and 2016. Maps of flock locations from the NPWS

BWS low tide counts and descriptions of waterbird distribution in and NPWS (2012)[1] have also been used to interpret the patterns derived from these analyses. Use of these data and associated analyses are described in detail in the report.

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

Further data available to the assessment included: a hydrographic study of Bannow Bay (Murphy & Co., 1990); data on intertidal habitats & *Zostera* (Natura Environmental Consultants and Robinson, 2003; ASU, 2010; NPWS, 2012) and data intertidal benthic fauna (ASU, 2010; Forde et al., 2015).

Conservation objectives & Screening

The Special Conservation Interests (SCIs) of the Bannow Bay SPA include: -

- non-breeding populations of Light-bellied Brent Goose, Shelduck, Pintail, Oystercatcher, Golden Plover, Grey Plover, Lapwing, Knot, Dunlin, Black-tailed Godwit, Bar-tailed Godwit, Curlew and Redshank.

The conservation objectives for the non-breeding SCI species at Bannow Bay are to maintain their favourable conservation condition, which are defined by there being stable or increasing long-term population trends and no significant decrease in numbers or range of areas used within Bannow Bay.

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

The trestle study (Gittings and O'Donoghue, 2012) showed that, across all the sites studied, Oystercatcher and Redshank generally have neutral or positive responses to intertidal oyster cultivation. The results from Bannow Bay for Oystercatcher conformed to this pattern. Therefore, Oystercatcher can be screened out from further assessment. However, Redshank appeared to show an exception to the general pattern at Bannow Bay; as such we have screened in Redshank.

The trestle study (Gittings and O'Donoghue, 2012) classified the response of Curlew to intertidal oyster cultivation as neutral/positive, but with only a moderate degree of confidence. However, there was variation between sites in the nature of the response. At Bannow Bay, Curlew appeared to show a negative response to trestles; as such we have screened in Curlew.

The other SCI species either have negative responses to oyster trestles (Shelduck, Golden Plover, Grey Plover, Lapwing, Knot, Dunlin, Black-tailed Godwit and Bar-tailed Godwit) or uncertain or unknown responses (Light-bellied Brent Goose and Pintail); therefore full appropriate assessment is also required for these species.

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

Other sites

[1] NPWS (2012). *Bannow Bay Special Protection Area (Site Code 4033): Conservation objectives supporting document.* Version 1.0.

All of the SCI species of Ballyteige Burrow SPA (Light-bellied Brent Goose, Shelduck, Golden Plover, Grey Plover, Lapwing, Black-tailed Godwit and Bar-tailed Godwit) are also SCIs of the Bannow Bay SPA, and are species that are potentially negatively affected by intertidal oyster cultivation. Following consideration of species mobility, site fidelity etc., and given the proximity of the two sites, the SCIs of Ballyteige Burrows SPA that are known to move inland to feed on fields, and/or do not have high site fidelity, have been screened in for further assessment; these are Light-bellied Brent Goose, Golden Plover, Lapwing, Black-tailed Godwit and Bar-tailed Godwit.

The SCI of the Keeragh Islands SPA is a breeding population of Cormorant. The SCIs of the Saltee Islands SPA are breeding populations of Fulmar, Gannet, Cormorant, Shag, Lesser Black-backed Gull, Herring Gull, Kittiwake, Guillemot, Razorbill and Puffin. Pelagic species that feed in the open sea (i.e. Fulmar, Gannet, Kittiwake, Guillemot, Razorbill and Puffin) have been screened out and are not considered further. Further to a re-examination of data on Herring Gull from the trestle study (see pg. 3.20) there is no evidence that Herring Gull react negatively to oyster trestles; Herring Gull can therefore be screened out from further assessment. As the aquaculture sites at Bannow Bay are within the foraging ranges of Cormorant (Keeragh Islands SPA; Saltee Islands SPA) and Shag and Lesser Black-backed Gulls (from the Saltee Islands SPA) these are considered further.

Other SPAs in the wider environs were also considered and screened out.

Assessment of impacts on intertidal species (excluding Pintail)

The predicted displacement from intertidal oyster and mussel cultivation in Bannow Bay is shown below (i.e. Table 8.5 of the AA). The predicted displacement from full occupancy of the renewal sites (which do not include the sites with trial licenses) ranges from over 3% of the total Bannow Bay population for Grey Plover and Bar-tailed Godwit to less than 0.1% for several other species.

Full occupancy of all the sites (renewals and applications) may cause much higher levels of displacement, including over 14% of the Bannow Bay Bar-tailed Godwit population, over 12% of the Bannow Bay Grey Plover population, and over 9% of the Bannow Bay Dunlin population.

Table 1 - Predicted displacement (% of total Bannow Bay population) (see pg. 8.31-8.34).

Species	% occurrence in 0O413		Predicted displacement	
	mean from 2009/10 low tide counts	corrected for existing trestle occupancy	Renewal sites	All sites
Light-bellied Brent Goose	15%	15%	1.2%	4.7%
Shelduck	1%	1%	0.0%	0.2%
Golden Plover	0%	0%	0.0%	0.1%
Grey Plover	39%	40%	3.1%	12.3%
Lapwing	5%	5%	0.4%	1.5%
Knot	11%	11%	0.9%	3.5%
Dunlin	28%	29%	2.2%	9.0%
Black-tailed Godwit	4%	4%	0.3%	1.3%
Bar-tailed Godwit	46%	47%	3.6%	14.5%
Curlew	14%	14%	1.1%	4.3%
Redshank	18%	18%	1.4%	5.7%

2009/10 data source: 2009/10 Waterbird Survey Programme as undertaken by the National Parks & Wildlife Service.

	Negligible Displacement
	Measureable, but non-significant displacement levels
	Significant, or near-significant, displacement impact of ca. 5%

	High levels of displacment

The predicted displacement figures in the above table are based on three key assumptions: (1) the 2009/10 low tide counts provide an accurate representation of the species low tide distribution; (2) in the absence of intertidal oyster cultivation, the species would be uniformly distributed throughout all the available intertidal habitat within subsite 0O413; and (3) the species are completely excluded from the areas occupied by the trestles. Given the very limited available data it was necessary to make these assumptions. However, all three assumptions are unlikely to be true for some, or all, of the species involved.

The comparisons between the bird usage counts and NPWS waterbird survey programme (WSP) datasets (2009/210), and between the WSP and trestle study datasets (2011), show that most species did not show consistent distribution patterns across all three datasets. This is not surprising as each dataset only included four or five counts and waterbird distribution patterns at this scale usually show a high degree of variability. In particular, the three species with the highest predicted displacement levels (Grey Plover, Dunlin and Bar-tailed Godwit) all showed higher relative numbers in the mid zone/subsite 0O413 in the WSP dataset compared to the other two datasets. Therefore, the distribution data from the WSP may exaggerate the overall average level of occurrence of these species in the subsite 0O413 and result in overestimation of the likely displacement impact for these species. Both Light-bellied Brent Goose and Curlew showed more or less consistent distribution patterns across the three datasets, suggesting that the use of distribution data from the WSP should not have affected the calculation of the likely displacement impact.

In the case of Grey Plover, our observations suggest that the birds in subsite 0O413 may preferentially use the area on the south side of the main tidal channel, outside the aquaculture area (although this could be an indicator of impact from the aquaculture activities, i.e. displacement).

Subsite 0O413 contains a heterogeneous mixture of intertidal habitats. The ASU habitat map (see Chapter 5.0 of the AA) shows that three broad sediment types occur in this subsite: littoral mud along the northern/western side of the subsite, muddy sand in the middle part of the subsite and littoral fine sand in the southern/eastern part of the subsite. As discussed in Chapter 5.0, the actual distribution of sediment types within this subsite is more complex than represented in the ASU map. The distribution patterns recorded between sectors in the trestle study counts may reflect this habitat variation and show that the assumption that, in the absence of intertidal oyster cultivation, species would be uniformly distributed throughout all the available intertidal habitat within subsite 0O413 is not correct. In particular, these distribution patterns indicate that the aquaculture areas occupy a transitional zone between the muddier sediments in the upper estuary that hold high densities of most species and the sandier sediments in the middle zone of the estuary that hold low densities of most species.

It is also not the case that all species are completely excluded from the areas occupied by the trestles. The overall results of the trestle study indicate that, while Grey Plover and Knot are completely excluded, the impact on Dunlin and Bar-tailed Godwit is a reduction in density, rather than complete exclusion. The data from Bannow Bay indicates that most species had more strongly negative patterns of association with trestle blocks compared to the overall pattern across the trestle study. This may indicate some site-specific factor causing a higher level of impact. However, it is also possible that this is an artefact due to the small number of counts: the trestle study was designed to investigate overall patterns of association across sites, rather than to produce reliable data for individual sites.

Impact assessment

The displacement analysis above predicts that full occupation of the aquaculture sites could cause: -

- high levels of displacement (9-13%) to the Bannow Bay Grey Plover, Dunlin and Bar-tailed Godwit populations;
- significant, or near-significant, displacement levels of around 5% to the Bannow Bay Light-bellied Brent Goose, Curlew and Redshank populations;

- measurable but non-significant displacement levels of 1.3-3.5% to the Bannow Bay Lapwing, Knot and Black-tailed Godwit populations;
- and negligible displacement levels of 0.1-0.2% to the Bannow Bay Shelduck and Golden Plover populations.

However, for the reasons discussed above, there is a high level of uncertainty to these predictions. Therefore, the actual displacement levels to these species could be significantly less than predicted. Conversely the displacement levels to these species could be significantly greater than predicted.

Therefore, we consider that, in general, the potential for significant displacement impacts cannot be discounted simply because the predicted displacement level is less than 5%, and that Light-bellied Brent Goose, Grey Plover, Lapwing, Knot, Dunlin, Black-tailed Godwit, Bar-tailed Godwit, Curlew and Redshank may all be subject to significant adverse impacts from full occupation of the aquaculture sites. However, we consider that potential for significant displacement impacts is very unlikely for Shelduck and Golden Plover.

While significant numbers of Shelduck and Golden Plover occur in the mid zone of the estuary, these birds almost all occur in the muddy bay on the eastern side of Bannow Island (subsite 0O418). During the WSP counts, there was only a single counts of 7 Shelduck and 17 Golden Plover from subsite 0O413. In the trestle study counts the mean Shelduck count in the sectors overlapping subsite 0O418 was 19 (range 6-42), while no Golden Plover were recorded. In February and March 2016, Shelduck were also concentrated in subsite 0O418 and no Shelduck or Golden Plover were recorded in the areas around the trestles (the Golden Plover only occurred at the upper end of the estuary in subsite 0O416). Therefore, there is consistent evidence across three winters indicating that Shelduck and Golden Plover usage of subsite 0O413 is very low.

Assessment of impacts on other species

Pintail has disappeared from Bannow Bay. Its disappearance does not appear to be related to the development of aquaculture activities in the bay, but may be due to a combination of a national population decline and a re-distribution of the remaining population.

No information is available about the occurrence of visiting **Cormorant** from the Keeragh Islands SPA within Bannow Bay. In winter, Cormorant regularly occur within Bannow Bay but it is not known to what extent, if any, Cormorants use Bannow Bay in summer. No evidence is available about the response of Cormorants to oyster trestles. In general, intertidal oyster cultivation is likely to have neutral or positive impacts on the availability of prey resources for Cormorant in the areas occupied by the activity, compared to areas of similar habitat elsewhere in Bannow Bay. Therefore, intertidal oyster cultivation is not likely to cause any displacement of Cormorant within Bannow Bay.

The response of **Lesser Black-backed Gull** to trestles is unknown. An assessment of the potential occurrence of breeding birds from the Saltee Islands SPA was undertaken by considering evidence about the typical foraging range and diet of the species during the breeding season. It is clear that Lesser Black-backed Gull can range very widely from their breeding colonies and the aquaculture areas in Bannow Bay may be within the core foraging range of the Saltee Islands SPA population. While Lesser Black-backed Gull may be more likely to use food resources in the open sea compared to some other gull species, food resources in the intertidal zone can be a significant component of the diet in at least some breeding colonies. In the absence of specific information about the diet of the Lesser Black-backed Gull colony of the Saltee Islands, the possibility cannot be discounted that intertidal habitat in Bannow Bay provides food resources for the colony. Without firm information on the diet of the Saltee Islands Lesser Black-backed Gull colony, the occurrence of Lesser Black-backed Gull in Bannow Bay during the summer, and/or the response of Lesser Black-backed Gull to oyster trestles, it is not possible to make an assessment of the potential impact of aquaculture activities in Bannow Bay on the colony.

Cumulative impacts

This section presents an assessment of potential cumulative impacts from intertidal oyster cultivation in combination with other activities. Cormorant is not included in this assessment because the main assessment has concluded that this species are likely to have a neutral or positive response to intertidal oyster and mussel cultivation. Therefore, as the species included in this assessment are only associated with intertidal habitat, activities only affecting deep subtidal habitat such as boat traffic are not included in this assessment. Potentially disturbing activities considered include beach recreation, bait digging, hand collection of shellfish and shore angling. Overall, the available information indicates that non-aquaculture related disturbance generating activities are unlikely to be causing significant impacts to the species covered in this assessment. Therefore, it is not necessary to consider potential in-combination effects with intertidal oyster and mussel cultivation.

Consideration was also given to potential effects on food resources by bait digging, shellfish collection and changing patterns of effluent discharge (i.e. nutrient inputs). There was no evidence that any such activities / proposed changes will cause a significant reductions in food supply for any of the SCI species, and it is not necessary to consider potential in-combination effects with intertidal oyster and mussel cultivation.

Acknowledgements

This assessment would not have been possible without the detailed information on aquaculture activities provided by BIM and the operators. We are particularly grateful to Brian O'Loan (BIM) for his assistance. We are also very grateful to all the following operators who provided us with information: Eugene Fitzpatrick, Tomas Ffrench, and Tommy and Jodie Hickey.

This assessment uses: data 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; and data from the 2009/10 Waterbird Survey Programme as undertaken by the National Parks & Wildlife Service.

The information provided by local NPWS staff was also invaluable for this assessment. We are very grateful to Tony Murray and Ciara Flynn for meeting with us, providing us with information, and responding to our queries.

Francis O'Beirn (Marine Institute) provided useful information and answered many queries. We are also grateful to: Olivia Crowe (BirdWatch Ireland), Lesley Lewis and David Tierney (NPWS) for assistance with the provision of bird data.

1. Introduction

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

1.2 This report presents an Appropriate Assessment of aquaculture in Bannow Bay. The aquaculture sites are within Bannow Bay SPA (site code 004033) and this SPA is the primary focus of this assessment. Following a screening exercise, Special Conservation Interests (SCIs) from three other SPAs are included in this assessment. These SPAs are: Ballyteige Burrows SPA (004020), Keeragh Islands SPA (004118) and Saltee Islands SPA (004002). The boundaries of the SPAs are shown in Figure 1.1.

1.3 The only aquaculture activity in Bannow Bay is suspended oyster and mussel cultivation using bags and trestles in the intertidal zone (referred to as intertidal oyster and mussel cultivation hereafter). The subject of the assessment are areas that have either already been licensed for intertidal mussel and oyster cultivation, 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 Marine.

1.4 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.

1.5 The data analysis and report writing was done by Tom Gittings. Paul O'Donoghue assisted with project design, document preparation and undertook document review. Ross Macklin provided information on fish populations in Bannow Bay. Data entry was carried out by John Deasy.

1.6 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* (Gittings and O'Donoghue, 2012). This report, and additional unpublished data from this project, are referred to hereafter as the *trestle study*.

1.7 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

1.8 The structure of the report is as follows: -

- Section 2 of the report describes the methodology used for the assessment.
- Section 3 of the report contains a preliminary screening assessment that reviews the Special Conservation Interests (SCIs) of the Bannow Bay 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.
- Section 4 of the report describes the Conservation Objectives, and their attributes and targets that have been defined for the SCIs that were screened in for this assessment.
- Section 5 of the report contains a brief summary of waterbird habitats and distribution in Bannow Bay, and of the status and distribution of the SCI species included in the assessment. This section only contains a very brief summary of distribution patterns; detailed

analyses of distribution patterns of individual, species are carried out, as appropriate, in the impact assessment sections later in the document.

- Section 6 discusses the history of intertidal oyster and mussel cultivation in Bannow Bay and provides a description of the current and proposed future extent of the activity and the nature of its operations.
- Section 7 discusses the potential impact of intertidal oyster and mussel cultivation on waterbirds.
- Section 8 contains an assessment of cumulative impacts.
- Section 9 concludes the report by assessing the impact of intertidal oyster and mussel cultivation in Bannow Bay, and any in-combination impacts (if relevant), on the conservation objectives of the SCIs included in this assessment.

Wildlife zones

1.9 The aquaculture profile for Bannow Bay (O'Loan, 2015) refers to "*wildlife zones agreed by NPWS and DAFM in 1999 as part of a management plan for aquaculture in the bay*". These wildlife zones appear to have been used to guide the development of aquaculture in Bannow Bay and avoid areas of perceived high sensitivity.

1.10 While NPWS have provided some documentation that appears to be related to these wildlife zones, we have not been able to establish the scientific rationale behind the designation of these zones.

1.11 For the purposes of this report we have to make an objective scientific assessment based on the available evidence. Therefore, while we acknowledge the good faith of the aquaculture industry in following the guidance indicated by these wildlife zones, we have not been able to consider these zones in our assessment due to the lack of information about the scientific rationale behind their designation.

Constraints to this assessment

1.12 This assessment is based on a desktop review of waterbird data for Bannow Bay combined with a limited number of site visits. The waterbird data available for Bannow Bay is very limited. Therefore, the conclusions derived from the analysis of this data are subject to significant caveats, which are discussed in the relevant sections of this report.

1.13 One of the SCIs of the Bannow Bay SPA is Pintail. This species no longer occurs in Bannow Bay, and there is no information available on its distribution within the bay when it did occur. Therefore, this information gap has severely limited the scope of the assessment that was possible for this SCI.

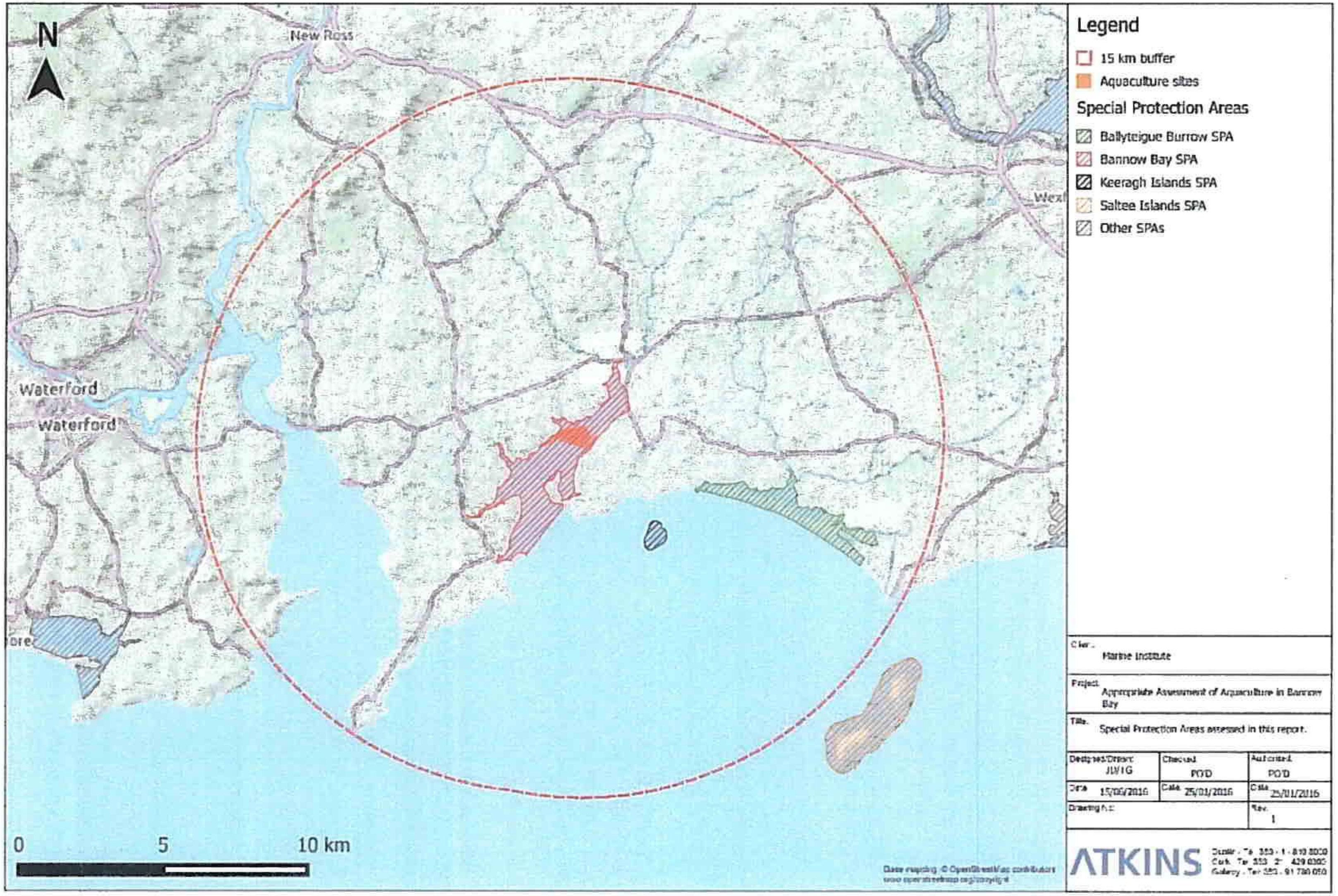


Figure 1.1 - Special Protection Areas assessed in this report.

2. Methodology

General

2.1 This assessment is based on a desktop review of existing information about waterbird population trends and distribution in Bannow Bay in addition to a number of site familiarisation site visits by both TG and PO'D.

Data sources

2.2 The SPA boundaries are derived from NPWS shapefiles[2] (which were last updated on 09/11/2015).

2.3 The spatial extents of the aquaculture sites have been derived from shapefiles supplied by the Marine Institute (shapefile dated 7th July 2015).

2.4 The spatial extents of historical and existing intertidal oyster cultivation activity have been derived from the following sources: -

- GPS mapping of the extent of oyster trestles in 2009 (supplied by Brian O'Loan, BIM; see also O'Loan, 2014), 2010 (Gittings and O'Donoghue, 2012), 2011 (digitised from aerial imagery) and 2015 (supplied by the Marine Institute).
- GPS mapping of access routes in 2016 (supplied by the Marine Institute).

2.5 Information on the development and current practices of intertidal oyster cultivation activities in Bannow Bay was obtained from the aquaculture profile document compiled by Bord Iascaigh Mhara in December 2015 (O'Loan, 2015), interviews with major producers in March 2016, and information from the Bannow Bay CLAMS report (CLAMS, 2002).

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

- Bird usage counts carried out in 1998 and 1999 by NPWS;
- Irish Wetland Bird Survey (I-WeBS) counts 1994/95-2014/15;
- NPWS Waterbird Survey Programme (WSP) 2009/10 counts;
- The descriptions of waterbird distribution within Bannow Bay in the SPA Conservation Objectives Supporting Document (NPWS, 2012b);
- Consultation with the I-WeBS counter (Tony Murray, pers. comm.);
- Data collected during the 2011 trestle study (Gittings and O'Donoghue, 2012), including unpublished data not presented in the report;
- General observations made during site visits by TG in November 2011 (for the trestle study) and in February and March 2016.

[2] http://www.npws.ie/maps-and-data/designated-site-data/download-boundary-data (accessed 13th January 2016)

2.7 Information on the distribution of biotopes in Bannow Bay is taken from the following sources: the survey of intertidal biotopes by ASU (2010), the survey of subtidal biotopes by AQUAFACT (2010), and the map showing the distribution of benthic communities in NPWS (2011b).

2.8 The extent and timing of exposure of intertidal habitats is based on observations made during survey work in the oyster trestle study (Gittings and O'Donoghue, 2012), including unpublished data not presented in the report, supplemented by observations in February and March 2016 and mapping of tideline alignments from aerial imagery.

2.9 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/).

2.10 Information on other activities (such as recreational use and shellfish gathering) was obtained primarily from the data on potentially disturbing activities recorded during the WSP counts, the trestle study, and site visits carried out for this assessment.

Mapping

Intertidal mapping

2.11 Ordnance Survey Ireland (OSI) mapping of intertidal habitat is out of date and does not provide a good representation of the current distribution of intertidal habitat in Bannow Bay, particularly in the middle and lower parts of the bay. The OSI mapping forms the basis for the mapping of the *mudlfats and sandflats not covered by seawater at low tide (1140)* Annex I habitat in NPWS (2011b). Therefore, the NPWS mapping is similarly unreliable.

2.12 For the purposes of this assessment, we have used Bing aerial imagery from November 2011 to map the extent of intertidal habitat. On our site visits on 9th February and 7th March 2016 we compared the extent of intertidal habitat shown in this imagery with the extent of intertidal habitat exposed on those dates. The predicted low tides on those dates were 0.5 m on the 9th February and 0.8 m on the 7th March. However, strong winds on the 9th February appeared to keep the tide higher than predicted. The Bing aerial imagery from November 2011 appeared to correspond quite closely to the extent of intertidal habitat exposed on the 7th March, indicating that it represents the degree of exposure on a moderate spring tide (mean low tide is 1.0 m).

Trestle mapping

2.13 The trestle mapping datasets received for this assessment used differing conventions: some datasets mapped individual trestle lines separately while others mapped blocks of trestles.

2.14 For the purposes of our assessment, we were interested in the areas occupied by blocks of trestles, as birds may be excluded from areas enclosed by the trestles. At many sites, trestles are arranged in more or less regular patterns and it is easy to define trestle blocks. However, at Bannow Bay the arrangement of many of the trestles is less regular.

2.15 To standardise the mapping of the different datasets we reviewed each dataset, and mapped blocks, or amalgamated blocks, where the distance between the trestles/blocks was less than around 25 m. This distance is taken from the width of wide lanes that occur within trestle blocks at other sites. Marginal cases were judged on the basis of the overall arrangement of the trestles and the degree of impedance that they would be likely to present to foraging birds.

Site divisions

2.16 Bannow Bay was divided in eight subsites for the 2009/10 WSP survey (Figure 2.1). For the purposes of analysing waterbird distribution, the subsites have been amalgamated into three broad zones: the Lower Estuary, the Middle Estuary and the Upper Estuary (Figure 2.2). The WSP subsites and the WSP zones are the main divisions used to analyse waterbird distribution in this report. However, the other waterbird datasets that are also referred to use different divisions of the site.

2.17 The 1998/99 bird usage counts divided Bannow Bay into nine count sectors (Figure 2.3). It should be noted that these counts did not cover the outermost part of the bay (the area broadly corresponding to the WSP subsite 0O410). For the purposes of analysing waterbird distribution, the sectors have been amalgamated into three broad zones: the Lower Estuary, the Middle Estuary and the Upper Estuary (Figure 2.4). These zones correspond approximately to the zones used for analysing the WSP counts.

2.18 The 2011 trestle study focused on a sub-section of Bannow Bay and covered the area north and west of the main tidal channel upstream of Saintkierans/Newtown. The study area was divided into eight count sectors (Figure 2.5)[3]. For comparison with the 2009/10 WSP counts, these sectors can be divided into two groups: C1-C3 and OY1 and OY2, which are largely within sector 0O413; and C4-C6, which are largely within sector 0O416.

Wintering waterbird datasets

I-WeBS

2.19 Waterbird distribution has been monitored as part of the Irish Wetland Bird Survey (I-WeBS) most winters since 1995/96. No counts were carried out in 2000/01, 2003/04, 2009/10, 2010/11 and 2012/13, while in 2001/02, only a single poor quality count was completed. For 2009/10, the I-WeBS dataset includes the NPWS BWS counts.

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. At Bannow Bay, between one to six counts have been carried out each winter (mean 3.4, excluding poor quality counts; Table 2.1). Counts have been carried out in January in all but one of the winters with I-WeBS coverage. Coverage of other months has been less consistent.

[3] For the purposes of presentation these count sectors have been redrawn to match the intertidal mapping used in this report.

Table 2.1 - I-WeBS coverage of Bannow Bay

Winter	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Number of counts
1994/95					√	√	√	3
1995/96		√		√	√	√	√	5
1996/97					√			1
1997/98	√	√			√			3
1998/99		√	√		√			3
1999/00	√				√			2
2000/01								
2001/02							√*	
2002/03			√	√*	√		√*	2
2003/04								
2004/05			√		√	√		3
2005/06					√	√	√	3
2006/07	√	√	√	√	√	√		6
2007/08	√	√			√	√		4
2008/09		√	√	√	√	√	√	6
2009/10**	√	√	√	√	√	√		6
2010/11								
2011/12		√	√	√				3
1012/13								
2013/14				√	√			2
Totals	5	8	7	6	14	8	4	

* poor quality counts (coded as 2 for Quality, or 2 for Accuracy, in the I-WeBS dataset).

** counts for 2009/10 are WSP counts but are included in the I-WeBS dataset.

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.

2.21 From 1994/95-2002/03, the I-WeBS counts were carried out by two counters. Since 2004/05, the counts have been carried out by a different counter working alone. This latter counter times the counts to target the ebb or flood tide at the upper end of the estuary, which is the optimum timing for counting this key area. The timing of the counts in the other parts of Bannow Bay may vary.

Waterbird Survey Programme

2.22 Details of the Waterbird Survey Programme (WSP) methodology and results at Bannow Bay are described in Cummins and Crowe (2010) and Lewis and Tierney (2014).

Counts

2.23 Four low tide and two high tide counts were carried out. The counts were carried out by a coordinated team of three professional counters. Each count was completed in a single day and there was complete coverage on each count (Cummins and Crowe, 2010). However, the January high tide count was affected by fog, so the high tide count was repeated in February.

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.

Flock maps

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

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

Trestle study

2.27 Bannow Bay was included in a study carried out of the relationship between intertidal oyster cultivation and waterbird distribution (Gittings and O'Donoghue, 2012). This work included an extensive study across six sites, and one of these sites was Bannow Bay.

2.28 At Bannow Bay, a study area was defined that included the main areas of trestles, and a control area comprising of trestle-free intertidal habitat. The control area was selected to represent similar intertidal biotopes to those occupied by trestles, and so that the overall study area formed a coherent unit. This study area covered the block of intertidal habitat to the north and west of the main tidal channel upstream from Saintkierans/Newtown. It comprised 29% of the 937 ha of intertidal habitat mapped by Aquatic Services Unit (2010) in Bannow Bay.

2.29 The study area did not include the areas of trestles on the eastern side of the main tidal channel, or along the western shoreline. These trestles occur in an intertidal habitat (mixed sediment shore), which is not comparable to the intertidal habitat within the study area. The study area was divided into eight count sectors.

2.30 Four counts were carried out in January and February 2011. Each count was carried out on low tides of 0.6-0.9 m, during the period when the intertidal habitat within the study area were fully exposed. On each count the numbers of all waterbird species were counted in each sector and their location (within or outside trestle blocks), position (tideline or intertidal) and activity (feeding or roosting/other) were recorded.

2.31 As part of the trestle study it was intended that counters would map the tideline on each count, to allow calculation of tideline lengths and intertidal areas. At Bannow Bay, the counter felt unable to gauge the position of the tideline with sufficient accuracy to map it. However, we had mapped the tideline during preliminary site visits prior to the trestle study counts. Our observations during these site visits indicated that, within the area covered by those counts, there is little variation in the exposure of the count sectors during low tides of 1.0 m or less (apart from at the southern end of sector C1), because the intertidal habitat is fully exposed. Therefore, we considered that our tideline mapping was sufficiently representative to use for the analysis of all the trestle study counts carried out at Bannow Bay.

NPWS bird usage counts

2.32 NPWS carried out a series of counts in 1998/99, which were used to draw up the bird usage map that was included in the draft conservation plan for the Bannow Bay SPA.

2.33 We have been provided with a copy of the count data and the bird usage map (which includes the count sector boundaries), but no further details about the counts appear to be available. However, from the distribution of birds shown on the bird usage map it is clear that the counts must have been carried out at low tide.

2.34 A total of five counts were carried out (13th January 1998, 12th March 1998, 6th October 1998, 16th November 1998, 22nd January 1999). Bannow Bay was divided into nine sectors for these counts, but the outermost part of the bay (approximately the area covered by WSP subsite 0O410) was not covered by the bird usage counts. The count sector divisions do not correspond to the subsite divisions used for the WSP.

Analyses of waterbird distribution

General distribution patterns

2.35 The 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. Most waterbird species will roost at high tide in shoreline or terrestrial areas, which will not be affected by the activities being assessed. However, we have included assessment of potential impacts on roosting birds, where relevant.

2.36 Waterbird distribution has been mainly analysed by calculating the mean percentage distribution count data across subsites and/or zones in the bird usage counts, WSP and trestle study datasets. However, we have only calculated percentage distributions where we consider the data to be consistent (i.e., excluding counts with poor coverage and/or low numbers). For the analyses from the WSP dataset we used the low tide counts only (unless otherwise stated) and excluded counts from non-tidal habitats.

2.37 To compare between datasets, we corrected the percentage distributions for differences in the relative areas of the zones. We first calculated adjusted percentage distributions for the bird usage and trestle study counts ($adj\%dist_{zone\text{-}bu}$ and $adj\%dist_{zone\text{-}ts}$) using the following formulas: -

$$adj\%dist_{zone\text{-}bu(raw)} = (\%dist_{zone\text{-}bu} \times \%area_{zone\text{-}bu}/\%area_{zone\text{-}wsp})$$

$$adj\%dist_{zone\text{-}ts(raw)} = (\%dist_{zone\text{-}ts} \times \%area_{zone\text{-}ts}/\%area_{zone\text{-}wsp})$$

where $\%dist_{zone\text{-}bu(raw)}$ and $\%dist_{zone\text{-}ts(raw)}$ are the mean percentage distributions of the waterbird species in the zone in the bird usage (bu) and trestle study (ts) counts, respectively; $\%area_{zone\text{-}bu}$ and $\%area_{zone\text{-}bu}$ are the percentages of the total area counted occupied by the zone, as defined for the bird usage and trestle study counts, respectively; and $\%area_{zone\text{-}wsp}$ is the percentage of the total area counted occupied by the zone, as defined for the WSP counts. We then standardised the raw adjusted percentages so that, for each species, they totalled 100%, using the following formulas:

$$adj\%dist_{zone\text{-}bu(stand)} = adj\%dist_{zone\text{-}bu(raw)}/adj\%dist_{sum\text{-}bu(raw)}$$

$$adj\%dist_{zone\text{-}ts(stand)} = adj\%dist_{zone\text{-}ts(raw)}/adj\%dist_{sum\text{-}ts(raw)}$$

where $adj\%dist_{sum\text{-}bu(raw)}$ and $adj\%dist_{sum\text{-}ts(raw)}$ are the sums of the raw adjusted percentages across all the zones for the bird usage and trestle study counts, respectively.

2.38 For comparison of the bird usage and WSP counts, we excluded the subsite 0O410 from the calculations of percentage areas and percentage distributions in the WSP counts, as this area was not covered in the bird usage counts. For this comparison, we used the total areas of the zones, rather than the intertidal areas, because there were major changes in the distribution of the intertidal habitat in the bay between the two counts.

2.39 We restricted the comparison of the trestle study and WSP counts to the mid and upper zones. We excluded the subsites 0O417 and 0O418 from the calculations of percentage areas and percentage distributions in the WSP counts, as these areas were not covered in the trestle study counts. For this comparison we used areas of intertidal habitat.

2.40 In addition, WSP flock map data, and observations from our site visits, have also been used to inform our interpretation of the distribution patterns.

Association with oyster trestles

2.41 We used the site-specific data for Bannow Bay from the trestle study to analyse patterns of association with oyster trestles.

2.42 We tested the null hypothesis that bird distribution within our study area at Bannow Bay was not affected by the presence of oyster trestles, so that the observed occurrence of birds within areas of oyster trestles was not significantly different from that predicted by the percentage of the available habitat occupied by the oyster trestles. We calculated the numbers that would be expected to occur within the oyster trestle blocks under the null hypothesis and then used Jacobs' Index (D; Jacobs 1974) to quantify the degree of positive or negative association with trestle blocks.

2.43 Because many waterbirds follow the tideline, and the tideline may provide particularly favourable habitat, it is necessary to consider the distribution of tideline habitat, as well as the total area of intertidal habitat in this type of analysis. Therefore, for analysis of the extensive study data, we calculated the expected number of birds in areas of oyster trestles on each count using the following formula: -

$$\text{Expected number} = (N_{INT} * P_{INT}) + (N_{TL} * P_{TL})$$

2.44 where N_{INT} and N_{TL} are the total numbers in the intertidal away from tideline, and on the tideline, respectively, and P_{INT} and P_{TL} are the proportions of intertidal habitat area, and tideline length, within oyster trestles, respectively.

2.45 For each species, we carried out two analyses of the extensive study dataset: one using all the sectors and the other using only sectors close to the trestle areas (sectors C2-C5 and OY1 and OY2).

2.46 We adapted Jacobs Index (Jacobs 1974) to compare the predicted and observed occurrence of birds within trestle blocks on each count. The index is defined as: -

$$D = r - p / (r + p - 2rp)$$

2.47 D can vary from -1 (indicating complete avoidance) to +1 (strong preference). We defined r as the proportion of the total count recorded within the trestle blocks and p as the predicted number within the trestle blocks divided by the total count. We calculated index values for each count with predicted numbers of ten or more, and the mean index value across all the counts.

Breeding population data and interpretation

2.48 Information on the location of breeding colonies and population numbers was obtained from a variety of sources, as referenced in the relevant sections of text.

Assessment methodology

Screening

2.49 The SCIs of the Bannow Bay SPA, and other nearby SPAs, were reviewed and screened in for detailed assessment if: -

- The SCI was considered likely to have significant spatial overlap with the aquaculture activities in Bannow Bay, 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.

2.50 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.

2.51 For SCIs designated for their wintering populations, we considered the general ecology of the species and, in particular, its known usage of non-tidal habitats and/or the degree of site faithfulness.

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

2.53 The main source for our information on foraging ranges was the Seabird Wikispace. This provides a range of values for foraging ranges (the mean, the mean maximum and the maximum). The explanatory document for the Seabird Wikispace (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.

2.54 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, 2013). 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.*"

2.55 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

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

2.57 The primary source of information used for the identification of potential impacts is the trestle study (Gittings and O'Donoghue, 2012). This 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 main analyses used were: ordination analyses to investigate the influence of oyster trestles on waterbird assemblages (with the position of species in the ordination providing an indication of their association with oyster trestles); and comparison of observed numbers within trestle blocks with numbers predicted assuming that birds are distributed evenly across available habitat. 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 association, negative association, exclusion response, and variable response (response may vary between sites). In addition, for this assessment, we have carried out further site specific analysis of data from the trestle study (see above).

2.58 The trestle study was carried out during periods with typical levels of husbandry activity. Therefore, the effects of disturbance due to husbandry activity associated with intertidal oyster cultivation are included in the categorisation of species responses and such disturbance impacts are not analysed separately in this assessment. However, potential disturbance impacts from other activities (such as recreational activities) are included in the cumulative assessment.

2.59 The trestle study focused on species associated with the intertidal and/or shallow subtidal habitats. One of the SCIs screened in for this assessment (Cormorant) is a fish-eating species that is primarily associated with deep (>0.5 m) subtidal habitats, and the trestle study does not provide information on their responses to intertidal oyster cultivation. A literature review was carried out to assess the potential impact of intertidal oyster and mussel cultivation on fish.

Assessment of impact magnitude

Displacement impacts

2.60 Where potential impacts from intertidal oyster cultivation 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 intertidal oyster and mussel cultivation was calculated, or qualitatively assessed when quantitative data was not available. This overlap is considered to represent the potential magnitude of the impact, as it represents the maximum potential displacement if the species has a negative response to intertidal oyster cultivation. Where appropriate, information on species habitat usage was used to refine the assessment of likely impact magnitude.

Impacts on population trends

2.61 There has been aquaculture activity at Bannow Bay since the late 1980s and we have reasonably good information on the way in which the activity has developed over time (see Chapter 5). Therefore, in theory, analysis of the 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, we have not carried out this analysis for the following reasons.

2.62 In contrast to Dungarvan Harbour, where large-scale development of aquaculture activity took place in the mid-1990s (see Gittings and O'Donoghue, 2014), the spatial extent of aquaculture activity at Bannow Bay has been limited until very recently. Therefore, any impacts from aquaculture activity on population trends are likely to be very minor. This is illustrated by the fact that in Table 8.5 the correction factor for existing trestle occupancy is less than 1%.

2.63 The population trend data for Bannow Bay is based on the I-WeBS counts. However, as discussed above, the I-WeBS coverage of Bannow Bay has been patchy with limited numbers of counts per winter, inconsistent coverage of months between winters, and with some winters having no coverage. It is not unusual for waterbird monitoring datasets to have missing data and statistical techniques have been developed to deal with this situation by calculating imputed values (see Appendix 3 in NPWS, 2012b). However, as the proportion of imputed values in a dataset increases, the accuracy of the population trends calculated from the dataset will decrease. For the population trends calculated for Bannow Bay (NPWS, 2012b) the imputed values comprise 49-55% of the dataset, depending upon the species (unpublished data provided by NPWS).

2.64 Atkinson *et al.* (2006) simulated the effects of using imputed data in calculating waterbird population trends for three species with increasing levels of inter-annual variability in counts: Turnstone, Dunlin and Knot. They found that increasing the percentage of imputed values up to a maximum of 50% did not significantly affect the accuracy of national trends calculated across a large number of sites. However, as might be expected, trend data for individual sites is much more sensitive to the use of imputed values. The analyses carried out by Atkinson *et al.* (2006) are rather complex. However, the key message from their results was that site-based trends for species with high inter-annual variability, such as Knot, are very sensitive to high levels of missing data. For example, with a dataset containing three months count data per winter and 50% imputed values, around 10% of the simulations with a simulated decline of 20% produced a trend with a decline of greater than 50%.

2.65 The percentage of imputed values in the Bannow Bay dataset is at the upper limit of the range considered acceptable for calculating national population trends. Given the fact that we would expect any impact of aquaculture development at Bannow Bay on waterbird population trends to be minor, we do not consider that it would be appropriate to use population trends calculated from the Bannow Bay dataset for this purpose.

Assessment of significance

2.66 The significance of any potential impacts identified has been assessed with reference to the attributes and targets specified by NPWS (2011a, 2011c, 2012b and 2014b). 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.

Bannow Bay SPA and Ballyteige Burrows SPA SCIs

Attribute 2 – Distribution

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

2.68 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 Bannow Bay population would be detectable against background levels of annual variation.

2.69 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.

2.70 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 and, for the purposes of this assessment, 5% has been taken to be the threshold value below which displacement effects are not considered to be significant. This is a conservative threshold, as error levels combined with natural variation are likely to, in many cases; prevent detectability of higher levels of change. This threshold is also likely to be very conservative in relation to levels that would cause reduced survivorship (see above).

Attribute 1 - Population trends

2.71 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 assess the impact on this attribute given the current level of available data.

Keeragh Islands SPA and Saltee Islands SPA SCIs

2.72 Two SCIs were screened in from these SPAs: the Cormorant breeding population in the Keeragh Islands and the Lesser Black-backed Gull breeding population in the Saltee Islands.

2.73 NPWS have published site specific conservation objectives for the Saltee Islands SPA, which include detailed attributes and targets for the Lesser Black-backed Gull breeding population. NPWS have only published generic conservation objectives for the Keeragh Islands SPA. However, for the purposes of our assessment, we have assumed that the attributes and targets specified for the Cormorant breeding population in the Saltee Islands SPA[4] also apply to the Cormorant breeding population in the Keeragh Islands SPA.

2.74 We used these attributes and targets to assess the significance of potential impacts to these two SCIs.

[4] Cormorant is also a SCI of the Saltee Islands SPA, but this SCI was screened out due to the distance from Bannow Bay relative to the typical foraging range of the species.

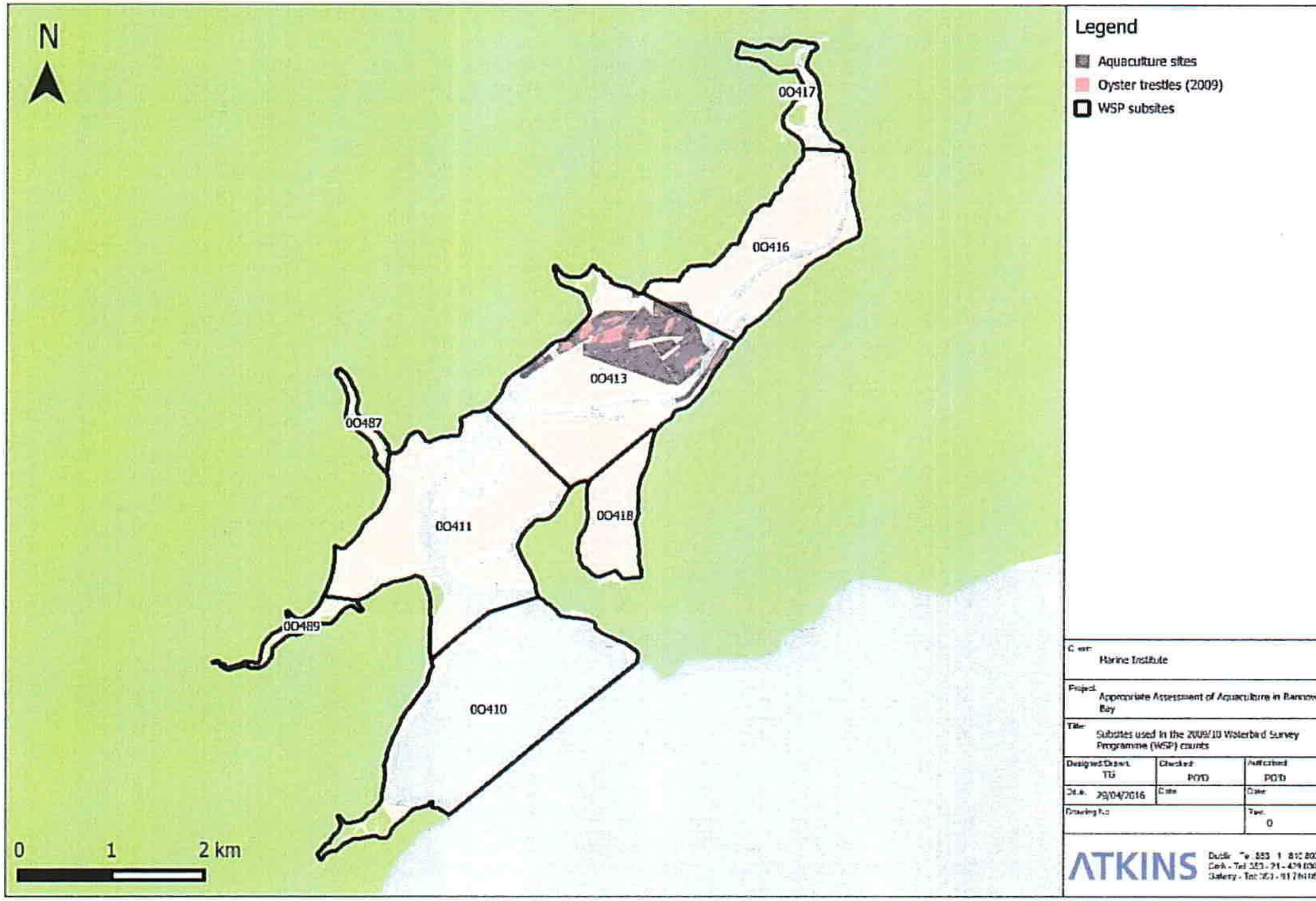


Figure 2.1 - Subsites used in the 2009/10 Waterbird Survey Programme (WSP) counts.

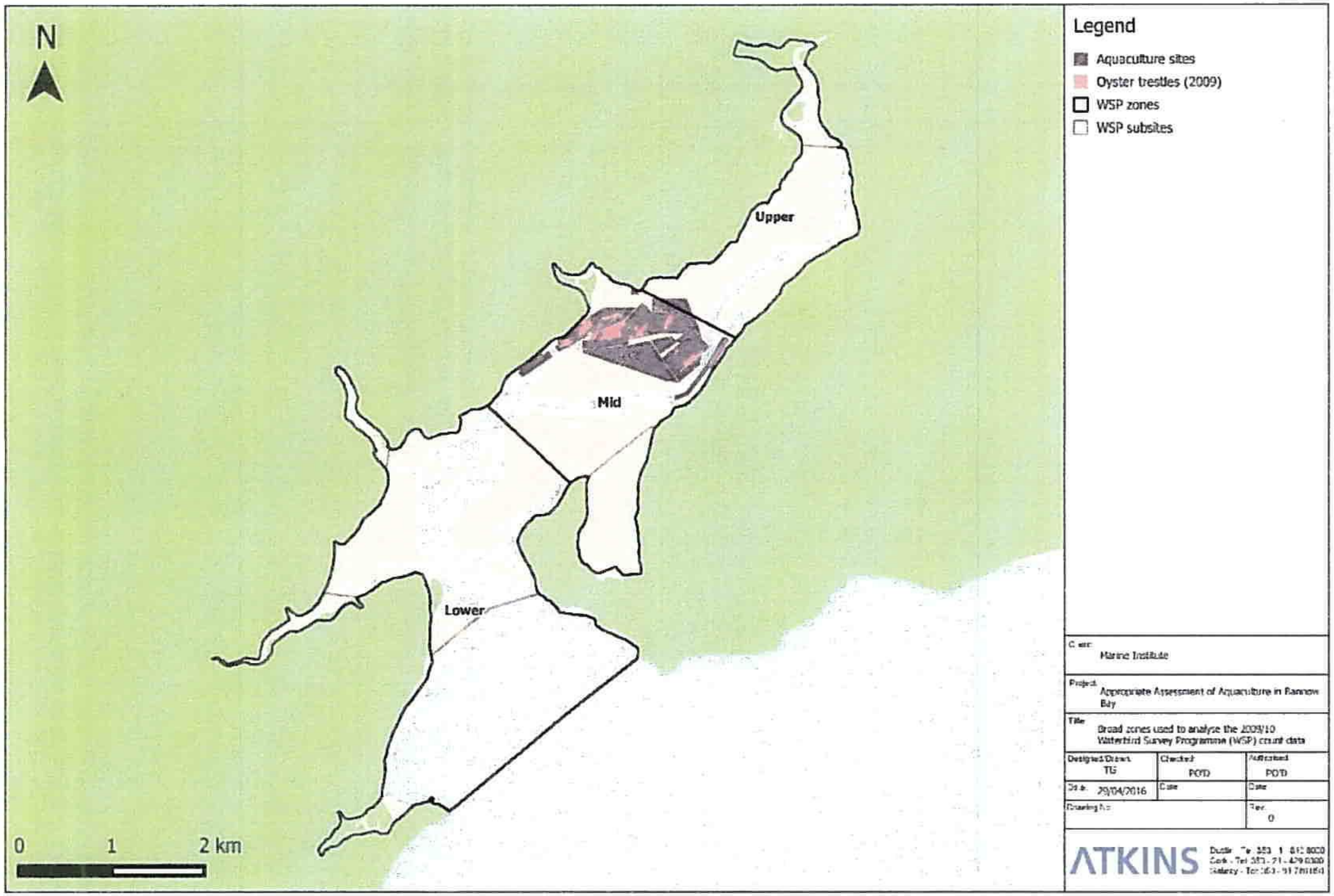


Figure 2.2 - Broad zones used to analyse the 2009/10 Waterbird Survey Programme (WSP) count data.

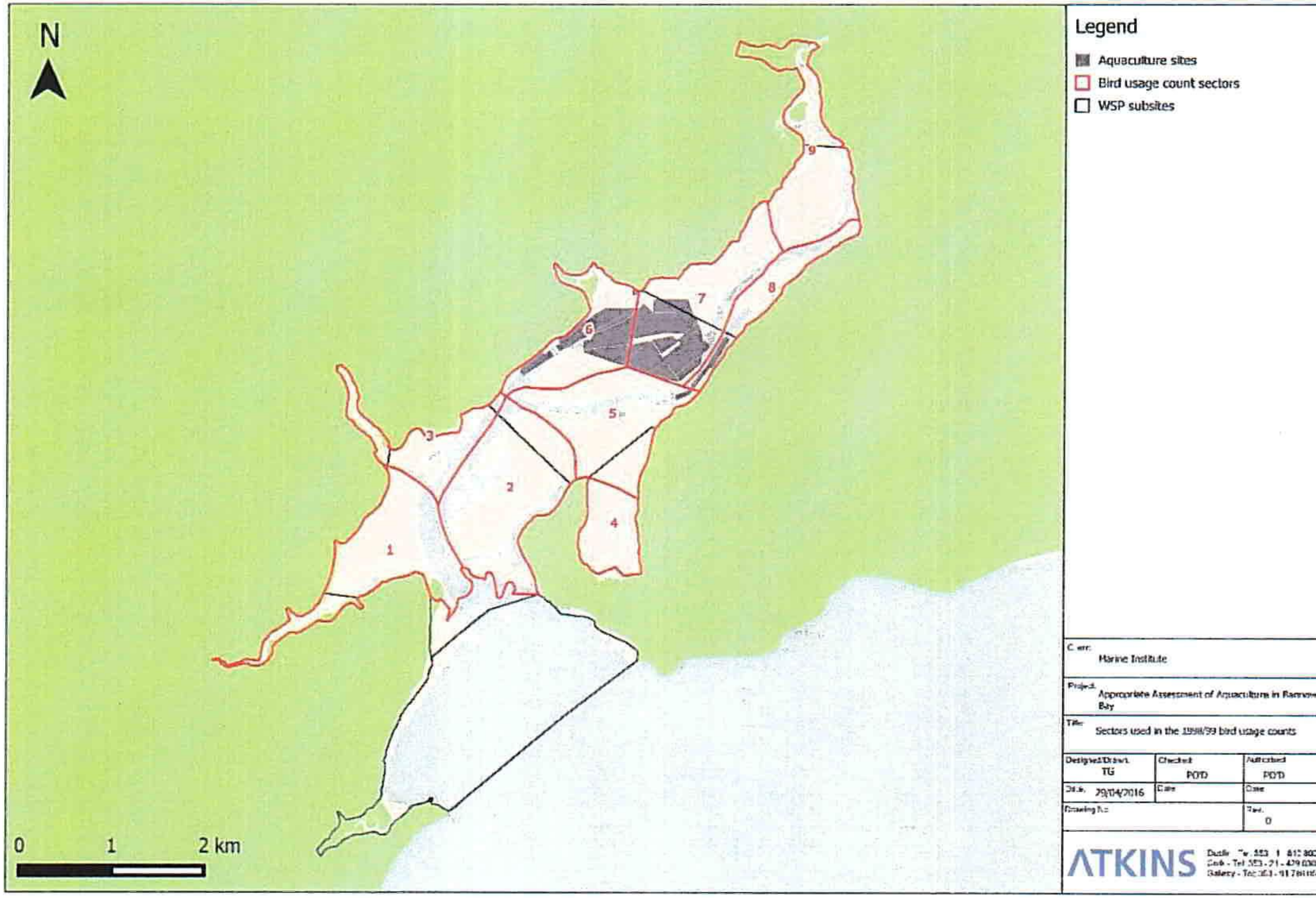


Figure 2.3 - Sectors used in the 1998/99 bird usage counts.

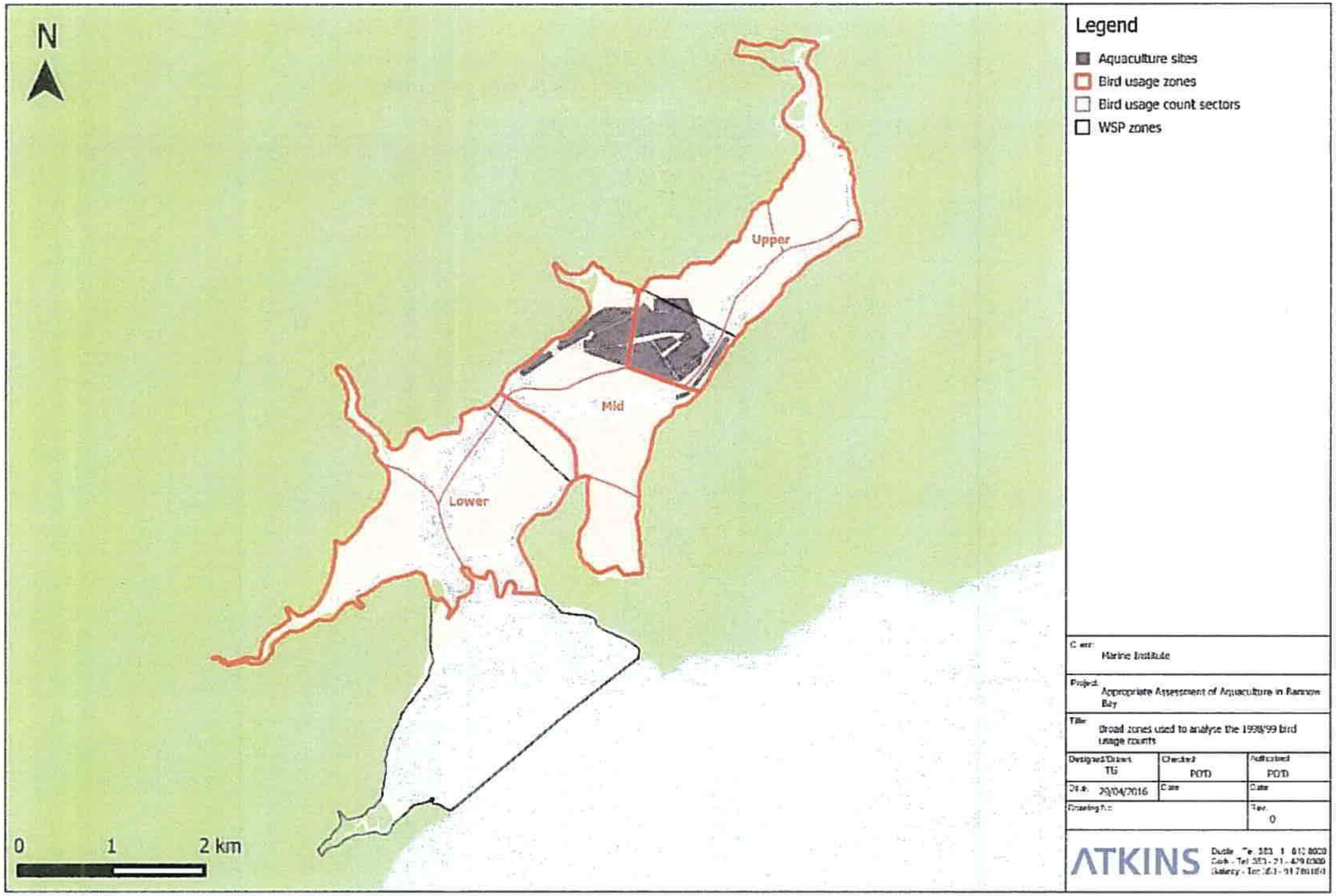


Figure 2.4 - Broad zones used to analyse the 1998/99 bird usage counts.

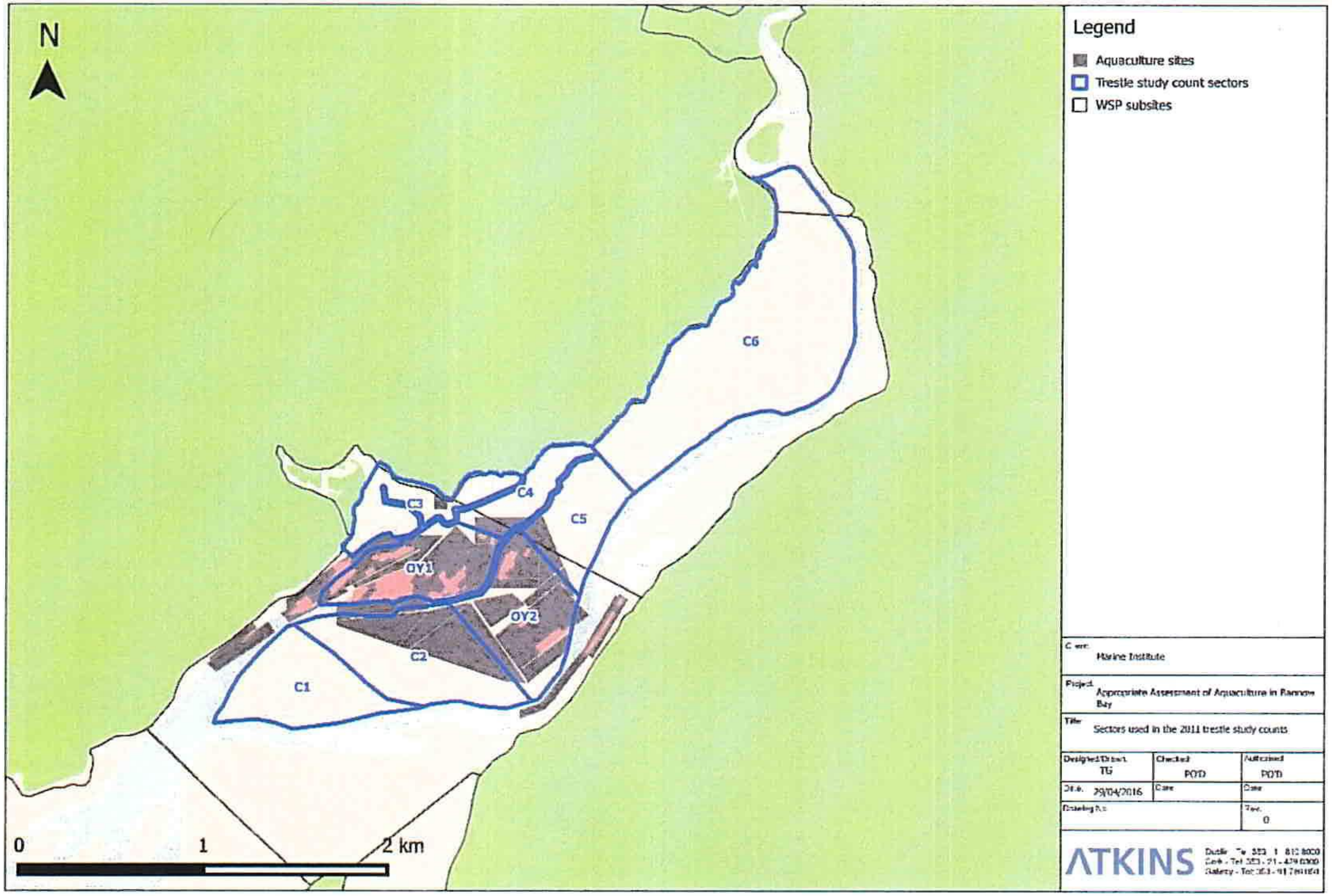


Figure 2.5 - Sectors used in the 2011 trestle study counts.

3. Screening

Introduction

3.1 In addition to the Bannow Bay SPA, there are two other SPAs within 15 km of the aquaculture areas in Bannow Bay (the Ballyteige Burrows and Keeragh Island SPAs), while a third SPA (the Saltee Islands SPA) is just outside the 15 km buffer. The potential for the SCIs of these SPAs to be negatively affected by aquaculture activities in Bannow Bay is screened below, while some other more distant SPAs are also considered.

Bannow Bay SPA

Waterbird SCIs

3.2 All of the SCI species (Light-bellied Brent Goose, Shelduck, Pintail, Oystercatcher, Golden Plover, Grey Plover, Lapwing, Knot, Dunlin, Black-tailed Godwit, Bar-tailed Godwit, Curlew and Redshank) make significant use of subtidal and/or intertidal habitat in Bannow Bay. The intertidal oyster and mussel cultivation covered in this assessment will affect 92.7 ha of intertidal habitat and have the potential to cause significant changes to habitat structure and/or food availability. Therefore, the activities being assessed could potentially have significant impacts on SCIs that use subtidal and/or intertidal habitat.

3.3 The trestle study (Gittings and O'Donoghue, 2012) showed that, across all the sites studied, Oystercatcher and Redshank generally have neutral or positive responses to intertidal oyster cultivation. The results from Bannow Bay for Oystercatcher conformed to this pattern. Therefore, Oystercatcher can be screened out from further assessment. However, Redshank appeared to show an exception to the general pattern at Bannow Bay (see Table 8.4). Further data would be required to confirm that Redshank do avoid trestles at Bannow Bay, but, for this assessment, we have screened in Redshank.

3.4 The trestle study (Gittings and O'Donoghue, 2012) classified the response of Curlew to intertidal oyster cultivation as neutral/positive, but with only a moderate degree of confidence. However, there was variation between sites in the nature of the response. At Bannow Bay, Curlew appeared to show a negative response to trestles (see Table 8.4). Further data would be required to confirm that Curlew do avoid trestles at Bannow Bay, but, for this assessment, we have screened in Curlew.

3.5 The other SCI species either have negative responses to oyster trestles (Shelduck, Golden Plover, Grey Plover, Lapwing, Knot, Dunlin, Black-tailed Godwit and Bar-tailed Godwit) or uncertain or unknown responses (Light-bellied Brent Goose and Pintail).

3.6 Therefore, full appropriate assessment is required for the following species: Light-bellied Brent Goose, Shelduck, Pintail, Golden Plover, Grey Plover, Lapwing, Knot, Dunlin, Black-tailed Godwit and Bar-tailed Godwit, Curlew and Redshank.

Wetlands and waterbirds

3.7 The Conservation Objectives define the favourable conservation condition of the wetlands and waterbird SCI at Bannow Bay purely in terms of habitat area.

3.8 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.

Ballyteige Burrow SPA

Waterbird SCIs

3.9 All of the SCI species of Ballyteige Burrow SPA (Light-bellied Brent Goose, Shelduck, Golden Plover, Grey Plover, Lapwing, Black-tailed Godwit and Bar-tailed Godwit) are also SCIs of the Bannow Bay SPA, and are species that are potentially negatively affected by intertidal oyster cultivation. Some of these species (Light-bellied Brent Goose, Golden Plover, Lapwing and Black-tailed Godwit) are known to be very mobile, as they regularly move inland to feed in fields. Therefore, it is likely that there is some degree of interchange between the populations at both sites. The other species (Shelduck, Grey Plover, and Bar-tailed Godwit) are strictly confined to tidal habitats and may, therefore, be less likely to move between sites during the winter. The site fidelity for Shelduck and Grey Plover is described as high in NPWS (2014a) indicating that movements between sites within a winter are not usually a significant factor. However, the site fidelity for Bar-tailed Godwit is only described as moderate in NPWS (2014a), indicating a greater potential for movements between sites.

3.10 Therefore, given the proximity of the two sites, the SCIs of Ballyteige Burrows SPA that are known to move inland to feed on fields, and/or do not have high site fidelity, have been screened in for further assessment. These are: Light-bellied Brent Goose, Golden Plover, Lapwing, Black-tailed Godwit and Bar-tailed Godwit.

Wetlands and waterbirds

3.11 The Conservation Objectives define the favourable conservation condition of the wetlands and waterbird SCI at Ballyteige Burrow purely in terms of habitat area.

3.12 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.

Keeragh Islands SPA

Preliminary screening

3.13 The Keeragh Islands SPA is around 4 km from the intertidal oyster cultivation area in Bannow Bay at its nearest point. The only SCI of this SPA is the Cormorant breeding population.

3.14 The mean foraging range of Cormorants from their breeding colonies is 8.5 km, with a mean maximum of 32 km and a maximum of 50 km (Seabird Wikispace; http://seabird.wikispaces.com/). Therefore, the aquaculture areas are within the likely core foraging range of the Keeragh Islands populations. This species has an unknown or uncertain response to intertidal oyster cultivation. Therefore, full appropriate assessment is required for this SCI.

Saltee Islands SPA

3.15 The Saltee Islands SPA is around 16 km from the intertidal oyster cultivation area in Bannow Bay at its nearest point, and around 19 km for a bird flying through the mouth of the bay. The SCIs of this SPA are the breeding populations of Fulmar, Gannet, Cormorant, Shag, Lesser Black-backed Gull, Herring Gull, Kittiwake, Guillemot, Razorbill and Puffin.

3.16 Fulmar, Gannet, Kittiwake, Guillemot, Razorbill and Puffin are pelagic species that feed in the open sea. Therefore, the Saltee Islands populations of these species are unlikely to have significant overlap with the aquaculture areas in Bannow Bay.

3.17 The mean foraging range of Cormorants from their breeding colonies is 8.5 km, with a mean maximum of 32 km and a maximum of 50 km (Seabird Wikispace; http://seabird.wikispaces.com/). Therefore, the aquaculture activities in Bannow Bay are outside the likely core foraging range of the Saltee Islands population of this species, although some birds from this population may visit these areas. Cormorant is already screened in for assessment due to the potential overlap with the Keeragh Islands population.

3.18 The mean foraging range of Shag from their breeding colonies is 6.5 km, with a mean maximum of 16 km and a maximum of 20 km (Seabird Wikispace; http://seabird.wikispaces.com/). Therefore, the aquaculture activities in Bannow Bay are outside the likely core foraging ranges of the Saltee Islands population of this species. As Shag are unlikely to fly overland, any spatial overlap between the Saltee Islands population and the aquaculture activities in Bannow Bay is likely to be minimal. Therefore, this SCI can be screened out from further assessment.

3.19 The aquaculture areas within Bannow Bay are likely to be within the core foraging range of the Saltee Islands Lesser Black-backed Gull colony (see paragraph 9.18). The trestle study classified the response of Lesser Black-backed Gulls to intertidal oyster cultivation as being unknown, as overall numbers were too low across all the sites for analysis. Therefore, due to the potential for significant spatial overlap, and the lack of certainty about the species' response to trestles, the Lesser Black-Backed Gull SCI of the Saltee Islands SPA has been screened in for full Appropriate Assessment.

3.20 Cramp and Simmons (2004) quote foraging ranges for Herring Gull 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, the aquaculture areas in Bannow Bay may be within the core foraging range of the Saltee Islands SPA population. The trestle study classified the response of Herring Gulls to intertidal oyster cultivation as being variable, due to a negative response in the intensive study at Dungarvan Harbour. However, re-analysis of this data has shown that this was due to data entry mistakes and that Herring Gull had a neutral or positive response to intertidal oyster cultivation across all the scales analysed (see Appendix C). The numbers of Herring Gull recorded at Bannow Bay in the trestle study were too small to be analysed separately. However, of the 63 Herring Gulls recorded across the four counts in the trestle study, 29 were recorded within trestle blocks. Therefore, there is no evidence that the response of Herring Gull to oyster trestles at Bannow Bay differs from the general pattern observed in the trestle study, and the Herring Gull SCI of the Saltee Islands SPA can be screened out from further assessment.

Other SPAs

3.21 Other SPAs in the wider vicinity of Bannow Bay include Tacumshin Lake SPA (19 km from the aquaculture areas in Bannow Bay), Tramore Back Strand SPA (19 km), Wexford Harbour (23 km), Lady's Island Lake SPA (24 km), Mid-Waterford Coast SPA (27 km), the Raven SPA (28 km) and the River Nore SPA (29 km).

3.22 Tacumshin Lake, Tramore Back Strand, Wexford Harbour, Lady's Island Lake and the Raven SPA are all designated for a range of non-breeding waterbird populations and breeding gull and tern populations. Little is known about movement patterns between sites for most non-breeding waterbird populations in Ireland. However, most of the SCI species from these SPAs that also occur in significant numbers at Bannow Bay are considered to have high, or moderate, site fidelity (NPWS, 2011d, 2013), indicating that long distance movements between sites within a winter are not usually a significant factor. The species that are most likely to move between sites are those that move away from coastal areas to feed on fields (Light-bellied Brent Goose, Golden Plover, Oystercatcher, Lapwing, Black-tailed Godwit and Curlew). These are all SCIs of the Bannow Bay SPA and so have already been screened in above.

3.23 Wexford Harbour and Lady's Island Lake are also designated for breeding gull and tern populations. The breeding gull and tern species in these SPAs (Black-headed Gull, Sandwich Tern, Roseate Tern, Common Tern, Arctic Tern and Little Tern) all have relatively short foraging ranges from their breeding colonies and the aquaculture areas in Bannow Bay would be outside their potential foraging ranges.

3.24 The Mid-Waterford Coast SPA is designated for breeding Cormorant, Peregrine, Herring Gull and Chough populations. The foraging range of the Herring Gull population from this SPA could potentially overlap with the aquaculture areas in Bannow Bay. However, this species can be screened out based on their response to oyster trestles (see above). Due to the distance from Bannow Bay, and (for Chough) the ecology of the species, the other SCIs are unlikely to have significant spatial overlap with the aquaculture areas in Bannow Bay.

3.25 The River Nore SPA is designated for its Kingfisher population. While small numbers of Kingfisher may occur in Bannow Bay during the winter, there is no reason to suppose that there is significant spatial overlap.

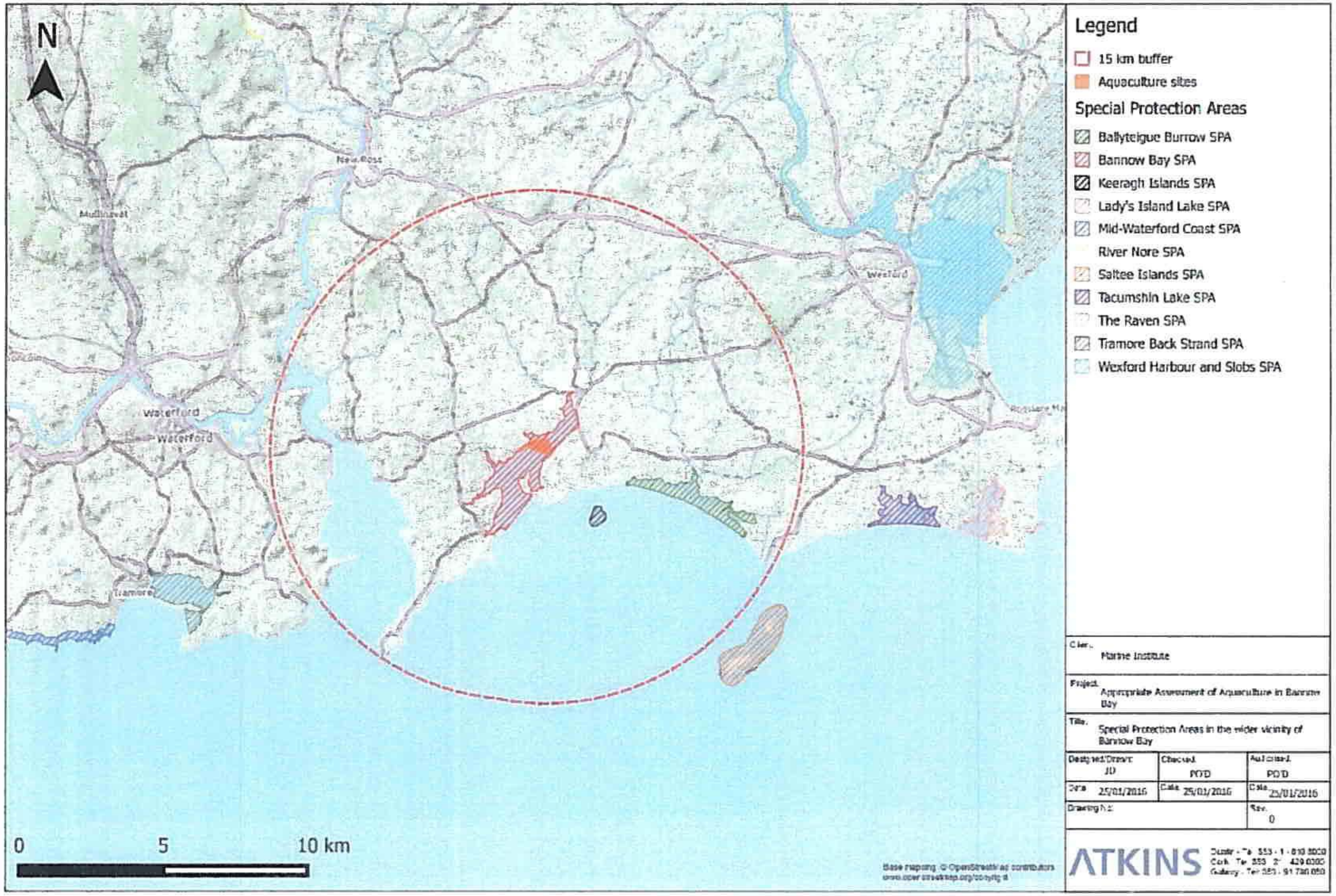


Figure 3.1 - Special Protection Areas in the wider vicinity of Bannow Bay.

4. Conservation objectives

Bannow Bay SPA

4.1 The conservation objectives for the non-breeding populations of Light-bellied Brent Goose, Shelduck, Pintail, Golden Plover, Grey Plover, Lapwing, Knot, Dunlin, Black-tailed Godwit, Bar-tailed Godwit, Curlew and Redshank at Bannow Bay are to maintain their favourable conservation condition (NPWS, 2012).

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

Table 4.1 - Attributes and targets for the conservation objectives for Light-bellied Brent Goose, Shelduck, Pintail, Golden Plover, Grey Plover, Lapwing, Knot, Dunlin, Black-tailed Godwit, Bar-tailed Godwit, Curlew and Redshank at Bannow Bay.

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 used by the ... [SCI species], other than that occurring from natural patterns of variation	As determined by regular low tide and other waterbird surveys. Waterbird distribution from the 2009/10 waterbird survey programme is discussed in Part Five of the conservation objectives supporting document

Source: NPWS (2012b).

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

Ballyteige Burrow SPA

4.3 The conservation objectives for the non-breeding populations of Light-bellied Brent Goose, Golden Plover, Lapwing, Black-tailed Godwit and Bar-tailed Godwit at Ballyteige Burrows are to maintain their favourable conservation condition (NPWS, 2014).

4.4 The favourable conservation conditions of these species at Ballyteige Burrows are defined by various attributes and targets, which are shown in Table 3.2.

Table 4.2 – Attributes and targets for the conservation objectives for Light-bellied Brent Goose, Golden Plover, Lapwing, Black-tailed Godwit and Bar-tailed Godwit at Ballyteige Burrows.

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 used by the ... [SCI species], other than that occurring from natural patterns of variation	As determined by regular low tide and other waterbird surveys. Waterbird distribution from the 2011/12 waterbird survey programme is discussed in Part Five of the conservation objectives supporting document

Source: NPWS (2014b)

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

Keeragh Islands SPA

4.5 The conservation objectives for the Cormorant breeding populations at Keeragh Islands are to maintain or restore their favourable conservation condition (NPWS, 2011c).

4.6 NPWS have only published generic conservation objectives for the Keeragh Islands SPA. Therefore, there are no site-specific attributes and targets to define the favourable conservation condition of this species.

Saltee Islands SPA

4.7 The conservation objectives for the Lesser Black-backed Gull breeding population at the Saltee Islands SPA are to maintain their favourable conservation condition (NPWS, 2011a). The favourable conservation condition of this species at the Saltee Islands SPA 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.

5. Status and habitats and distribution of the SCI species

Status of the SCI species

Bannow Bay

5.1 The conservation condition and trends of the Bannow Bay SCI species included in this assessment are summarised in Table 5.1. Shelduck, Grey Plover, Knot and Dunlin have been classified as having highly unfavourable conservation condition, while Light-bellied Brent Goose, Golden Plover, Lapwing, Curlew and Redshank have been classified as having intermediate (unfavourable)) conservation condition. However, we note that, due to the limited I-WeBS coverage of Bannow Bay, there are likely to be very wide confidence limits for the population trends used to assign conservation condition (see paragraphs 2.63-2.65). Therefore, we consider that the most that can be said is that species showing large declines (i.e., the species with highly unfavourable conservation condition) are likely to have shown a real decline.

Table 5.1 - Conservation condition and population trends of the SCI assessment species at Bannow Bay.

Special Conservation Interests (SCIs)	Site Conservation Condition	12 year site population trend[1]	5 year site population trend[2]	Current all-Ireland Trend[3]	Current international trend[4]
Light-bellied Brent Goose	Intermediate (unfavourable)	-6.99	-9.44	+58	Increase
Shelduck	Highly Unfavourable	-52.6	-48.9	+4.46	Stable (*alpina*)
Pintail	n/c	n/c	n/c	+26.8	Increase
Oystercatcher	Favourable	+0.4	-13.1	+23.5	Stable
Golden Plover	Intermediate (unfavourable)	-2.6	-29.0	-2.2	Stable
Grey Plover	Highly Unfavourable	-72.1	-52.8	-33.1	Stable
Lapwing	Intermediate (unfavourable)	-3.0	-35.4	-40.12	Decline
Knot	Highly Unfavourable	-53.0	-15.8	-2.91	Decline
Dunlin	Highly Unfavourable	-75.7	-57.5	-46.5	Decline
Black-tailed Godwit	Favourable	+27.2	+39.6	+70.2	Decline
Bar-tailed Godwit	Favourable	+10.1	-10.6	+1.5	Decline
Curlew	Intermediate (unfavourable)	-17.3	-22.7	-25.7	Decline
Redshank	Intermediate (unfavourable)	-4.6	-21.4	+22.7	Stable/Decline

Source: Tables 4.1 and 4.2 in NPWS (2012b).

n/c = not calculated. [1]site population trend analysis, 12 yr = 1994–2007; [2] site population trend analysis, 5 yr = 2002–2007; [3]all-Ireland trend calculated for period 1994/95 to 2008/09; [4] international trend after Wetland International (2006).

Ballyteige Burrows SPA

5.2 The conservation condition and trends of the Ballyteige Burrows SCI species included in this assessment are summarised in Table 5.2. Bar-tailed Godwit has been classified as having highly unfavourable conservation condition, Black- tailed Godwit has been classified as having unfavourable conservation condition, while Lapwing has been classified as having intermediate (unfavourable)) conservation condition.

Table 5.2 - Conservation condition and population trends of the SCI assessment species at Bannow Bay.

Special Conservation Interests (SCIs)	Site Conservation Condition	Site population trend[1]	Current all-Ireland Trend[2]	Current international trend[3]
Light-bellied Brent Goose	Favourable	+84	Increasing	Increasing
Golden Plover	Favourable	+12	Declining	Decreasing
Lapwing	Intermediate (unfavourable)	-60	Declining	Stable
Black-tailed Godwit	Unfavourable	-48	Increasing	Increasing
Bar-tailed Godwit	Highly unfavourable	-70	Stable	Increasing

Source: Tables 4.4 in NPWS (2014a).

[1]site population trend analysis, 1995/96-1999/00 vs 2006/07-2010/11; [2]all-Ireland trend after Crowe and Holt (2013); [3] international trend after Wetland International (2012).

Keeragh Islands SPA

5.3 The conservation condition of the breeding Cormorant population in the Keeragh Islands SPA has not been assessed.

5.4 The available population data (all apparently occupied nests) are: 160 (1986), 239 (1987), 200 (1988), 206 (1989) and 200 (2000) (JNCC Seabird Colony Data; http://jncc.defra.gov.uk/page-4460).

Saltee Islands SPA

5.5 The conservation condition of the breeding Lesser Black-backed Gull population in the Saltee Islands SPA has not been assessed.

5.6 The available population data (all apparently occupied nests or apparently occupied territories) are: 82 (1986), 80 (1987), 80 (1989), 620 (1994), 500 (1996), 231 (1998) and 184 (2000) (JNCC Seabird Colony Data; http://jncc.defra.gov.uk/page-4460). All this data is for the Great Saltee Island only, except for the data for 2000 which includes 40 on the Little Saltee Island.

Waterbird habitats and distribution in Bannow Bay

Tidal patterns

5.7 A hydrographic study of Bannow Bay (Murphy & Co., 1990) monitored tidal levels in the bay and calculated that the mean low water neap tide was 1.4 m and the mean low water spring tide was 0.9 m. This report noted that the restricted access to the bay meant that the tidal ranges in the bay were less than those in the open sea. The report also calculated the tidal heights that correspond to different durations of tidal coverage, and the percentage of the bay that were covered under these tidal regimes (Table 5.3).

5.8 It should be noted that there has been substantial changes to the topography of the outer bay since Murphy & Co.'s (1990) study, due to the erosion of the Big Burrow. Therefore, changes to the tidal regime are likely to have occurred.

Table 5.3 - Tidal levels and percentage of bay covered at different levels of tidal cover.

<table>
<tr><th>Tidal cover</th><th>Tidal heights (OD Malin)</th><th colspan="2">% of bay covered</th></tr>
<tr><td>60%</td><td>0.7 m</td><td rowspan="2">19%</td><td></td></tr>
<tr><td>70%</td><td>1.0 m</td><td rowspan="2">7%</td></tr>
<tr><td>80%</td><td>1.2 m</td><td rowspan="2">5%</td></tr>
<tr><td>90%</td><td>1.5 m</td><td rowspan="2">1%</td></tr>
<tr><td>95%</td><td>-</td><td></td></tr>
</table>

Source: Murphy & Co. (1990).

5.9 The nearest station for which Admiralty tidal data is available is Fethard-on-Sea. The mean and median low tides at Fethard-on-Sea are 1.0 m (calculated from all low tides between 1st September 2015 and 31st March 2016). While this does not represent the actual height of the mean low tide within Bannow Bay, it is a useful figure for comparing against tidal levels at Fethard-on-Sea on survey dates to give an indication of the degree of spring or neap tidal conditions in Bannow Bay on those dates. Subsequent references to tidal heights in this report refer to tidal data from Fethard-on-Sea, unless otherwise stated.

Extent of intertidal habitat

5.10 There has been substantial changes to the morphology of the outer part of the bay over the last 20 years. The Ordnance Survey Ireland mapping show a dune system, called the Big Burrow, which extended out from the western shore and cut off most of the mouth of the bay. This dune system has now almost completely disappeared, with just a small area of remnant dunes remaining adjacent to the western shoreline (NPWS, 2012a). However, a sand bar now appears to be forming on the eastern side of the mouth of the bay. NPWS (2012a) also note that: -

> "*Historically, the sand-flats around Grange and the back of Bannow Island were overlain with a thick band of shingle and cobble, much of which was removed over a number of decades for the purposes of building houses etc. resulted in an "unquantified" acceleration of the erosion along much of the low cliffs and coastal habitats around Grange and further south to Fethard.*"

5.11 The above changes have affected the distribution of intertidal habitats in the outer part of the bay. Furthermore, Murphy & Co. (1990) note that the tidal channel in the southern part of the bay is very mobile, and "*very substantial changes occur in the character of the main channel over some winters*". However, comparison of sequences of aerial imagery from 1995-2011 indicates that there has been little change in the configuration of the intertidal habitat in the middle and upper zones.

5.12 The distribution of littoral sediment and littoral rock intertidal habitat exposed at low tide in Bannow Bay is shown in Figure 5.1. This probably corresponds to a low tide of around 0.8 m (see Chapter 2). However, there appears to be relatively little variation in the exposure of intertidal habitat in the middle and upper zones of the bay under different low tide heights (up to around 1.0-1.1 m, at least). This is because the habitat consists of more or less level tidal flats with a steep bank along the main tidal channel. This contrasts to open sandflat areas (such as Dungarvan Harbour) with gently sloping shorelines, where the extent of tidal exposure is continually changing. There is probably greater variation in tidal exposure in the lower part of the middle zone and in the lower zone due to the presence of sandbanks along the main tidal channel.

5.13 The intertidal habitat in the middle zone, around the aquaculture sites is more or less fully exposed for a period of around 3-4 hours on each low tide (apart from, possibly, the higher neap tides). The pattern of exposure in this area on the ebb and flood tides is complex with a number of "*islands*" of higher elevation in the middle of the area (mainly within areas occupied by trestles) that may be exposed for six hours around low tide. The upper end of the estuary, and the bay to the east of Bannow Island, also have substantial exposure early/late on the ebb and flood tides.

5.14 The areas of intertidal habitat mapped at the mouth of the bay may include sandbanks that are rarely covered by the tide.

Habitats

5.15 The majority of intertidal habitat in Bannow Bay is unvegetated littoral sediment habitat: i.e., LS habitat, as defined by Fossitt (2007). Aerial imagery indicates that small areas of littoral rock habitat (LR) occur in the outer part of the bay. Areas of saltmarsh occur in several locations along the shoreline NPWS, 2012a).

5.16 The intertidal littoral sediment habitats were classified into 16 biotopes by ASU (2010), while the mapping in NPWS (2011b) distinguishes 10 marine community types. The ASU map shows a broad division into three main types: littoral mud (LS.MU) in the upper estuary, the inlet at Saltmills and the eastern side of Bannow Island; muddy sand (LS.LSa.MuSa) in the middle part of the estuary; and littoral fine sand (LS.LSa.FiSa) on the sandbanks around Bannow Island. The NPWS classification groups the littoral mud and muddy sand biotopes together as the *fine sands with Pygospio elegans and Corophium volutator community*, with the littoral fine sand biotope being mapped separately as the *intertidal sand dominated by polychaetes community*.

5.17 We consider that the distinction made by the ASU map between the littoral mud and muddy sand biotopes represents real variation that can be easily observed in the field and is relevant to the interpretation of waterbird distribution patterns. The ASU map gives an overall indication of the approximate distribution of the two sediment types. However, there is a lot of fine scale variation. For example, in the area around the aquaculture sites, the two sediment types appear to occur in a complex mosaic.

5.18 Both the ASU and NPWS maps identify a *Zostera* bed that occurs in the south-western part of the estuary, extending over an area of 18.5 ha. An NPWS map of the bed around the same time as the ASU survey indicates the bed covering a similar area. This *Zostera* bed was previously surveyed in 1991-92, when its area was estimated as < 1.0 ha (Natura Environmental Consultants and Robinson, 2003). Therefore, there appears to have been a significant increase in the area of the bed since the early 1990s.

Food resources

5.19 The major food resource in Bannow Bay for the SCI species considered in this assessment is the intertidal benthic fauna. Survey data on this fauna has been collected by ASU (2010) and Forde *et al.* (2015).

5.20 The *Zostera* bed provides an important food resource for Light-bellied Brent Goose. Grass fields around the bay are also an important food resource for this species, while invertebrates in these fields may be important food resources for Golden Plover, Lapwing, Black-tailed Godwit and Curlew.

5.21 Fish populations in Bannow Bay may provide food resources for the Cormorant SCI of the Keeragh Islands and the Lesser Black-backed Gull SCI of the Saltee Islands. Bannow Bay is an important nursery area for Grey (*Mugil cephalus*), Golden Grey (*Liza aurata*) and Thin-lipped Mullet (*Liza ramada*). Abundant adult mullet frequent the bay during the summer. It is also an important feeding and nursery area for Sea Bass (*Dicentrarchus labrax*) and Gilt Head Bream (*Sparus aurata*). Given the shallow expanses of sand and slob with adjoining rivers, Flounder

(*Platichthys flesus*) are abundant, including juveniles. In the late summer and autumn Sprat (*Sprattus sprattus*) are abundant in addition to sand eel (*Ammodytes* sp.). Packs of smooth hound (*Mustelus asterias*) enter the estuary during the summer but would not be of importance to birds. In the winter pelagic fish include whiting and coalfish are seasonally abundant. Other species include goby species in the sandy areas and blennies (where rock and weed adjoin sand). Anadromous species include small numbers of Atlantic salmon (*Salmo salar*), good numbers of sea trout (*Salmo trutta*), eel (*Anguilla anguilla*) and River Lamprey (*Lampetra fluviatilis*).

Habitat use

5.22 The majority of the waterbird species considered in this assessment are typically associated with intertidal habitat and in the WSP low tide counts, most species were mainly recorded in intertidal habitat (Table 5.4). The main exception was Light-bellied Brent Goose, where significant numbers occurred in the subtidal and terrestrial zones. The latter birds were feeding in fields. However, the dataset probably underestimates the number of Light-bellied Brent Goose in the terrestrial zone as the counts were focused on the intertidal and subtidal zones. The other species that typically feed in fields (Golden Plover, Lapwing, Black-tailed Godwit, Curlew and Lesser Black-backed Gull) were rarely, or never, recorded in the terrestrial zone during the WSP counts. However, again, this presumably reflects the survey methodology and does not necessarily indicate an absence of field feeding behaviour by these species.

5.23 Cormorant were mainly recorded in the intertidal zone during the WSP low tide counts, despite the fact that this species feeds in the subtidal zone. However, the Cormorant recorded in the intertidal zone were roosting. During the low tide counts, there was obviously limited availability of subtidal habitat for Cormorant to feed in. However, even during the high tide count most of the Cormorant were recorded in intertidal habitat.

5.24 The records of Knot and Redshank from the subtidal zone are presumably either errors in the dataset, or birds in shallow water just below the tideline.

Table 5.4 - Habitat use in the 2009/10 WSP low tide counts.

Species	Mean percentage of total count in habitat zones:			
	Intertidal	Subtidal	Supratidal	Terrestrial
Light-bellied Brent Goose	55%	10%	1%	21%
Shelduck	100%	0%	0%	0%
Cormorant	77%	18%	0%	1%
Golden Plover	100%	0%	0%	0%
Grey Plover	100%	0%	0%	0%
Lapwing	93%	0%	3%	3%
Knot	97%	3%	0%	0%
Dunlin	100%	0%	0%	0%
Black-tailed Godwit	100%	0%	0%	0%
Bar-tailed Godwit	100%	0%	0%	0%
Curlew	95%	0%	1%	3%
Redshank	91%	7%	1%	0%
Lesser Black-backed Gull	99%	1%	0%	0%

Data source: 2009/10 Waterbird Survey Programme as undertaken by the National Parks & Wildlife Service.
Sample sizes: n = 4 for all species, except Shelduck, Golden Plover and Lesser Black-backed Gull where n = 3.

Distribution

5.25 The broad patterns of distribution of waterbird species during the WSP low tide counts is summarised in Table 8.1. This indicates that some species are more or less uniformly distributed across the site (e.g., Dunlin, Curlew and Redshank), while others are concentrated in particular sections (e.g., Light-bellied Brent Goose and Cormorant in the lower zone, Shelduck in the mid zone and Black-tailed Godwit in the upper zone).

Table 5.5 - Mean percentage distribution of waterbird species between the three broad zones of Bannow Bay, during the 2009/10 WSP low tide counts

Species	Lower zone	Mid zone	Upper zone
Light-bellied Brent Goose	78%	20%	2%
Shelduck	20%	79%	2%
Cormorant	78%	13%	9%
Golden Plover	33%	50%	17%
Grey Plover	12%	83%	5%
Lapwing	23%	11%	66%
Knot	37%	45%	18%
Dunlin	35%	41%	24%
Black-tailed Godwit	9%	4%	86%
Bar-tailed Godwit	15%	53%	32%
Curlew	30%	36%	34%
Redshank	23%	53%	24%
Lesser Black-backed Gull	31%	20%	49%

Data source: 2009/10 Waterbird Survey Programme as undertaken by the National Parks & Wildlife Service.
Sample sizes: n = 4 for all species, except Shelduck and Golden Plover where n = 3.

5.26 Further analysis of species distribution patterns is presented in Chapters 8 and 9.

5.27 The bird usage map from the 1998/99 bird usage counts is included in Appendix D.

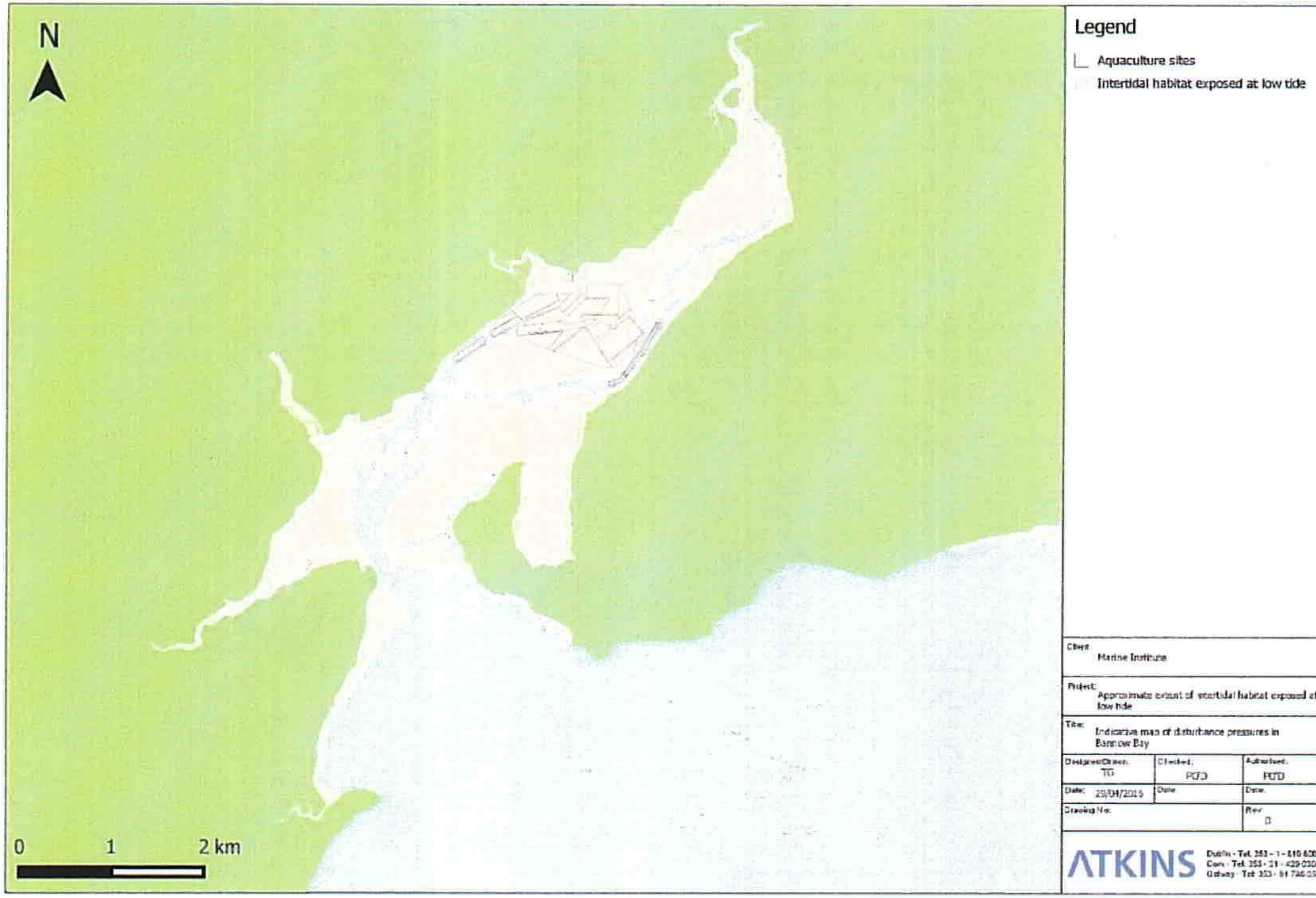


Figure 5.1 - Approximate extent of intertidal habitat exposed at low tide.

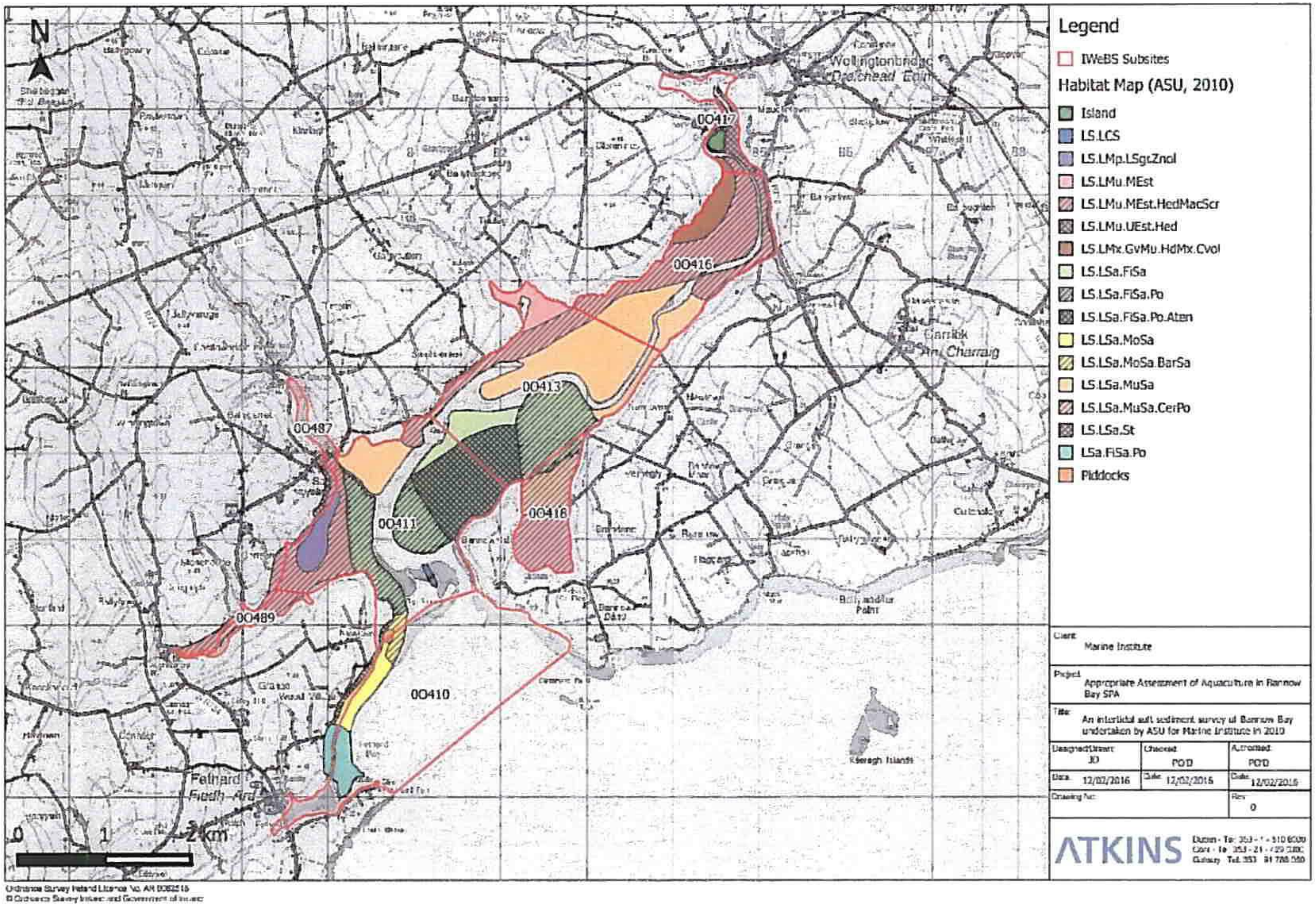


Figure 5.2 - Intertidal biotopes mapped by ASU (2010).

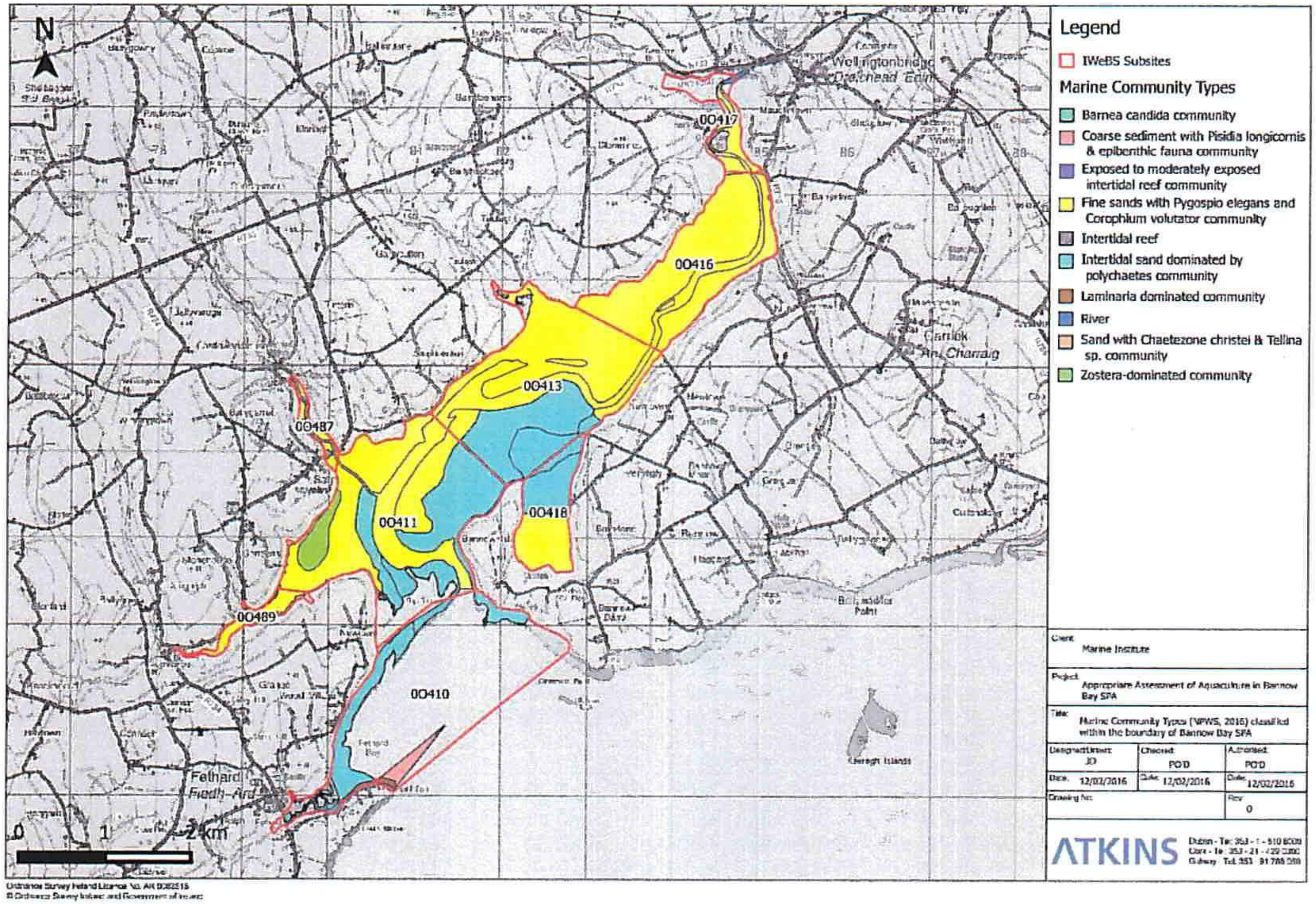


Figure 5.3 - Marine community types mapped by NPWS (2011b).

6. Intertidal oyster and mussel cultivation in Bannow Bay

Scope of activity

6.1 Within the Bannow Bay SPA, there are currently eight sites licensed for intertidal oyster cultivation, and these sites cover a total area of 18.9 ha (Figure 6.1). There are an additional 17 sites with applications for licenses for intertidal oyster cultivation, and these sites cover a total area of 73.8 ha (Figure 6.1). One of the application sites (89A) also includes an application for mussel cultivation. Four of the application sites (25/1A, 31/1A and 41/1A, 41/1B) are described as "*trials awaiting full licence*" in the aquaculture profile. However, this status is not recognised in the official data supplied by DAFM. All the application and licensed sites are in the middle part of Bannow Bay, spanning the estuary between Saintkierans/Taulaght on the western side of the bay and Newtown on the eastern side of the bay.

History of activity

6.2 Aquaculture sites were first licensed in 1993, with additional sites licensed in 2000 and 2003 (Table 6.1). However, intertidal oyster cultivation in Bannow Bay began prior to 1993. The first documented aquaculture started in 1984, in a site to the south of Saintkierans (site 7 in Table 6.1 and Figure 6.2), but this site is no longer active. Operations began in the currently active licensed sites between 1988 and 1991 (Table 6.1). A further phase of development took place in 2003, with commencement of activity in several trial sites (Table 6.1). Two of the current operators also used additional sites to the south of the main aquaculture area for a few years (Table 6.1 and Figure 6.2).

6.3 Information about the development of the sites was obtained from interviews with the operators and is summarised in Table 6.3. One operator (Hookhead Shellfish Ltd.) reached their current levels of site occupancy by 2005. Another operator (Fitzpatrick Oysters Ltd.) has had a gradual increase in production throughout their period of operations. The third currently active operator (Special Bannow Shellfish Ltd.) has had a major expansion in spatial occupancy of trial sites (31/1A and 32/1A) in recent years, although this appears to be due to the switch from double to single rows of trestles, as well as the increase in the number of trestles.

6.4 Production data is available from 1998 (Text Figure 6.1). This shows that production levels remained more or less stable up until 2009, but there has been a rapid increase in production between 2009 and 2014.

6.5 The earliest available mapping of areas occupied by trestles was carried out in 2009. The trestles were also mapped in November 2010 for the trestle study and in 2011; although the 2010 mapping did not include the trestles along the western and eastern shorelines. The most recent mapping of the trestles was carried out in 2015.

6.6 In 2009, the total area occupied by trestles was around 11 ha. This had increased to around 26 ha by 2011 and 32 ha by 2015. Comparison of the trestle mapping from 2009 and 2010 shows a significant expansion in the trestle occupancy in site 41/1/A (Figure 6.3). Between 2010 and 2011 (Figure 6.4) and between 2011 and 2015 (Figure 6.5), there was gradual expansion in the rows of trestle in site 32/1A.

6.7 Overall, there appear to have been four main phases of aquaculture development in Bannow Bay:

- 1984-1987: one site, outside the currently farmed area.
- 1988-2002: development of eight scattered, small sites.
- 2003-2009: development of four larger trial sites.
- 2010-2015: expansion in spatial occupancy in sites 41/1A and 32/1A and major increase in production levels.

Table 6.1 - History of licensed aquaculture in Bannow Bay.

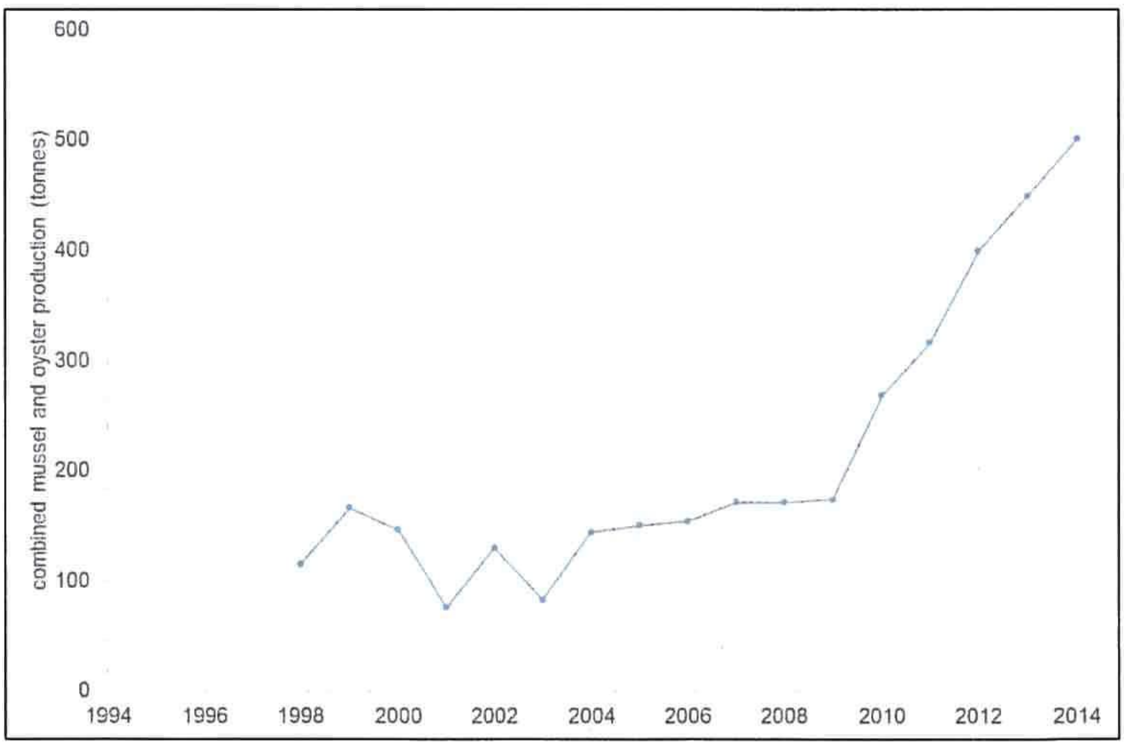
Operator	Site	Status	Current status	Activity started	Foreshore licence	Aquaculture licensing:	
						first licensed	most recent
Bannow Bay Fisheries	7	Licensed	not active	1984	1995	2000	2000
Bannow Island Shellfish Ltd.	31A	Licensed	active	1988		1993	1993
	31B	Licensed	active	1988		1993	1993
	31/1A	Application	active	?2003		2003	2003
Fitzpatrick Oysters Ltd.	41A	Licensed	active	1991	1996		2000
	41B	Licensed	active	1991	1996		2000
	41/1A	Application	active	2003			2003
	41/1B	Application	active	2003			2003
Hookhead Shellfish Ltd.	25A	Licensed	active	1990	1995	2000	2005
	25B	Licensed	active	1990	1995	2000	2005
	25/1A	Application	active	2003		2003	
Special Bannow Shellfish Ltd.	32A	Licensed	active	1988		1993	2003
	32B	Licensed	active	1988		1993	2003
	32/1A	Application	active	2003		2003	2003

Table 6.2 - Additional historical aquaculture sites used in Bannow Bay.

Operator	Activity started	Duration
Hookhead Shellfish Ltd.	1990	3 years
Special Bannow Shellfish Ltd.	around 2000	a few years

Table 6.3 - Development of aquaculture activity in Bannow Bay.

Operator	Sites	Activity started	Development of activity
Bannow Bay Fisheries	7	1984	Not currently active. No other information.
Bannow Island Shellfish Ltd.	31A and 31B	1988	No information.
	31/1A	?2003	No information.
Fitzpatrick Oysters Ltd.	41A and 41B	1991	Started at 10 tonnes/year. Gradually increased to current levels of 30 tonnes/year, which were reached around 2009-2011.
	41/1A	2003	Reached 70-80 tonnes by 2007, and increased to 80-100 tonnes by 2015.
	41/1B	2003	Holding area.
Hookhead Shellfish Ltd.	25A, 25B	1993	Started with 200-300 trestles in 25A and 25B. Gradually increased to current levels of 1000 trestles (across all three sites), which were reached in 2005.
	25/1A	2003	
Special Bannow Shellfish Ltd.	32A, 32B	1988	Started with 800-1000 trestles, now 1000-1200 trestles
	32/1A	2003	4000 trestles in double rows in 2009/10, now 6500 trestles in single rows.



Text Figure 6.1. Aquaculture production in Bannow Bay from data supplied by Brian O'Loan, BIM.

Description of activity

6.8 Most existing and proposed aquaculture activity in Bannow Bay involves suspended oyster using bags and trestles in the intertidal zone (intertidal oyster cultivation).

6.9 One of the application sites (89A) also includes an application for mussel cultivation, and mussel cultivation already takes place within Bannow Bay. The existing and proposed mussel cultivation will use identical methods to that used for intertidal oyster cultivation.

6.10 The trestles vary in height but typically do not exceed 0.5 m height and their height above the sediment is often less as they sink into the sediment.

6.11 The arrangement of trestles varies between the sites. In the Fitzpatrick Oysters Ltd. and Hookhead Shellfish Ltd. sites, the trestles are arranged in long rows, more or less parallel to the adjacent tidal channels. The separation between the rows varies from around 5-15 m, with occasional wider gaps. Access lanes, around 20 m wide, run perpendicular to the rows. The Bannow Island Shellfish Ltd./Special Bannow Shellfish Ltd. sites adjacent to the eastern shoreline, contain tightly packed short (4-5 m) rows of trestles, 1-2 m apart, with 2-3 m gaps between each block. The offshore Bannow Island Shellfish Ltd./Special Bannow Shellfish Ltd. sites are arranged in blocks. Each block contains eight rows of trestles around 75 m long, and with gaps of around 5 m between each row. The blocks are arranged in lines broadly parallel to the tidal flow, with gaps of around 20 m between each block in a line, while the lines are separated by gaps of around 50 m.

6.12 Currently, there is a one year production cycle. Half-grown oysters are introduced in early spring to fatten out in spring, summer and autumn. These oysters are then harvested in the winter. Previously, a 2-3 year production cycle was used, which involved growing mussels from seed, but mortality events in the early 2000s led to the change in production cycle. However some seed is still brought in (in much smaller quantities) for the 2-3 year production cycle. The current stock input into the bay for oysters is 2.5 million G6 seed annually and 165-170 tonnes of half-grown (20-40 g) oysters. Mussel intake is about 50 tonnes of half-grown mussels.

6.13 The oysters and mussels are put into mesh bags, with mesh sizes of 9 mm typically used for the half-grown mussels and 4-6 mm for the seed mussels. The bags are then placed on top of the trestles, where they are on-grown until they are ready for harvesting. The function of the trestles is to keep the animals off the seabed, preventing grit getting inside the oysters, providing increased water flow and allowing suitable shell growth. The mesh bags facilitate handling and prevent predation.

6.14 Husbandry activities takes place throughout the year, although the activity may be less intensive in later summer/early autumn (July-September). Two operators work every weekday, while one operator only works on the spring low tides (10 days/month). The typical duration of husbandry activity per day is 3-4 hours around the low tide period. Husbandry activities involve turning the mesh bags every spring tide to rid the bags of any settled silt, stop the growth of oyster shell into the mesh and destroy fouling organisms.

6.15 The Fitzpatrick Oysters Ltd. and Hookhead Shellfish Ltd. sites, and the Bannow Island Shellfish Ltd./Special Bannow Shellfish Ltd. shoreline sites are accessed by tractor, while a flat-bottomed boat is used to access the Bannow Island Shellfish Ltd./Special Bannow Shellfish Ltd. offshore sites. The access routes are shown in Figure 6.6.

Table 6.4 - Summary of existing husbandry activity levels in Bannow Bay.

Operator	Days/month	Vehicles	Workers
Fitzpatrick Oysters Ltd.	20	2 tractors	4
Hookhead Shellfish Ltd.	10	1 tractor	3
Special Bannow Shellfish Ltd.	20	2 tractors and a flat-bottomed boat	6

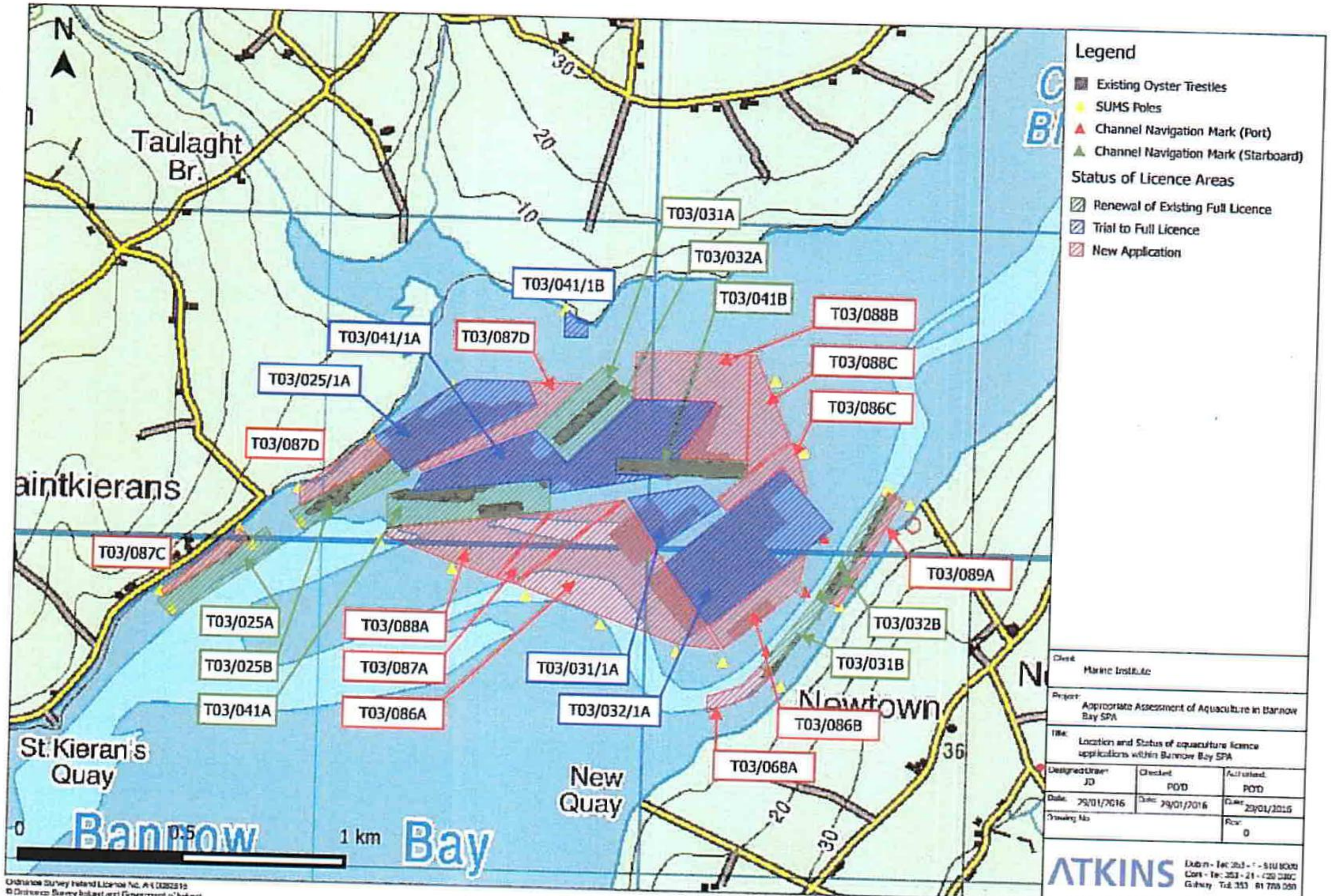


Figure 6.1 - Aquaculture sites in Bannow Bay included in this assessment based upon profiling information. Trial to full licence sites are considered as 'new applications'.

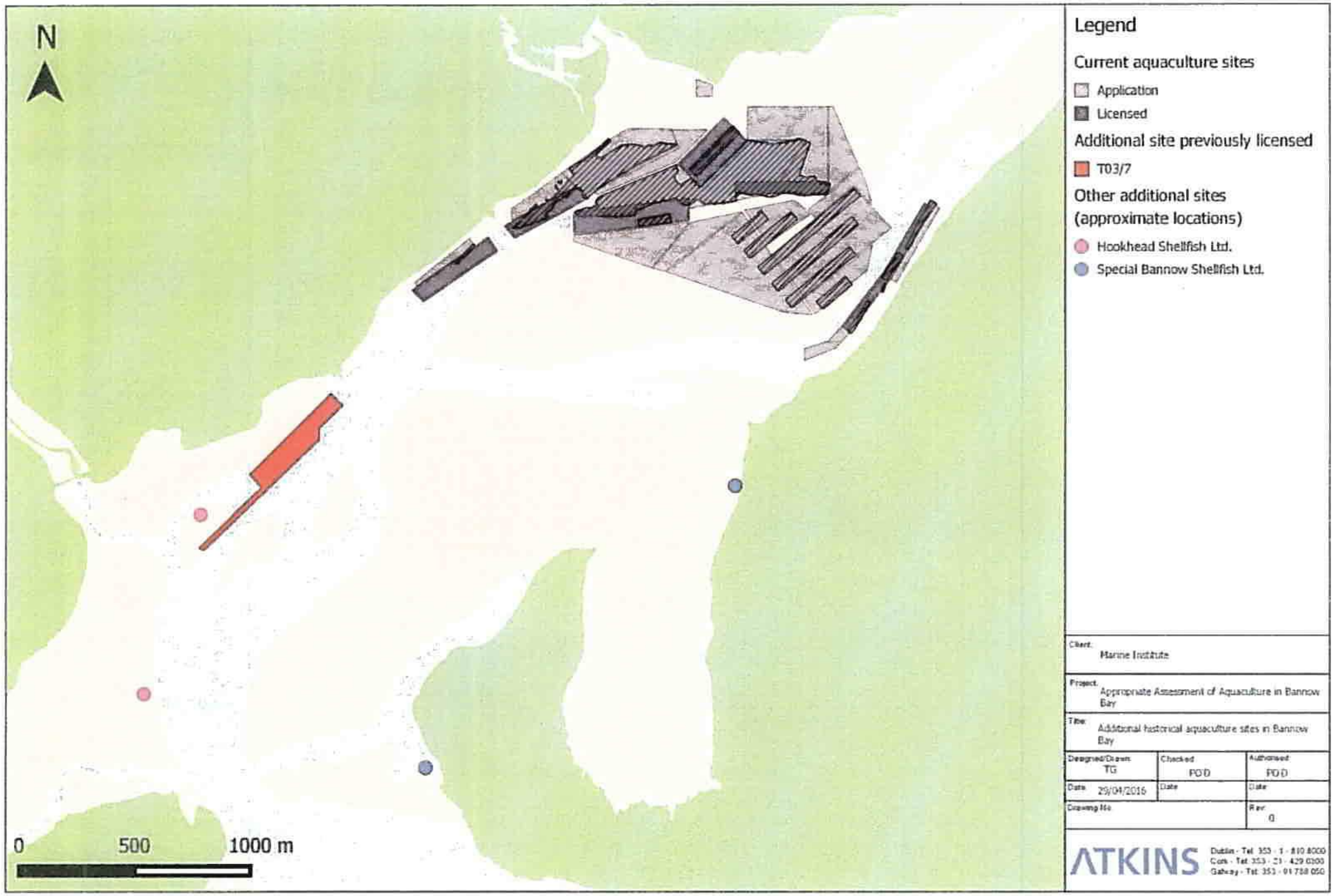


Figure 6.2 - Additional historical aquaculture sites in Bannow Bay allied with exisiting and proposed sites.

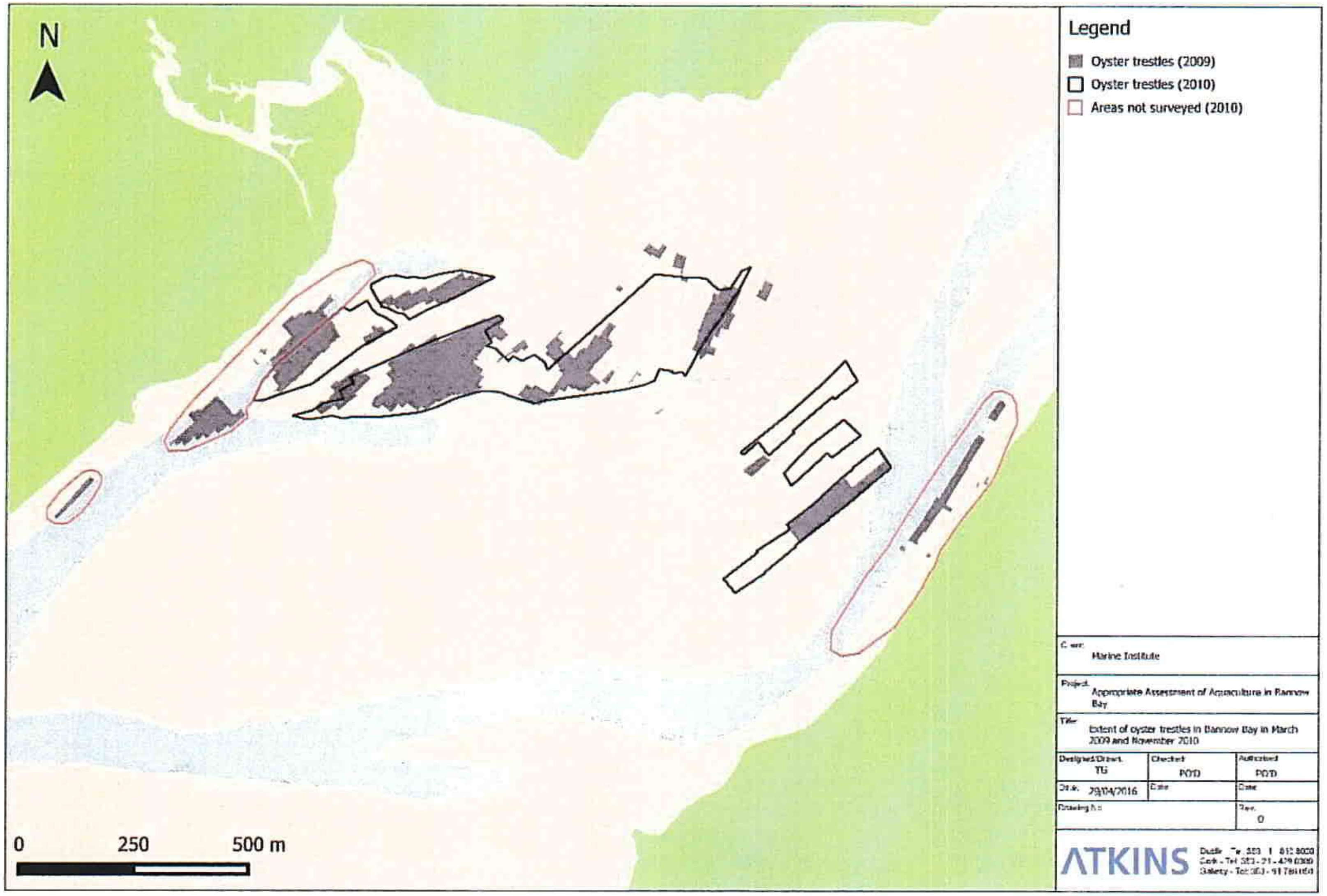


Figure 6.3 - Comparison of trestle occupancy in Bannow Bay between 2009 and 2010.

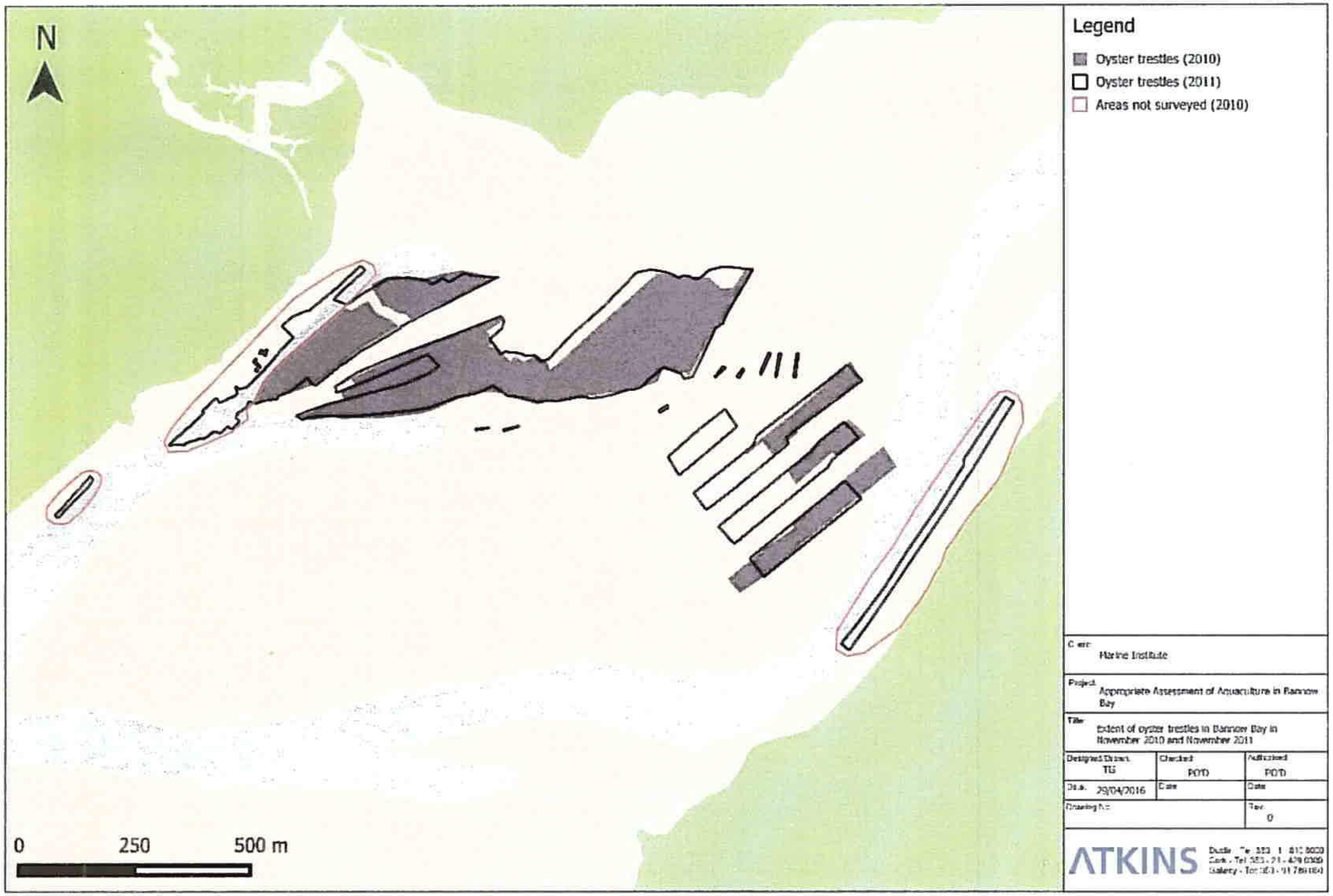


Figure 6.4 - Comparison of trestle occupancy in Bannow Bay between 2010 and 2011.

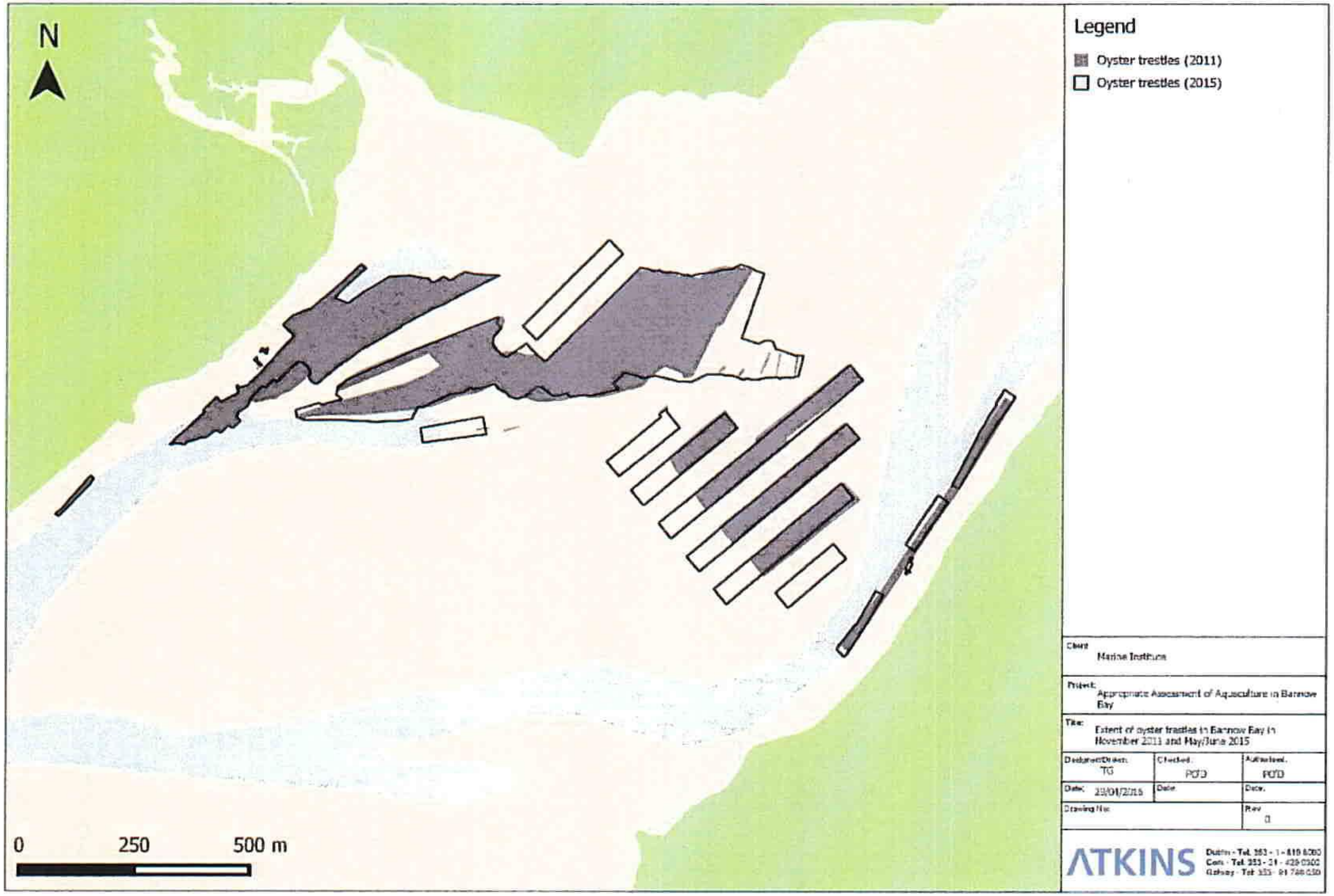


Figure 6.5 - Comparison of trestle occupancy in Bannow Bay between 2011 and 2015.

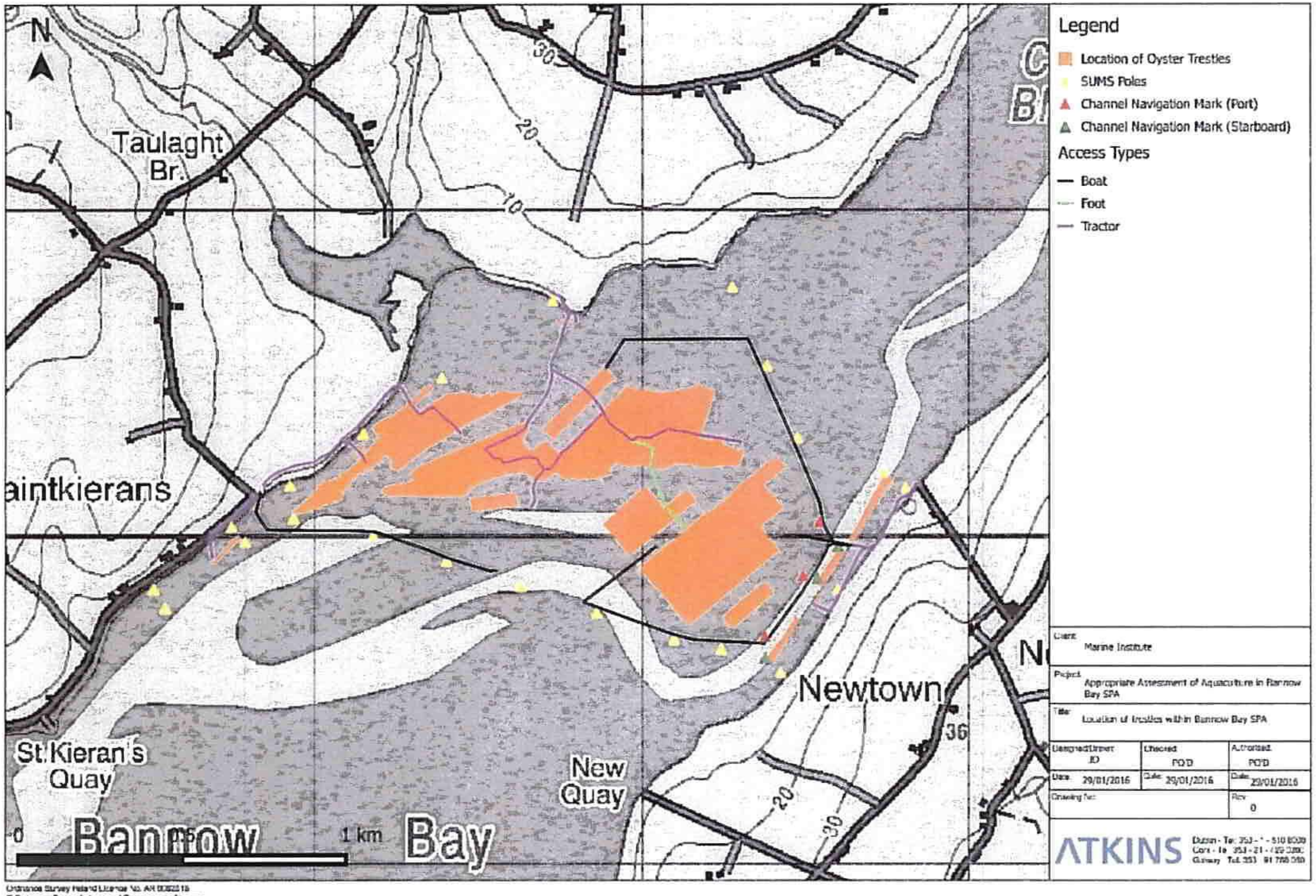


Figure 6.6 - Existing and proposed routes to access the aquaculture sites for husbandry work.

7. Potential impacts of intertidal oyster and mussel cultivation

Introduction

7.1 This section provides a review of the potential impacts of suspended oyster and mussel cultivation using bags and trestles in the intertidal zone (referred to hereafter as intertidal oyster and mussel cultivation). It provides a framework for the detailed assessment of likely impacts on individual species in Chapters 8 and 9.

Habitat changes

Habitat structure

7.2 Intertidal oyster and mussel cultivation causes a significant alteration to the intertidal habitat through the placement of physical structures (oyster trestles) on the intertidal habitat. 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, based on the results of the trestle study, 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.

Food resources

Benthic fauna

7.3 Intertidal oyster and mussel cultivation may cause impacts to benthic invertebrates through sedimentation and eutrophication, and this could potentially affect food resources for waterbird species.

7.4 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.

7.5 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 *Capitella 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.

7.6 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 number of sites nationally, including Bannow Bay. 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. Therefore, the site-specific research indicates that intertidal oyster cultivation in Bannow Bay is unlikely to have had major impacts on food resources for waterbirds that feed on benthic fauna.

Fish

7.7 Dumbauld *et al.* (2009) also 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.

7.8 In addition to the alteration of the physical habitat, aquaculture could also, theoretically, have impacts on fish populations through 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 fishes; Gibbs, 2004). Carrying capacity modelling of the proposed introduction of suspended culture of green mussels into a New Zealand bay indicated that large-scale bivalve culture could cause the replacement of zooplankton by the cultured bivalves as the major grazers in the system with consequent impacts on pelagic fish (Jiang and Gibbs, 2005). However, Leguerrier *et al.*'s (2004) model of the impact of oyster cultivation on a food web in a French bay indicated that oyster cultivation caused secondary production to increase benefitting fish populations, particularly those that used the mudflats as a nursery area. Lin et al.'s (2009) model and observations of the removal of oyster cultivation from a eutrophic lagoon in Taiwan indicated that reef fish populations were enhanced by oyster cultivation but pelagic and soft-bottom fish increased following the removal of the oyster cultivation.

Disturbance

7.10 Intertidal oyster cultivation requires intensive husbandry activity (see Chapter 1) 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, Great Crested Grebe and Cormorant), 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) 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.

8. Assessment of impacts on intertidal waterbird species (excluding Pintail)

Introduction

8.1 This section presents a detailed assessment of the potential impacts of the existing and proposed aquaculture activities in Bannow Bay on the SCI species of Bannow Bay SPA, excluding those SCI species that have already been screened out (see Section 4). These also include the five SCI species screened in from the Ballyteige Burrows SPA.

8.2 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.

8.3 The area occupied by trestles is not exposed outside the four-five hour period centred on low tide and no husbandry activity takes place outside this period. Therefore, disturbance from husbandry activities will not cause any displacement impacts outside the four-five hour period centred on low tide and will not cause impacts to any high tide roosts.

Distribution patterns

Distribution patterns in 2009/10

8.4 The broad patterns of distribution of waterbird species during the WSP low tide counts is summarised in Table 8.1. This indicates that some species are more or less uniformly distributed across the site (e.g., Dunlin, Curlew and Redshank), while others are concentrated in particular sections (e.g., Light-bellied Brent Goose in the lower zone, Shelduck in 0O418 in the mid zone and Black-tailed Godwit in the upper zone).

Table 8.1 - Mean percentage distribution of waterbird species between the three broad zones of Bannow Bay, and within the two subsites in the mid zone, during the WSP low tide counts.

Species	Lower zone	Mid zone		Upper zone
		0O413	0O418	
Light-bellied Brent Goose	78%	15%	5%	2%
Shelduck	20%	1%	78%	2%
Golden Plover	33%	0%	50%	17%
Grey Plover	12%	39%	44%	5%
Lapwing	23%	5%	6%	66%
Knot	37%	11%	34%	18%
Dunlin	35%	28%	13%	24%
Black-tailed Godwit	9%	4%	0%	86%
Bar-tailed Godwit	15%	46%	7%	32%
Curlew	30%	14%	22%	34%
Redshank	23%	18%	35%	24%

Data source: 2009/10 Waterbird Survey Programme as undertaken by the National Parks & Wildlife Service.
Sample sizes: n = 4 for all species, except Shelduck and Golden Plover where n = 3.

Distribution patterns in 2011

8.5 The distribution of waterbirds in the 2011 trestle study counts is summarised in Table 8.2. This includes data for the species that occurred in significant numbers on all the counts. Of the other species included in this assessment: Light-bellied Brent Goose were recorded on two counts with sizeable numbers in one or both counts in all the sectors except C1 and C6, Golden Plover were only recorded on one count (in sector C6), Grey Plover occurred on all the counts with small numbers in all the sectors except C3; large Lapwing flocks occurred in C3 on two counts and C6 on one count; and Knot were not recorded on any of the counts.

8.6 Overall, the data indicates that the two southernmost sectors (C1 and C2) held the very low numbers of most species relative to their area. These sectors hold sandbanks that appear to dry out rapidly after they are exposed. From observations in February and March 2016, the sandbanks on the opposite side of the tidal channel, along the western side of Bannow Island appear to hold similar, or even lower, densities of waterbirds. Sectors OY2, C4 and C6 generally held high numbers relative to their area. Numbers in sector OY1 may have been reduced by the high occupancy of this sector by trestle blocks. The only moderate relative numbers in sector C3 may have reflected the upper shore character of this sector. There is no obvious reason for the low relative numbers of most species in sector C5.

8.7 Two points to note from this analysis: -

- The aquaculture areas occupy a transitional zone between the muddier sediments in the upper estuary that hold high densities of most species and the sandier sediments in the middle zone of the estuary that hold low densities of most species.
- Sector OY2, which had low occupancy of oyster trestles at the time of this survey, held relatively high numbers of most species.

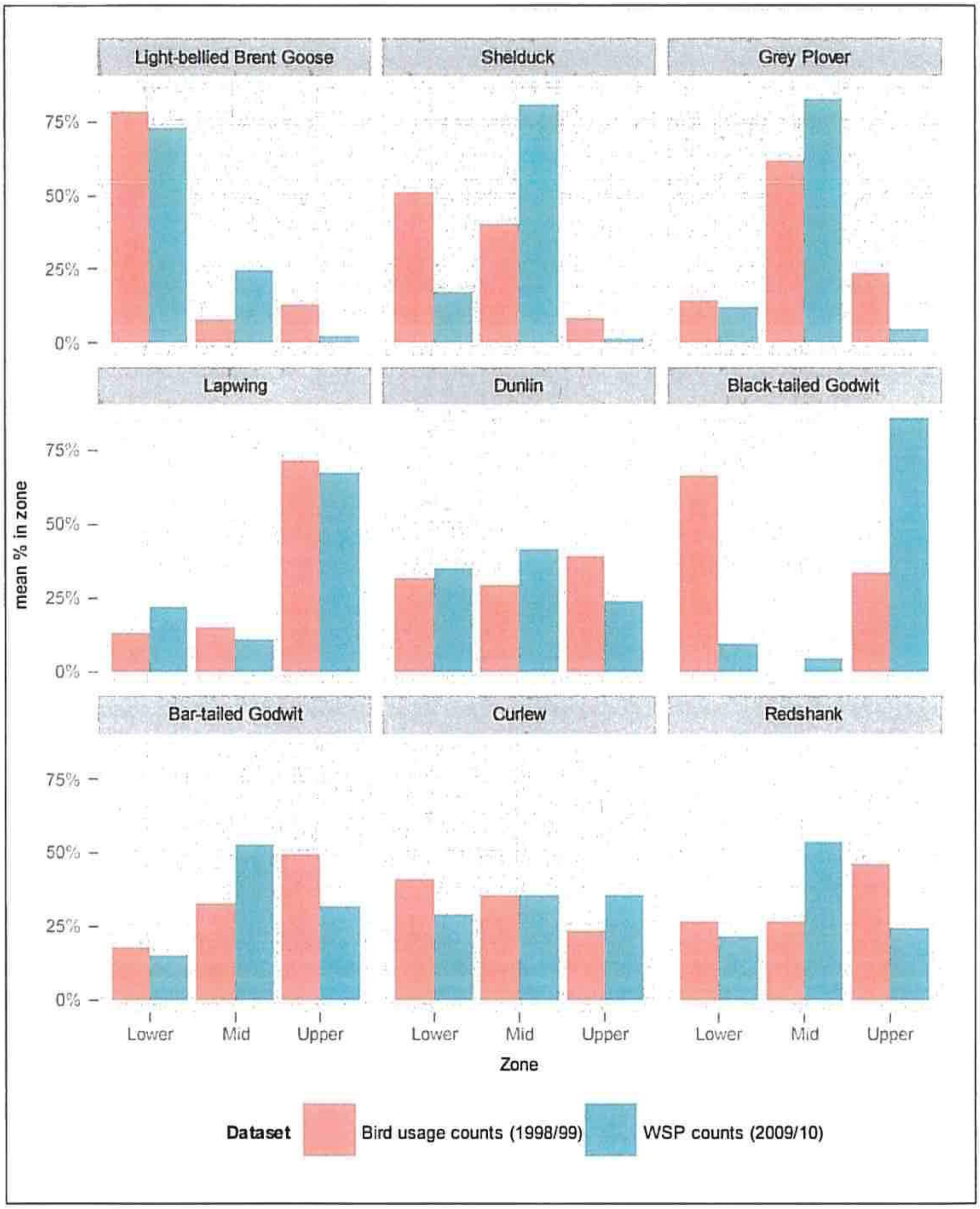
Table 8.2 - Distribution of waterbirds during the trestle study counts, January-February 2011.

Species	Mean percentage of total count/km^2							
	C1	C2	C3	OY1	OY2	C4	C5	C6
Shelduck	0%	0%	40%	0%	49%	20%	0%	74%
Dunlin	7%	4%	21%	7%	38%	95%	0%	65%
Black-tailed Godwit	0%	0%	0%	0%	95%	0%	62%	66%
Bar-tailed Godwit	25%	4%	19%	23%	34%	45%	4%	60%
Curlew	6%	2%	14%	17%	45%	34%	5%	70%
Redshank	7%	5%	24%	19%	63%	54%	65%	47%

The sectors are arranged in sequence from south to north and west to east.

Distribution patterns in 1998/99 compared to 2009/10

8.8 The data used to calculate the percentages in Table 8.1 is from the 2009/10 WSP, which included four low tide counts of Bannow Bay. This is clearly a very limited basis on which to try and draw conclusions about waterbird distribution patterns. However, comparisons with the distribution patterns from other datasets can be made to assess the representativeness of the 2009/10 distribution patterns. The first comparison we have made is with the distribution patterns from the bird usage counts, which were carried out in 1998/99.



Text Figure 8.1 - Comparison of waterbird distribution patterns in the bird usage (1998/99) and WSP (2009/10) counts.

8.9 For the purposes of comparison, we have combined the sectors used for the bird usage counts into three zones that are broadly equivalent to the zones used to analyse the WSP counts. However, due to differences in the sector divisions, the mid zone that we have defined for the bird usage counts is significantly smaller than the WSP mid zone. Also, it should be noted that the bird usage counts did not cover the outermost part of the bay (i.e., subsite 00410). We have compared the distribution in the two datasets by excluding counts in 00410 from the WSP dataset, and by standardising the percentage distribution by the areas of each zone.

8.10 The percentage distributions of the various waterbird species between the three zones in the bird usage and WSP counts are compared in Text Figure 8.1. In both datasets, Light-bellied Brent Goose were strongly concentrated in the lower zone, Grey Plover in the middle zone, Lapwing in the upper zone and Dunlin and Curlew showed a more or less even distribution across the three zones. However, there were some marked differences in the distribution patterns of the other species. Bar-tailed Godwit and Redshank all showed an increase in relative numbers in the mid zone compared to the upper zone between the bird usage and WSP counts. This could be due to the fact that the northern part of the area defined as the mid zone in the WSP counts was included in the upper zone for the analysis of the bird usage counts. This area appears to have muddier sediments than the area to the south (which was included in the mid zone in the analyses of both datasets) and may, therefore, be preferentially selected. Shelduck and Black-tailed Godwit showed a decrease in relative numbers in the lower zone between the bird usage and WSP counts. This could possibly indicate a decrease in the area of muddy sediments in this zone due to sand being washed in from the erosion of the sandbar at the mouth of the bay.

Distribution patterns in 2011 compared to 2009/10

8.11 The second comparison we have made is with the distribution patterns from the 2011 trestle study counts. The study area for the 2011 trestle study counts broadly corresponded to the subsites 0O413 and 0O416 from the 2009/10 WSP counts. Therefore, the distribution of species between these two subsites are compared in Table 8.3.

8.12 Some species showed relatively consistent patterns. These included: Light-bellied Brent Goose and Shelduck, which occur in relatively small numbers in the overall area concerned; Black-tailed Godwit, which showed a very strong preference for 0O416 in both datasets; and Curlew, which often shows more or less uniform distribution patterns across intertidal habitats. However, other species showed marked differences. In some cases they may represent high variability in distribution patterns. For example, the mean percentage in 0O413 of the total Bar-tailed Godwit count for 0O413 and 0O416 varied from 29-100% during the 2009/10 WSP counts. With this level of variability it is likely that two small samples would show large differences even if the underlying distribution pattern has not changed.

8.13 Grey Plover showed a relatively constant distribution pattern between subsites 0O413 and 0O416 in the 2009/10 counts. For this species, the differences in distribution patterns between the 2009/10 and 2011 counts may reflect the differences in the areas covered. The flock maps from the 2009/10 counts indicate that the Grey Plover mainly occurred in the south-eastern part of the subsite. The actual mapped positions of these flocks mainly lie on the northern side of the tidal channel. However, when these are compared to the position of the tidal channel shown on OSI mapping, the flock positions are mainly on the southern side of the tidal channel. In February and March 2016, the Grey Plover in subsite 0O413 were all feeding on the sandbank on the southern side of the tidal channel (although their distribution pattern may have been influenced by the much greater extent of trestles compared to that present in 2009/10). The exclusion of this sandbank from the area covered by the trestle counts may explain the much lower relative occurrence of Grey Plover in 0O413 in 2011 compared to 2009/10.

Table 8.3 - Comparison of waterbird distribution patterns in 2009/10 and 2011.

Species	Mean % in 00413 and 00416 in 2009/10	Mean % in 00413 out of total count for 00413 and 00416	
		2009/10 WSP low tide counts	2011 trestle study counts
Light-bellied Brent Goose	17%	94%	94%
Shelduck	2%	16%	23%
Golden Plover	17%		
Grey Plover	43%	82%	59%
Lapwing	29%	7%	63%
Knot	29%		
Dunlin	51%	59%	23%
Black-tailed Godwit	89%	9%	19%
Bar-tailed Godwit	76%	61%	34%
Curlew	43%	28%	24%
Redshank	39%	43%	33%

2009/10 data source: 2009/10 Waterbird Survey Programme as undertaken by the National Parks & Wildlife Service.
See text for details of adjustments to 2011 data.

Response to intertidal oyster cultivation

8.14 The overall response of the waterbird species to oyster trestles is summarised in Table 8.4, along with evidence about their response to oyster trestles at Bannow Bay (where available). The latter is presented in the form of Jacobs Index (D) values, which represent the degree of positive or negative association with oyster trestles: D can vary from -1 (indicating complete avoidance) to +1 (strong preference).

8.15 Grey Plover and Knot 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). These species did not occur in sufficient numbers in the trestle study counts to calculate D index values for Bannow Bay.

8.16 Dunlin and Bar-tailed Godwit both showed strong avoidance of oyster trestles in the data from the trestle study and this avoidance was further supported by subsequent monitoring work at Dungarvan Harbour (Gittings and O'Donoghue, 2015). The D index values from Bannow Bay conform to this pattern.

8.17 Light-bellied Brent Goose showed a variable response pattern in the trestle study with neutral/positive patterns of association at some sites, and negative patterns at other sites. At Bannow Bay, Light-bellied Brent Goose were only recorded on two of the four trestle study counts and they showed strongly negative patterns of association with trestles on both of these counts. This species often feeds on the algae that attaches to the trestle bags and at some sites large numbers can be present on the trestles on the ebb/flood tides to exploit this food source. However, this behaviour appears to be rare at Bannow Bay. During the trestle study, only 1% of the birds were observed on trestles, compared to 12-53% of birds at the other three sites with significant numbers of this species. During site visits in February and March 2016, specific watches were made during the ebb/flood tides, but no Light-bellied Brent Goose were observed on trestles despite the presence of large flocks in the area.

8.18 In the trestle study report, Curlew was classified as having an overall neutral/positive pattern of association with oyster trestles. However, based on further analysis of the dataset we now consider that the response should be classified as variable. At Bannow Bay, Curlew showed a consistently negative pattern of association with oyster trestles. As Curlew appear to show a more or less uniform distribution throughout Bannow Bay (see above), this negative pattern of association is unlikely to be an artefact despite the small sample size.

8.19 In the trestle study report, Redshank was classified as having an overall neutral/positive pattern of association with oyster trestles. This is supported by mean D indices close to zero across all sites, and summed D indices close to, or greater than, zero at five of the six sites included in the study. However, Bannow Bay was the one site where Redshank showed a negative pattern of association with oyster trestles.

Table 8.4 - Summary of patterns of association with oyster trestles at Bannow Bay

Species	Overall response	Jacobs index (D) values for Bannow Bay							
		All sectors				Close sectors			
		D sum	D min	D max	n	D sum	D max	D min	n
Light-bellied Brent Goose	Variable	-0.86	-0.69	-1.00	2	-0.92	-0.81	-1.00	2
Shelduck	(Negative)	-	-	-	-	-	-	-	-
Golden Plover	-	-	-	-	-	-	-	-	-
Grey Plover	Exclusion	-	-	-	-	-	-	-	-
Lapwing	(Negative)	-	-1.00	-1.00	3	-	-1.00	-1.00	2
Knot	Exclusion	-	-	-	-	-	-	-	-
Dunlin	Negative	-1.00	-1.00	-1.00	4	-1.00	-1.00	-1.00	4
Black-tailed Godwit	(Negative)	-1.00	-1.00	-1.00	2	-	-	-	-
Bar-tailed Godwit	Negative	-0.78	-0.67	-0.87	4	-0.60	-0.40	-0.81	3
Curlew	Variable	-0.66	-0.58	-0.95	3	-0.33	-0.39	-0.91	2
Redshank	Neutral/ positive	-0.76	-0.69	-0.95	3	-0.74	-0.59	-0.90	3

Overall response is as classified by Gittings and O'Donoghue (2012), with the exception of Curlew (see text).

8.20 The other species included in this assessment are: Shelduck, 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 Shelduck, 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.

8.21 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.

8.22 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. However, Lapwing showed strongly negative patterns of association with oyster trestles on three of the four trestle study counts at Bannow Bay.

8.23 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. At Bannow Bay, there was sufficient data to calculate D indices and these indicate a strongly negative patterns of association with oyster trestles.

Displacement analysis

8.24 The predicted displacement from intertidal oyster and mussel cultivation in Bannow Bay is shown in Table 8.5. The predicted displacement from full occupancy of the renewal sites (which do not include the sites with trial licenses) ranges from over 3% of the total Bannow Bay population for Grey Plover and Bar-tailed Godwit to less than 0.1% for several other species. Full occupancy of all the sites may cause much higher levels of displacement, including over 14% of the Bannow Bay Bar-tailed Godwit population, over 12% of the Bannow Bay Grey Plover population, and over 9% of the Bannow Bay Dunlin population.

Table 8.5 - Predicted displacement (% of total Bannow Bay population).

Species	% occurrence in 00413		Predicted displacement	
	mean from 2009/10 low tide counts	corrected for existing trestle occupancy	Renewal sites	All sites
Light-bellied Brent Goose	15%	15%	1.2%	4.7%
Shelduck	1%	1%	0.0%	0.2%
Golden Plover	0%	0%	0.0%	0.1%
Grey Plover	39%	40%	3.1%	12.3%
Lapwing	5%	5%	0.4%	1.5%
Knot	11%	11%	0.9%	3.5%
Dunlin	28%	29%	2.2%	9.0%
Black-tailed Godwit	4%	4%	0.3%	1.3%
Bar-tailed Godwit	46%	47%	3.6%	14.5%
Curlew	14%	14%	1.1%	4.3%
Redshank	18%	18%	1.4%	5.7%

2009/10 data source: 2009/10 Waterbird Survey Programme as undertaken by the National Parks & Wildlife Service.

8.25 The predicted displacement figures in Table 8.5 are based on three key assumptions: (1) the 2009/10 low tide counts provide an accurate representation of the species low tide distribution; (2) in the absence of intertidal oyster cultivation, the species would be uniformly distributed throughout all the available intertidal habitat within subsite 0O413; and (3) the species are completely excluded from the areas occupied by the trestles. Given the very limited available data it was necessary to make these assumptions. However, all three assumptions are unlikely to be true for some, or all, of the species involved.

8.26 The comparisons between the bird usage counts and WSP datasets, and between the WSP and trestle study datasets, show that most species did not show consistent distribution patterns across all three datasets. This is not surprising as each dataset only included four or five counts and waterbird distribution patterns at this scale usually show a high degree of variability. In particular, the three species with the highest predicted displacement levels (Grey Plover, Dunlin and Bar-tailed Godwit) all showed higher relative numbers in the mid zone/subsite 0O413 in the WSP dataset compared to the other two datasets. Therefore, the distribution data from the WSP may exaggerate the overall average level of occurrence of these species in the subsite 0O413 and result in overestimation of the likely displacement impact for these species. Both Light-bellied Brent Goose and Curlew showed more or less consistent distribution patterns across the three datasets, suggesting that the use of distribution data from the WSP should not have affected the calculation of the likely displacement impact.

8.27 In the case of Grey Plover, our observations suggest that the birds in subsite 00413 may preferentially use the area on the south side of the main tidal channel, outside the aquaculture area (although this could be an indicator of impact from the aquaculture activities).

8.28 Subsite 00413 contains a heterogeneous mixture of intertidal habitats. The ASU map (see Chapter 5) shows that three broad sediment types occur in this subsite: littoral mud along the northern/western side of the subsite, muddy sand in the middle part of the subsite and littoral fine sand in the southern/eastern part of the subsite. As discussed in Chapter 5, the actual distribution of sediment types within this subsite is more complex than represented in the ASU map.

8.29 The distribution patterns recorded between sectors in the trestle study counts may reflect this habitat variation and show that the assumption that, in the absence of intertidal oyster cultivation, species would be uniformly distributed throughout all the available intertidal habitat within subsite 00413 is not correct. In particular, these distribution patterns indicate that the aquaculture areas occupy a transitional zone between the muddier sediments in the upper estuary that hold high densities of most species and the sandier sediments in the middle zone of the estuary that hold low densities of most species.

8.30 It is also not the case that all species are completely excluded from the areas occupied by the trestles. The overall results of the trestle study indicate that, while Grey Plover and Knot are completely excluded, the impact on Dunlin and Bar-tailed Godwit is a reduction in density, rather than complete exclusion. The data from Bannow Bay indicates that most species had more strongly negative patterns of association with trestle blocks compared to the overall pattern across the trestle study. This may indicate some site-specific factor causing a higher level of impact. However, it is also possible that this is an artefact due to the small number of counts: the trestle study was designed to investigate overall patterns of association across sites, rather than to produce reliable data for individual sites.

Impact assessment

8.31 The displacement analysis above predicts that **full occupation of all the aquaculture sites** could cause: -

- high levels of displacement (9-15%) to the Bannow Bay Grey Plover, Dunlin and Bar-tailed Godwit populations;
- significant, or near-significant, displacement levels of around 5% to the Bannow Bay Light-bellied Brent Goose, Curlew and Redshank populations;
- measurable but non-significant displacement levels of 1.3-3.5% to the Bannow Bay Lapwing, Knot and Black-tailed Godwit populations;
- and negligible displacement levels of 0.1-0.2% to the Bannow Bay Shelduck and Golden Plover populations.

8.32 However, for the reasons discussed above, there is a high level of uncertainty to these predictions. Therefore, the actual displacement levels to these species could be significantly less than predicted. Conversely the displacement levels to these species could be significantly greater than predicted.

8.33 Therefore, we consider that, in general, the potential for significant displacement impacts cannot be discounted simply because the predicted displacement level is less than 5%, and that Light-bellied Brent Goose, Grey Plover, Lapwing, Knot, Dunlin, Black-tailed Godwit, Bar-tailed Godwit, Curlew and Redshank may all be subject to significant adverse impacts from full occupation of the aquaculture sites. However, we consider that potential for significant displacement impacts is very unlikely for Shelduck and Golden Plover.

8.34 While significant numbers of Shelduck and Golden Plover occur in the mid zone of the estuary, these birds almost all occur in the muddy bay on the eastern side of Bannow Island (subsite 0O418). During the WSP counts, there was only a single counts of 7 Shelduck and 17 Golden Plover from subsite 0O413. In the trestle study counts the mean Shelduck count in the sectors overlapping subsite 0O418 was 19 (range 6-42), while no Golden Plover were recorded. In February and March 2016, Shelduck were also concentrated in subsite 0O418 and no Shelduck or Golden Plover were recorded in the areas around the trestles (the Golden Plover only occurred at the upper end of the estuary in subsite 0O416). Therefore, there is consistent evidence across three winters indicating that Shelduck and Golden Plover usage of subsite 0O413 is very low.

Full occupation renewal sites only would result in measurable but non-significant displacement levels of 1.1-3.6% to the Bannow Bay Light-bellied Brent Goose, Grey Plover, Dunlin, Bar-tailed Godwit, Curlew and Redshank populations (note the clarifications presented above).

9. Assessment of impacts on other species

Introduction

9.1 This chapter covers the following species: Pintail, Cormorant and Lesser Black-backed Gull.

Pintail

Population trends at Bannow Bay

9.2 Pintail is a SCI of the Bannow Bay SPA. However, Pintail has not been recorded in I-WeBS counts at Bannow Bay since the winter of 2005/06 and it was not recorded in either the WSP or the trestle study counts. In fact, Pintail was only regularly recorded at Bannow Bay between 1994/95 and 1996/97 (Table 9.1), and it was only recorded on one of the five 1998/99 bird usage counts. Nationally important numbers of Pintail were recorded in the 1984/85-1986/87 Winter Wetlands Survey of Bannow Bay (Sheppard, 1993). Therefore, it does appear that Pintail was a regular wintering species at Bannow Bay up until the mid-1990s.

Table 9.1 - I-WeBS count data for Pintail from Bannow Bay.

Winter	Sep	Oct	Nov	Dec	Jan	Feb	Mar
1994/95					14	0	0
1995/96		0		111	6	10	0
1996/97					130		
1997/98	0	0			0		
1998/99		0	0		20		
1999/00	0				0		
2001/02							0
2002/03			3	0	11		0
2004/05			0		0	0	
2005/06					47	18	6
2006/07	0	0	0	0	0	0	
2007/08	0	0			0	0	
2008/09		0	0	0	0	0	0
2009/10	0	0	0	0	0	0	
2011/12		0	0	0			
2013/14				0	0		

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.

Blank cells indicate that there was no count in that month/winter.

9.3 The disappearance of Pintail from Bannow Bay pre-dates major expansion of aquaculture activities in the bay. In the mid/late 1990s aquaculture was confined to small sites along the shoreline (see above).

9.4 The national trend for Pintail showed a decrease between the mid-1990s and the early 2000s, and then a subsequent recovery up to 2008/09 (the latest date for which trend graphs are available; Boland and Crowe, 2012). The short-term national trend for 2008/09 - 2012/13 is a mean annual change of -3% (Boland *et al.*, 2014). The disappearance of Pintail from Bannow Bay is, therefore, in line with the general trend, but the scale of the decrease is higher, and the population did not show any recovery when the national population started to increase again. However, there appears to be a geographical division in the trends for Pintail along a line between Tacumshin and Galway Bay: in Boland and Crowe (2012), five of the eight sites listed as no longer of significant importance are south of this line, while all the ten sites listed as nationally important are north this line. Therefore, the disappearance of Pintail from Bannow Bay may be due to a combination of a national population decline and a re-distribution of the remaining population.

Response to oyster trestles

9.5 Pintail were not recorded in the trestle study and we have no information on whether it shows negative or neutral/positive patterns of association with oyster trestles.

9.6 None of the Irish sites that support significant numbers of Pintail have significant areas of oyster trestles. Therefore, it would be impossible to carry out research in Ireland to determine the nature of patterns of association between Pintail and oyster trestles.

Impact assessment

9.7 Pintail has disappeared from Bannow Bay. Its disappearance does not appear to be related to the development of aquaculture activities in the bay, but may be due to a combination of a national population decline and a re-distribution of the remaining population.

9.8 There is no information on whether Pintail shows negative or neutral/positive patterns of association with oyster trestles, and, due to the distribution of the remaining population, it would not currently be possible to carry our research to obtain this information. Therefore, it is not possible to predict whether development of aquaculture activities in Bannow Bay would prevent the recovery of the population should the species begin to occur again at Bannow Bay. However, it should be noted that observed habitat preferences in Cork Harbour would suggest Pintail would have most likely used areas of saltmarsh away from aquaculture zones.

Cormorant

Occurrence in Bannow Bay

9.9 No information is available about the occurrence of visiting Cormorant from the Keeragh Islands SPA within Bannow Bay. In winter, Cormorant regularly occur within Bannow Bay but it is not known to what extent, if any, Cormorants use Bannow Bay in summer.

9.10 West *et al.* (1975) studied the diet of birds from this colony. They did not record any eels, or estuarine or freshwater fish species, and the fish identified included mackerel, plaice and wrasse. Therefore, the birds appeared to be feeding exclusively on marine fish. This would suggest that the birds were not making significant use of food resources within the estuarine section of Bannow Bay (including the areas that are now aquaculture sites), although they may have been feeding in the outer part of the SPA. However, this study was carried out over 40 years ago. At other marine colonies, Cormorant diets can include a significant component of estuarine and freshwater fish species (West *et al.*, 1975; Tierney *et al.*, 2011). Therefore, more recent evidence on the diet composition of the Keeragh Islands colony would probably be required before their usage of estuarine habitat within Bannow Bay can be discounted.

9.11 In the 2009/10 WSP counts, Cormorant mainly occurred in the lower zone of Bannow Bay (mean percentage of total count = 81%; range 48-96%, n = 5), and a similar pattern was shown in the 1998/99 bird usage counts. However, these were mainly low tide counts, and Cormorant may make greater use of the mid and upper zones at high tide.

Response to oyster trestles

9.12 No evidence is available about the response of Cormorants to oyster trestles.

9.13 Cormorant are fish-eating birds. In general intertidal oyster cultivation is likely to either have no effect on, or increase local abundances of fish (see Chapter 7). There is no evidence as to whether the development of large-scale aquaculture at Bannow Bay could cause negative impacts on fish population through reduced recruitment or through indirect food web effects (see Chapter 7), though it is suspected that any such response would be neutral (F. O'Beirn, pers comm). If such ecosystem-scale effects occurred they could be manifested through both displacement of birds (reduced usage of Bannow Bay) and/or impacts on long-term population trends.

Impact assessment

9.14 Intertidal oyster cultivation is likely to have neutral or positive impacts on the availability of prey resources for Cormorant in the areas occupied by the activity, compared to areas of similar habitat elsewhere in Bannow Bay. Therefore, intertidal oyster cultivation is not likely to cause any displacement of Cormorant within Bannow Bay.

9.15 It is not possible to directly assess whether intertidal oyster cultivation is affecting the overall availability of prey resources in Bannow Bay through ecosystem-scale effects, though as noted it is suspected that any such response would be neutral (F. O'Beirn, pers comm) (see above).

Lesser Black-backed Gull

Occurrence in Bannow Bay

9.16 No information is available about the occurrence of visiting Lesser Black-backed Gull from the Saltee Islands SPA within Bannow Bay. In winter, Lesser Black-backed Gull regularly occur within Bannow Bay but it is not known to what extent, if any, Lesser Black-backed Gull use Bannow Bay in summer.

9.17 Some assessment can, however, be made of the potential occurrence of visiting Lesser Black-backed Gull from the Saltee Islands SPA within Bannow Bay by considering evidence about the typical foraging range and diet of the species during the breeding season.

9.18 Thaxter *et al.* (2012) quote a mean foraging range of Lesser Black-backed Gull from its breeding colonies of 71.9 km, a mean maximum of 141 km and a maximum of 181 km. However, these figures are based on a very small number of studies (2 for the mean and 3 for the mean maximum). Camphuysen (2011) reported median foraging distances from a breeding colony at Texel (The Netherlands) ranging from 5-31 km, and maximum foraging distances ranging from 19-359 km, depending upon the area that the birds were feeding in. Therefore, it is clear that Lesser Black-backed Gull can range very widely from their breeding colonies and the aquaculture areas in Bannow Bay may be within the core foraging range of the Saltee Islands SPA population.

9.19 The Lesser Black Backed Gull is omnivorous and can utilise a wide array of energy sources, consuming fish, small mammals, invertebrates, plant material, rubbish, fish discards, etc.(Cramp and Simmons, 2004). Though it is capable of obtaining food by dipping to surface, shallow plunging and aerial pursuit of prey, a large portion of its diet seems to come from kleptoparasiting food from other birds (both inter- and intra-specific); it is also generally accepted that open sea fish feeding contributes more to the diet of the Lesser Black Backed Gull than scavenging compared to other large gulls (studies quoted by Cramp and Simmons, 2004).

9.20 The diet of Lesser Black-backed Gull has been studied at Irish breeding colonies at Cape Clear (Creme and Kelly, 1992) and the Magharee Islands (Kelly, 2009). At the Magharee Islands, the diet was dominated by terrestrial beetles, marine fish and anthropogenic garbage (54.3%, 27.4% and 20.2%, respectively).

9.21 At two German North Sea colonies, the diet was dominated by marine fish and open sea crabs indicating that the birds were mainly feeding at sea (Kubetzki and Garthe, 2003). However, at another German North Sea colony, during the incubation period the gulls fed mainly upon crustaceans and molluscs from the intertidal zone, but during chick-rearing, they took mainly crustaceans and fish which were gathered mostly as trawler discards (Garthe *et al.*, 1999). At a breeding colony at Texel, the diet was dominated by marine fish but the polychaete worm *Nereis longissimi* comprised 3-25% of the diet over the five seasons studied, which indicates that the birds made significant use of the intertidal zone in at least some seasons (Camphuysen, 2011). At an Irish Sea colony in Cumbria, marine molluscs comprised 10-14% of the diet (Kim and Monaghan, 2006).

9.22 Therefore, while Lesser Black-backed Gull may be more likely to use food resources in the open sea compared to some other gull species, food resources in the intertidal zone can be a significant component of the diet in at least some breeding colonies. In the absence of specific information about the diet of the Lesser Black-backed Gull colony of the Saltee Islands, the possibility cannot be discounted that intertidal habitat in Bannow Bay provides food resources for the colony.

Response to oyster trestles

9.23 The trestle study classified the response of Lesser Black-backed Gull to oyster trestles as unknown, due to lack of sufficient data for detailed analysis. While Lesser Black-backed Gull is very closely related to Herring Gull (which has a neutral/positive association with oyster trestles), there are significant ecological differences between the two species and it would be dangerous to infer that they have a similar response to oyster trestles. Of the 958 Lesser Black-backed Gull counted across all sites and days in the extensive study only eight birds were recorded within trestle blocks. Furthermore, it is notable that in the trestle study, 18% of the total number of Herring Gulls recorded across all sites and counts were on trestles, but none of the Lesser Black-Backed Gulls were on trestles (total numbers: 958 Lesser Black-Backed Gulls and 1437 Herring Gulls). However, most of the Lesser Black-backed Gull recorded in the extensive study were roosting birds often in large flocks. It would not be surprising that roosting flocks of Lesser Black-backed Gull, which typically occur on open intertidal flats, avoid trestle blocks. But this does not necessarily mean that feeding Lesser Black-backed Gull similarly avoid trestle blocks. In the context of assessing potential impacts to birds visiting Bannow Bay on foraging visits from the Saltee Islands colony, it is the impact to feeding birds that is important.

Impact assessment

9.24 The closest estuarine/intertidal site to the Saltee Islands Lesser Black-backed Gull colony is Ballyteige Burrows, which is around 10 km from the colony. Tacumshin and Lady's Island Lake are around 14-16 km from the colony, but these are lagoonal sites, rather than intertidal sites. The aquaculture areas in Bannow Bay are around 17 km from the colony. Therefore, if estuarine/intertidal areas provide significant food resources for the colony, it is possible that the aquaculture areas in Bannow Bay contribute to these food resources. If Lesser Black-backed Gull has a negative association with oyster trestles, then aquaculture activities in Bannow Bay could reduce the availability of prey biomass to the colony.

9.25 Without firm information on the diet of the Saltee Islands Lesser Black-backed Gull colony, the occurrence of Lesser Black-backed Gull in Bannow Bay during the summer, and/or the response of Lesser Black-backed Gull to oyster trestles, it is not possible to make an assessment of the potential impact of aquaculture activities in Bannow Bay on the colony.

10. Assessment of cumulative impacts

Introduction

10.1 This section presents an assessment of potential cumulative impacts from intertidal oyster cultivation in combination with other activities. Cormorant is not included in this assessment because the main assessment has concluded that this species are likely to have a neutral or positive response to intertidal oyster and mussel cultivation. Therefore, as the species included in this assessment are only associated with intertidal habitat, activities only affecting deep subtidal habitat such as boat traffic are not included in this assessment.

Activities

10.2 An indicative distribution map of the activities considered in this assessment is shown in Figure 10.1. This is based mainly on the mapping of activities during the WSP counts, the trestle study and on site visits.

Disturbance generating activities

Beach recreation

10.3 Beach recreation areas occur in the outermost part of Bannow Bay. Grange Beach, which is located on the western shore of the outermost part of the bay, received the Green Coast Award for 2016. However "*access to the beach is along a rough track*", which may limit the level of usage (www.discoverireland.ie/; accessed 14/06/2016). Bannow Beach is located on the opposite shore to the south of Bannow Island. Both beaches are described as being "*popular throughout the year with recreational users, particularly walkers and birdwatchers*" (NPWS, 2012a).

10.4 The nature of the sediments and shoreline elsewhere in Bannow Bay do not provide attractive conditions for beach recreation. However, public roads run along several sections of shoreline and it is possible to also walk along sections of shoreline between the access points provided by the public roads.

10.5 During the WSP survey and our own site visits, a low level of recreational activity (walking along the shoreline) was observed in the outer part of the bay, while no recreational activity was recorded during the trestle study (Table 10.1).

Other activities

10.6 Water-based recreational activities were not recorded during the WSP counts, the trestle study, or our site visits. However, Grange Beach is described as an "*ideal spot for water sports such as kite surfing and wind surfing*" (www.discoverireland.ie/; accessed 14/06/2016).

10.7 Bait digging occurred relatively frequently (Table 10.1) with the activity spread widely around the middle and lower sections of the bay (Figure 10.1). On one of the WSP counts there were eight bait diggers in the bay on the eastern side of Bannow Island, but, otherwise, only one or two bait diggers were recorded per visit.

10.8 Hand collection of shellfish (winkle picking) appears to be a rare activity (Table 10.1), occurring in the mixed sediment shoreline between Saintkierans and Saltmills.

10.9 Shore angling was recorded on two of the WSP counts (Table 10.1) in the lower part of the bay (Figure 10.1). This activity may be more frequent at other seasons.

Table 10.1 - Summary of disturbance pressures recorded in surveys of, and site visits to, Bannow Bay.

Disturbance pressure	WSP counts (2009/10)		Trestle study (2011)		Site visits (2010, 2016)	
	frequency	intensity	frequency	intensity	frequency	intensity
Angling	2/6	1-4	0/4	-	0/3	-
Bait digging	4/6	1-8	0/4	-	1/3	2
Shellfish gathering	1/6	2	0/4	-	1/3	2
Shooting	1/6	1	0/4	-	0/3	-
Walking/dogs	4/6	1-2	0/4	-	1/3	2
Dogs	2/6	1	0/4	-	0/3	-
Horse riding	2/6	1	0/4	-	0/3	-

WSP data source: 2009/10 Waterbird Survey Programme as undertaken by the National Parks & Wildlife Service. Frequency indicates the number of visits on which the pressure was recorded while intensity indicates the number of people/animals involved in the pressure on the visits when it was recorded. Angling and shellfish gathering were not recorded separately in the WSP disturbance data received from NPWS; the data for these activities have been derived from review of the original field maps/datasheets.

Potential impacts

10.10 There is an extensive and complex literature on the impacts of disturbance from human activities on waterbirds in intertidal and shallow subtidal habitats. It is difficult to use this literature to make specific predictions about the nature and extent of potential disturbance impacts as the effects of disturbance vary between species and, within species, vary between sites and within sites. However, in general, with beach walks and/or when access is mainly along the shoreline (i.e. with little activity in the intertidal or shallow subtidal zone), disturbance impacts, while causing local (a few hundred metres) displacement of birds, does not appear to affect the large-scale distribution of birds across sites (e.g., Colwell and Sundeen, 2000; Lafferty, 2001; Gill *et al.*, 2001a & b; Neuman *et al.*, 2008; Trulio and Sokale, 2008; Yasué, 2006; but see Burton *et al.*, 2002b) or survivorship (Durell *et al.*, 2007; but see Stillman *et al.*, 2012). Disturbance in the intertidal zone will generally have greater impacts (Stillman *et al.*, 2012) and, where disturbance rates are high and/or concentrated areas of species food resources are affected, may cause significant impacts to large-scale distribution (Mathers *et al.*, 2000) and/or survivorship (Durell *et al.*, 2008; Goss-Custard *et al.*, 2006; Stillman *et al.*, 2012; West *et al.*, 2008). However, some studies of shellfish gathering in the intertidal zone have concluded that it does not affect waterbird populations (Dias *et al.*, 2008; Navedo and Masero (2007).

10.11 The main concentration of activity in the intertidal is likely to be in the beach recreation areas in subsite 0O410. While this will presumably mainly occur during summer, it may overlap with build-up of significant numbers of some of the SCI species in late summer/early autumn. This subsite generally supported low numbers of most species in the WSP counts. Light-bellied Brent Goose was the only species that occurred in significant numbers, but Light-bellied Brent Goose do not arrive until October and will, therefore, not overlap with high levels of recreation activity.

10.12 Shellfish gathering and bait digging will also involve activity in the intertidal zone. However, the levels of these activities appear to be low and they are unlikely to cause significant disturbance impacts.

10.13 Boat activity will generally not affect waterbirds in intertidal and shallow subtidal activity. However, some types of recreational watersports activities can occur in very shallow waters and have been observed to cause disturbance to waterbirds. For example, we have observed jet skiers in Ballycotton Bay travelling up tidal channels and across shallowly flooded areas causing disturbance to important feeding and roosting areas. In Cork Harbour, kayakers and windsurfers in the Aghada area can come close into the shoreline causing disturbance to high tide roosts.

These activities will mainly take place around the high tide period and may cause disturbance to feeding waterbirds in intertidal and shallow subtidal habitat on ebb/flood tides. However, the activities are likely to be concentrated around the beach recreation areas and will not, therefore, be likely to overlap with significant numbers of waterbirds.

10.14 Overall, the available information indicates that non-aquaculture related disturbance generating activities are unlikely to be causing significant impacts to the species covered in this assessment. Therefore, it is not necessary to consider potential in-combination effects with intertidal oyster and mussel cultivation.

Activities affecting waterbird food resources

Bait digging and shellfish collecting

10.15 Bait digging and shellfish collecting will remove food resources that would otherwise be available for consumption by waterbirds and may also cause mortality to non-target species (Masero *et al.*, 2008). Therefore, if these activities are extensive and/or affect concentrated food resources they could effect waterbird distribution (by causing displacement from depleted areas) and/or survivorship (by reducing the overall carrying capacity of the system).

10.16 In Bannow Bay, bait digging and shellfish gathering appear to be low intensity activities. Only 1-9 bait diggers were recorded on each day during the WSP count, and with no bait digger observed during the trestle study. This compares to bait digger numbers of 46-544 throughout the year in the Masero *et al.* (2006) study. Similarly, no more than two winkle pickers were recorded on each day during the WSP count, and no winkle pickers were observed during the trestle study. Therefore, it seems unlikely that bait digging or winkle picking is having measurable impacts in terms of resource depletion or physical habitat disturbance in Bannow Bay, and it is not necessary to consider potential in-combination effects with intertidal oyster and mussel cultivation.

Effluent discharge

10.17 Organic and nutrient inputs to estuaries increase productivity and may increase food resources for waterbirds. Therefore, adverse impacts to waterbirds might be expected to be caused by declines in organic and nutrient inputs associated with improvements in wastewater treatment There are a number of studies that document the effects of organic and nutrient loading from effluent discharges on the benthic fauna and typically the zones affected by individual discharges are restricted to within a few hundred metres of the outfall (Burton *et al.*, 2002a). The available evidence on the effects of nutrient reductions on estuarine waterbird populations is limited but, to date, no significant impacts have been reported (Burton *et al.*, 2002a, 2003). One study (Alves *et al.*, 2012) has reported localised (within 100 m) association between wastewater inputs and bird distribution; in this study the outfalls discharged in the intertidal zone and streams of sewage ran across the intertidal habitat.

10.18 There are two wastewater treatment plants (WWTPs) that discharge to Bannow Bay at Fethard-on-Sea and Wellingtonbridge.

10.19 The Fethard-on-Sea WWTP is a primary treatment plant that was installed in the late 1970s and upgraded to the current treatment level in 1995. The current outfall is a gravity outfall pipe which flows to an unnamed stream which flows to Fethard Bay c. 500 m downstream. There is a proposed upgrade of the plant, which includes decommissioning of the existing primary settlement tank and the construction of a new WWTP facility. The proposed upgrade would relocate the outfall to a marine outfall to the eastern Celtic Sea c. 240 m from the shore at Ramstown, c. 900 m southeast of Ingard Head (EPA, 2014). This project is included in the capital investment programme (CIP) by Irish Water for 2014-2016. A Natura Impact Statement has been published for this project.

10.20 The Wellingtonbridge WWTP is a primary treatment plant that was installed in the late 1960s. The primary settlement is calculated to remove approximately 40% of the Total Suspended Solids and 30% of the Biological Oxygen Demand (BOD) loading (Wexford County Council, 2009).The current outfall is to a local drain which then flows to the Corock Estuary at the head of Bannow Bay. This WWTP is listed as a priority 1 for capital works action to "*increase capacity of treatment plant*" from point source discharges and priority 1 for action in the Pollution Reduction Programme for Shellfish Waters in the Ballyteigue/Bannow Water Management Unit Action Plan.

10.21 The proposed upgrades of these two WWTPs will cause reductions in organic and nutrient inputs to Bannow Bay. However, the available evidence (see above) indicates that any impacts on waterbird populations from such reductions will be localised to the immediate vicinity of the existing outfall locations. The Wellingtonbridge WWTP outfall is located around 1 km upstream of the SPA, on a narrow tidal channel that is likely to only be used by very small numbers of a few species such as Curlew and Redshank. The Fethard-on-Sea WWTP outfall is located in a saltmarsh area dominated by *Spartina*, and, again, this area is not likely to be used by significant numbers of birds. Therefore, there is no evidence to indicate that the proposed upgrade of these WWTPs will cause a significant reductions in food supply for any of the SCI species, and it is not necessary to consider potential in-combination effects with intertidal oyster and mussel cultivation.

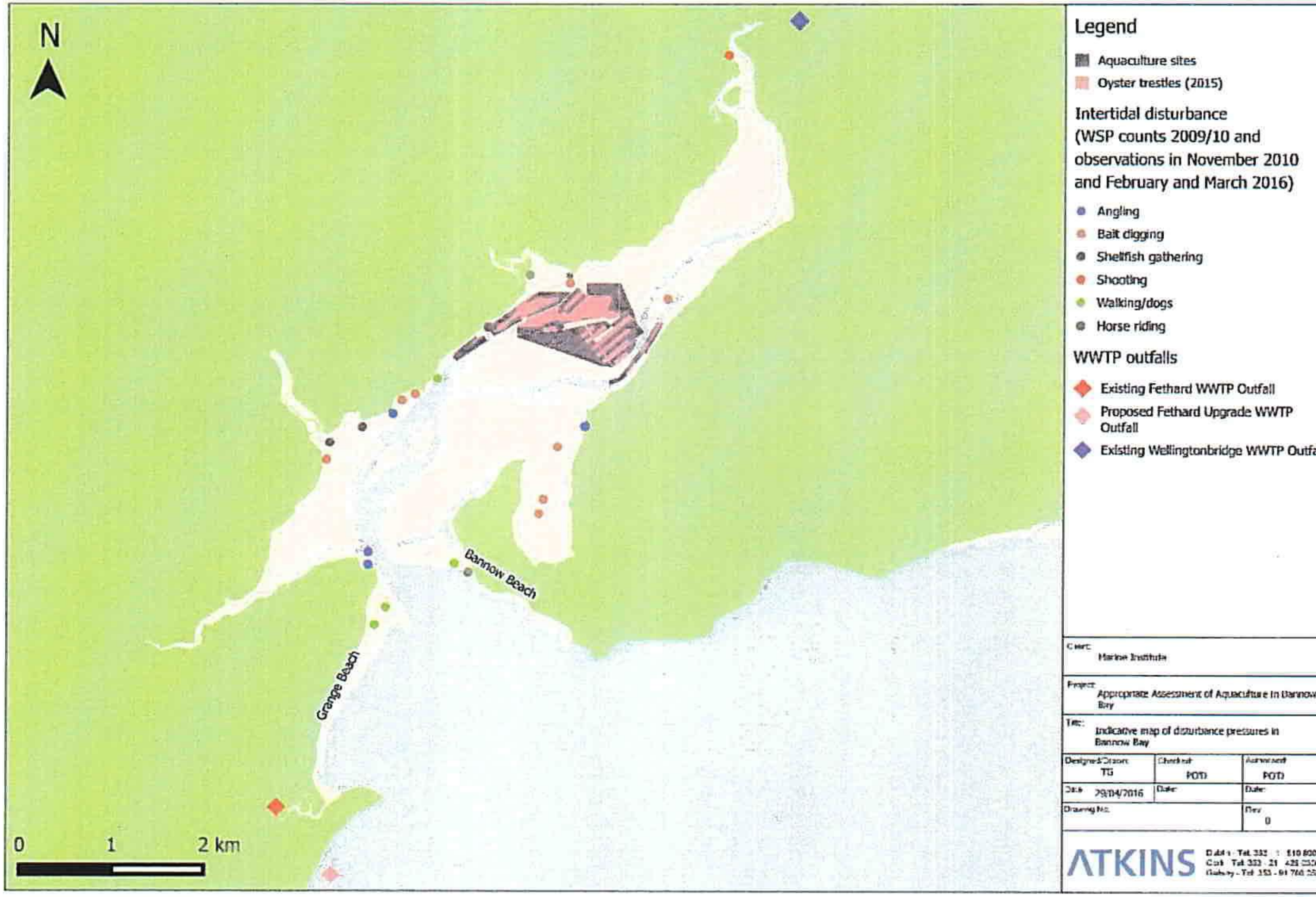


Figure 10.1 - Indicative map of disturbance pressures in Bannow Bay.

11. Assessment of impacts on conservation objectives

Introduction

11.1 Potential impacts on the screened-in SCIs are summarised below.

Bannow Bay SPA

Grey Plover, Dunlin, Bar-tailed Godwit

11.2 There is potential for full occupation of the aquaculture sites to cause substantial displacement impacts to these species. This would have a negative impact on attribute 2 (distribution) of the conservation objective for this species.

Light-bellied Brent Goose, Curlew and Redshank

11.3 There is potential for full occupation of the aquaculture sites to cause significant displacement impacts to these species. This would have a negative impact on attribute 2 (distribution) of the conservation objective for this species.

Lapwing, Knot, Black-tailed Godwit

11.4 The potential displacement impacts from full occupation of the aquaculture sites would be non-significant but measurable. Given the uncertainty about the assessment, due to the limited data, the potential for significant displacement impacts cannot be discounted beyond reasonable scientific doubt. If these occur, they would have a negative impact on attribute 2 (distribution) of the conservation objective for this species.

Shelduck and Golden Plover

11.5 The potential displacement impacts from full occupation of the aquaculture sites would be negligible. Despite the uncertainty about the assessment, due to the limited data, the potential for significant displacement impacts can be discounted based on additional evidence about the distribution patterns of these species. Therefore, no impacts to the conservation objectives for these species are predicted.

Pintail

11.6 Pintail does not currently occur at Bannow Bay and its decline and disappearance from the site does not appear to be related to the development of aquaculture activities. However, due to lack of information, it is not possible to predict whether development of aquaculture activities in Bannow Bay would prevent the recovery of the population should the species begin to occur again at Bannow Bay.

11.7 The conservation objective for this SCI is "*to maintain the favourable conservation condition of Pintail in Bannow Bay SPA*" (NPWS, 2012c). As Pintail do not currently occur at Bannow Bay, this conservation objective is meaningless and the impact to the conservation objective cannot, therefore, be assessed.

Ballyteige Burrows SPA

Light-bellied Brent Goose, Lapwing, Black-tailed Godwit and Bar-tailed Godwit

11.8 This assessment for the Bannow Bay SPA concluded that there is potential for full occupation of the aquaculture sites to cause substantial (Bar-tailed Godwit) or significant (Light-bellied Brent Goose) displacement impacts to these species within Bannow Bay, or the potential for such impacts cannot be discounted beyond reasonable scientific doubt (Lapwing and Black-tailed Godwit).

11.9 The effects of any such impacts on the conservation objectives for the Ballyteige Burrows SPA would depend upon the connectivity between the two sites. If there connectivity is high, the two sites would effectively support a single population and it is possible that major displacement impacts within Bannow Bay would affect attribute 1 (population trend) of the conservation objectives for the Ballyteige Burrows SPA.

11.10 Any such impacts would not affect attribute 2 (distribution) of the conservation objectives for Ballyteige Burrows SPA, as this attribute refers to distribution within Ballyteige Burrows.

Keeragh Islands SPA

Cormorant

11.11 This assessment has not identified any significant potential impacts from aquaculture activities on this species. Therefore, no impacts to the conservation objectives for this SCI is predicted.

Saltee Islands SPA

Lesser Black-backed Gull

11.12 Due to lack of information, it is not possible to assess whether aquaculture activities in Bannow Bay are likely to cause significant impacts to this species. Therefore, the impact to the conservation objective for this SCI cannot be assessed.

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Appendix A
Scientific names

Common name	Scientific names	BTO code
Arctic Tern	*Sterna paradisaea*	AE
Bar-tailed Godwit	*Limosa lapponica*	BA
Black-headed Gull	*Chroicocephalus ridibundus*	BH
Black-tailed Godwit	*Limosa limosa*	BW
Chough	*Pyrrhocorax pyrrhocorax*	CF
Common Tern	*Sterna hirundo*	CN
Cormorant	*Phalacrocorax carbo*	CA
Curlew	*Numenius arquata*	CU
Dunlin	*Calidris alpina*	DN
Fulmar	*Fulmarus glacialis*	F.
Gannet	*Morus bassanus*	GX
Golden Plover	*Pluvialis apricaria*	GP
Guillemot	*Uria aalge*	GU
Herring Gull	*Larus argentatus*	HG
Kingfisher	*Alcedo atthis*	KF
Kittiwake	*Rissa tridactyla*	KI
Lapwing	*Vanellus vanellus*	L
Lesser Black-backed Gull	*Larus fuscus*	LB
Light-bellied Brent Goose	*Branta bernicla hrota*	PB
Little Tern	*Sternula albifrons*	AF
Oystercatcher	*Haematopus ostralegus*	OC
Peregrine	*Falco peregrinus*	PE
Pintail	*Anas acuta*	PT
Puffin	*Fratercula arctica*	PU
Razorbill	*Alca torda*	RA
Redshank	*Tringa totanus*	RK
Roseate Tern	*Sterna dougallii*	RS
Sandwich Tern	*Sterna sandvicensis*	TE
Shag	*Phalacrocorax aristotelis*	SA
Shelduck	*Tadorna tadorna*	SU

Appendix B
Waterbird count data

B.1 WSP counts

B.1.1 The waterbird count data from the 2009/10 WSP low tide counts is summarised in Table B.1.

Table B.1.1 - Summary of waterbird count data from the WSP low tide counts of Bannow Bay, 2009/10.

Species	Date	Lower Estuary	Middle Estuary		Upper Estuary	Totals
			0O413	0O418		
Light-bellied Brent Goose	08/10/2009	169	177	0	34	380
	18/11/2009	523	28	139	2	692
	16/12/2009	452	24	1	0	477
	12/02/2010	730	22	6	0	758
Shelduck	08/10/2009	0	0	0	36	36
	18/11/2009	4	0	191	2	197
	16/12/2009	134	0	248	11	393
	12/02/2010	87	7	281	4	379
Cormorant	08/10/2009	17	11	2	9	39
	18/11/2009	9	8	0	5	22
	16/12/2009	14	0	0	1	15
	12/02/2010	15	2	0	0	17
Golden Plover	08/10/2009	0	17	3250	13	3280
	18/11/2009	0	0	310	312	622
	16/12/2009	3500	0	17	0	3517
	12/02/2010	1	0	0	36	37
Grey Plover	08/10/2009	0	79	37	2	118
	18/11/2009	1	17	83	6	107
	16/12/2009	2	16	11	0	29
	12/02/2010	30	12	22	9	73
Lapwing	08/10/2009	16	10	14	193	233
	18/11/2009	393	76	235	1629	2333
	16/12/2009	1378	103	205	1638	3324
	12/02/2010	180	52	7	390	629
Knot	08/10/2009	32	13	0	106	151
	18/11/2009	28	36	89	2	155
	16/12/2009	85	35	183	0	303
	12/02/2010	272	1	56	0	329
Dunlin	08/10/2009	135	241	13	275	664
	18/11/2009	164	82	218	47	511
	16/12/2009	662	559	15	2	1238
	12/02/2010	326	145	66	425	962
Black-tailed Godwit	08/10/2009	6	751	27	4869	5653
	18/11/2009	0	2	0	60	62
	16/12/2009	36	0	1	201	238
	12/02/2010	64	1	0	225	290
Bar-tailed Godwit	08/10/2009	27	247	0	84	358
	18/11/2009	55	186	134	177	552

Species	Date	Lower Estuary	Middle Estuary		Upper Estuary	Totals
			0O413	0O418		
	16/12/2009	131	188	6	25	350
	12/02/2010	64	276	29	681	1050
Curlew	08/10/2009	168	196	121	319	804
	18/11/2009	185	39	106	127	457
	16/12/2009	104	25	23	139	291
	12/02/2010	95	52	159	89	395
Redshank	08/10/2009	146	110	360	289	905
	18/11/2009	137	50	370	241	798
	16/12/2009	97	49	53	19	218
	12/02/2010	88	198	203	166	655
Lesser Black-backed Gull	08/10/2009	4	7	0	11	22
	18/11/2009	2	10	8	4	24
	16/12/2009	0	0	0	0	0
	12/02/2010	2	0	0	27	29

Data source: 2009/10 Waterbird Survey Programme as undertaken by the National Parks & Wildlife Service.

B.2 2011 trestle study counts

B.2.1 The waterbird count data from the 2011 trestle study counts is summarised in Table B..

Table B.2.1 - Summary of waterbird count data from the 2011 trestle study counts.

Species	Date	Mid zone		Upper zone	Total
		control sectors	trestle sectors		
Light-bellied Brent Goose	04/01/2011	0	0	0	0
	23/01/2011	414	49	72	535
	03/02/2011	0	0	0	0
	17/02/2011	84	213	79	376
Shelduck	04/01/2011	4	2	52	58
	23/01/2011	0	8	222	230
	03/02/2011	7	11	223	241
	17/02/2011	18	24	30	72
Cormorant	04/01/2011	0	2	1	3
	23/01/2011	0	0	0	0
	03/02/2011	3	0	1	4
	17/02/2011	4	0	3	3
Golden Plover	04/01/2011	10	2	0	12
	23/01/2011	2	0	28	30
	03/02/2011	4	0	3	7
	17/02/2011	2	1	4	7
Lapwing	04/01/2011	6	0	12	18
	23/01/2011	106	0	1	107
	03/02/2011	248	0	17	265
	17/02/2011	0	0	902	902
Dunlin	04/01/2011	266	97	605	968
	23/01/2011	65	0	693	758
	03/02/2011	13	0	529	542
	17/02/2011	61	226	684	971
Black-tailed Godwit	04/01/2011	0	0	152	152
	23/01/2011	0	0	125	125
	03/02/2011	0	0	0	0
	17/02/2011	14	0	14	28
Bar-tailed Godwit	04/01/2011	78	18	332	428
	23/01/2011	138	50	351	539
	03/02/2011	29	114	287	430
	17/02/2011	150	139	638	927
Curlew	04/01/2011	2	9	90	101
	23/01/2011	13	9	207	229
	03/02/2011	31	15	109	155
	17/02/2011	49	52	202	303
Redshank	04/01/2011	12	14	91	117
	23/01/2011	56	14	77	147
	03/02/2011	6	22	97	125

Species	Date	Mid zone		Upper zone	Total
		control sectors	trestle sectors		
	17/02/2011	17	24	123	164
Lesser Black-backed Gull	04/01/2011	5	0	0	5
	23/01/2011	3	1	0	4
	03/02/2011	4	4	0	8
	17/02/2011	2	3	37	42

Knot was not recorded in the trestle study counts.

Appendix C
Errata to Gittings and O'Donoghue (2012)

C.1 Introduction

C.1.1 The trestle study (Gittings and O'Donoghue, 2012) classified the response of Herring Gulls to intertidal oyster cultivation as being variable, due to a negative association with trestles in the intensive study at Dungarvan Harbour. However, re-analysis of this data has shown that there were data entry mistakes that affected this particular analysis. The corrected analysis is shown below.

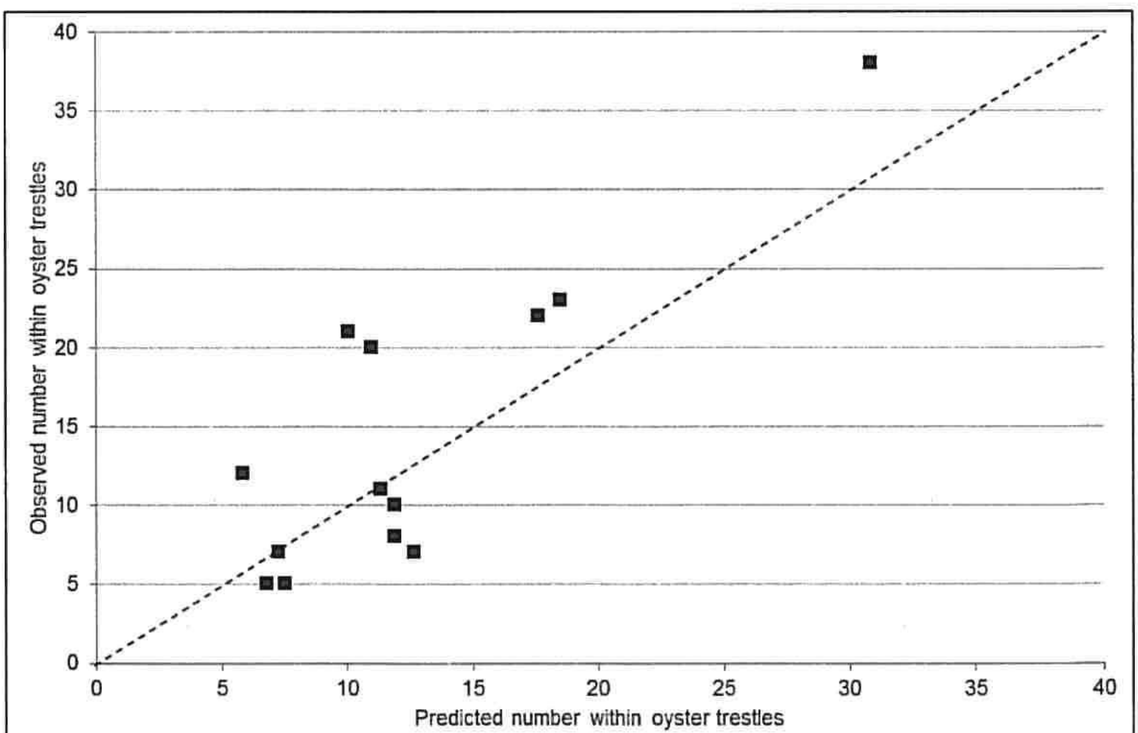
C.2 Corrected analysis

C.2.1 The corrected analysis of the association of Herring Gull with trestles in the intensive study at Dungarvan Harbour is shown in Text Figure B.1.

C.2.2 This graph compares the numbers of Herring Gulls observed within trestle blocks to those that would be predicted to occur if oyster trestles had no effect on their distribution. The dashed line indicates where the observed and predicted numbers are equal. The observed numbers are very similar to the predicted numbers, indicating that the distribution of Herring Gulls was not affected by the presence of trestle blocks.

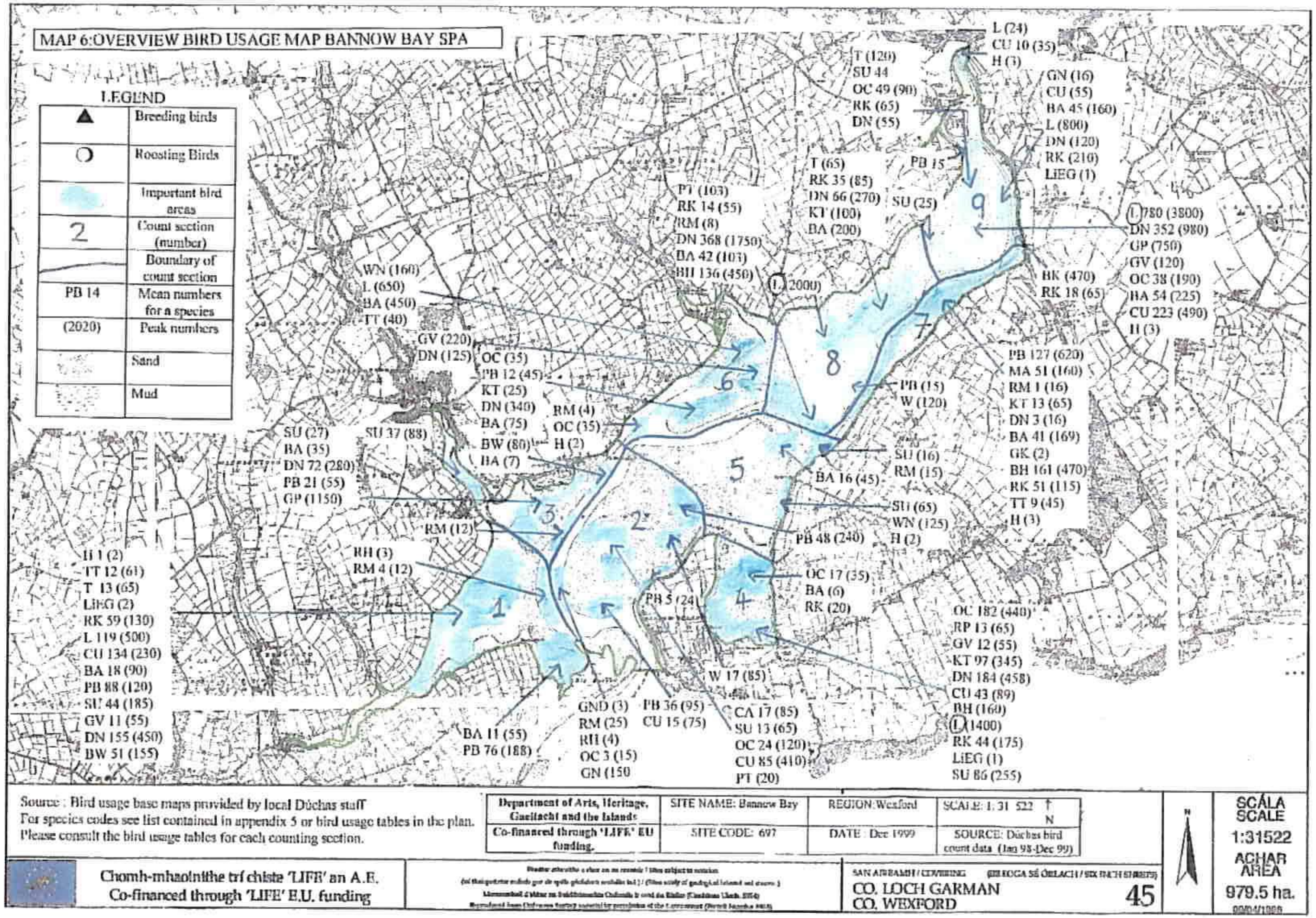
C.3 Conclusion

C.3.1 With the above corrected analysis, Herring Gull showed neutral/positive patterns of association with trestle blocks at all three scales of analysis carried out in the trestle study. Mean Herring Gull densities in the intensive study were slightly higher outside trestle blocks compared to within (10.3 versus 8.2 birds/10 ha), but this difference was not significant ($F_{1,11}$ = 0.036, p = 0.852). Therefore, we now conclude that Herring Gull show a neutral/positive response to oyster trestles.



Text Figure B.1 - Observed compared to predicted occurrence of Herring Gull within oyster trestle blocks using data from sectors OY2 and OY3 at Dungarvan Harbour.

Appendix D
Bird usage map from the NPWS bird usage counts, 1998/99


MAP 6:OVERVIEW BIRD USAGE MAP BANNOW BAY SPA
LEGEND
Breeding birds
Roosting Birds
Important bird areas
2
Count section (number)
Boundary of count section
PB 14
Mean numbers for a species
(2020)
Peak numbers
Sand
Mud
L (24)
CU 10 (35)
H (3)
T (120)
SU 44
OC 49 (90)
RK (65)
DN (55)
GN (16)
CU (55)
BA 45 (160)
L (800)
DN (120)
RK (210)
LIEG (1)
T (65)
RK 35 (85)
DN 66 (270)
KT (100)
BA (200)
PB 15
SU (25)
PT (103)
RK 14 (55)
RM (8)
DN 368 (1750)
BA 42 (103)
BH 136 (450)
L 2000
L 780 (3800)
DN 352 (980)
GP (750)
GV (120)
OC 38 (190)
BA 54 (225)
CU 223 (490)
H (3)
BK (470)
RK 18 (65)
WN (160)
L (650)
BA (450)
TT (40)
GV (220)
DN (125)
OC (35)
PB 12 (45)
KT (25)
DN (340)
BA (75)
BW (80)
BA (7)
RM (4)
OC (35)
H (2)
PB 127 (620)
MA 51 (160)
RM 1 (16)
KT 13 (65)
DN 3 (16)
BA 41 (169)
GK (2)
BH 161 (470)
RK 51 (115)
TT 9 (45)
H (3)
PB (15)
W (120)
SU (16)
RM (15)
BA 16 (45)
SU (65)
WN (125)
H (2)
PB 48 (240)
SU (27)
BA (35)
DN 72 (280)
PB 21 (55)
GP (1150)
SU 37 (88)
RM (12)
RH (3)
RM 4 (12)
H 1 (2)
TT 12 (61)
T 13 (65)
LIEG (2)
RK 59 (130)
L 119 (500)
CU 134 (230)
BA 18 (90)
PB 88 (120)
SU 44 (185)
GV 11 (55)
DN 155 (450)
BW 51 (155)
OC 17 (35)
BA (6)
RK (20)
PB 5 (24)
OC 182 (440)
RP 13 (65)
GV 12 (55)
KT 97 (345)
DN 184 (458)
CU 43 (89)
BH (160)
L (1400)
RK 44 (175)
LIEG (1)
SU 86 (255)
W 17 (85)
CA 17 (85)
SU 13 (65)
OC 24 (120)
CU 85 (410)
PT (20)
GND (3)
RM (25)
RH (4)
OC 3 (15)
GN (150
PB 36 (95)
CU 15 (75)
BA 11 (55)
PB 76 (188)
1
2
3
4
5
6
7
8
9
Source : Bird usage base maps provided by local Dúchas staff
For species codes see list contained in appendix 5 or bird usage tables in the plan.
Please consult the bird usage tables for each counting section.
Department of Arts, Heritage, Gaeltacht and the Islands
Co-financed through 'LIFE' EU funding.
SITE NAME: Bannow Bay
SITE CODE: 697
REGION: Wexford
DATE : Dec 1999
SCALE: 1:31 522
N
SOURCE: Dúchas bird count data (Jan 98-Dec 99)
Chomh-mhaoinithe trí chiste 'LIFE' an A.E.
Co-financed through 'LIFE' E.U. funding
CO. LOCH GARMAN
CO. WEXFORD
45
SCÁLA
SCALE
1:31522
ACHAR
AREA
979.5 ha.