ATKINS

Annex II

Marine Institute Bird Studies

Wexford Harbour, the Raven and Rosslare Bay: Appropriate Assessment of Aquaculture

28th July 2016

Notice

This report was produced by Atkins Ecology for the Marine Institute for the specific purpose of the Marine Institute Bird Studies project.

Document History

JOB NUMBER: 2927			DOCUMENT REF: 2927Dg22_Wexford_Rev2.docx			
2	Revision 2	TG	POD	POD	JN	28-7-2016
1	Revision 1	TG	POD	POD	JN	20-5-2016
0	Draft for Comment	TG	POD	POD	JN	30-4-2015
Revision	Purpose Description	Originated	Checked	Reviewed	Authorised	Date

Plan Design Enable

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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 responding to numerous queries and collating large amounts of information for us, and to John Dennis and Michael Murphy (BIM) for additional assistance. We are also very grateful to all the following operators who provided us with information: Michel Barbe, Michael Crowley, Paddy Cullen, Simon Dingemanse, Eugene Duggan, Billy Gaynor, Stephen Kelly, Desmond Lett, Martin Murphy, Martin Scallan, Sean Ryan and Paddy Swords.

The information provided by local NPWS staff was also invaluable for this assessment. We are very grateful to Dominic Berridge, Tony Murray, Lorcan Scott, Ciara Flynn and Alyn Walsh 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) and Oliver Tully (Marine Institute) for assistance with the provision of bird data; Brian Coulter for provision of the Wexford Harbour chartlets, and permission to use this information in our report; and Jim Casey and Marina Cumiskey (OPW) for provision of LIDAR data for Wexford Harbour.

Executive Summary

Introduction

This report contains an Appropriate Assessment of aquaculture in Wexford Harbour, the Raven and Rosslare Bay. The Wexford Harbour and Slobs SPA (site code 004076) and the Raven SPA (site code 004019) are the primary focus of this assessment. Four other SPAs are also included in this assessment: Cahore Marshes SPA (site code 004143), Lady's Island Lake SPA (site code 004009), the Saltee Islands SPA (site code 004002) and Tacumshin Lake SPA (site code 004092).

This assessment is based on a desktop review of existing information. This included published reports and papers and unpublished data from waterbird surveys. Where relevant, the report identifies information gaps that may affect the reliability of the conclusions of this assessment.

The research carried out for this assessment also included a preliminary study of the disturbance impacts of marine traffic on Red-breasted Merganser and other subtidal species (Appendix C) and a review of potential disturbance impacts from dredger activity to Greenland White-fronted Goose (Appendix D).

Spatial Extent

The areas that are the focus of this assessment are the Wexford Harbour and Slobs SPA, the Raven SPA and Rosslare Bay. Rosslare Bay is included in this assessment because there are applications for new licences in this area. While these applications are not within any SPA, the populations of some SCI species from the Wexford Harbour and Slobs SPA and/or the Raven SPA are likely to make significant use of this area. The boundaries between the Wexford Harbour and Slobs SPA and the Raven SPA are ecologically arbitrary. Therefore, for most purposes in this assessment, we have considered these two SPAs as a single site.

Activities Covered

The aquaculture activities covered in this assessment are those associated with applications for renewal of existing licences, and for new licences, in the Wexford Harbour and Slobs SPA, the Raven SPA and Rosslare Bay. These are: -

- Bottom culture of Blue Mussels (*Mytilus edulis*) in the subtidal zone (referred to as mussel bottom cultivation hereafter).
- Off-bottom culture of Pacific Oysters (*Crassostrea gigas*) using bag and trestles in the intertidal zone (referred to as intertidal oyster cultivation hereafter).
- Suspended culture of Blue Mussels on longlines and rafts in the subtidal zone (referred to as suspended mussel cultivation hereafter).

The subject of this assessment are areas that have either already been licensed for cultivation, or for which there are applications for such licences (these are collectively referred to as aquaculture sites).

Methodology

The spatial extents of the aquaculture sites have been derived from shapefiles supplied by the Marine Institute (dated 06/08/2014), based upon site lists supplied to the Marine Institute by the Department of Agriculture, Food and the Marine. Details of existing and proposed aquaculture activities have been taken from the *Aquaculture_profile_wexford_harbour_draft_3* (prepared by Brian O'Loan, BIM, received 12/03/2015). This information was supplemented by: additional information provided by BIM, based on interview notes with specific operators; and by responses from the operators to specific questions.

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 and breeding birds, where relevant.

The distribution of waterbirds was analysed using data from the Irish Wetland Bird Survey (I-WeBS) counts (1994/95-2011/12); Non-Estuarine Waterbird Survey (NEWS) counts (1997/98 and 2006/07); National Parks and Wildlife Service (NPWS) Baseline Waterbird Survey (BWS) low tide counts (carried out in 2009/10); Little Tern monitoring reports for 2013, 2014 & 2015; Marine Institute Common Scoter survey from March & December 2014; Red-breasted Merganser disturbance study (Appendix C) and a review of potential disturbance impacts from dredger activity to Greenland White-fronted Goose (Appendix D).

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 Wexford Harbour (004076) and the Raven (004019) SPAs. Impacts that will cause displacement of 5% or more of the total Wexford Harbour (004076) and the Raven (004019) SPAs population of a non-breeding SCI species have been assessed as potentially having a significant negative impact.

The distribution of biotopes within the Wexford Harbour and Slobs SPA, and the Raven SPA, is based upon the NPWS biotope map, as shown in Figure 3 of the marine supporting document for the Slaney River Valley SAC (NPWS, 2011f) and Figure 2 of the marine supporting document for the Raven Point Nature Reserve SAC (NPWS, 2011e).

Information on tidal zones, and the depths of subtidal habitats, was derived from a variety of sources including Admiralty Chart data, the Wexford Harbour chartlets (produced by Brian Coulter), and bathymetry data provided by the Geological Survey of Ireland.

Conservation objectives & Screening

The Special Conservation Interests of the Wexford Harbour and Slobs SPA are: -

- non-breeding populations of: Bewick's Swan, Whooper Swan, Greenland White-fronted Goose, Light-bellied Brent Goose, Shelduck, Wigeon, Teal, Mallard, Pintail, Scaup, Goldeneye, Red-breasted Merganser, Little Grebe, Great Crested Grebe, Cormorant, Grey Heron, Coot, Oystercatcher, Golden Plover, Grey Plover, Lapwing, Knot, Sanderling, Dunlin, Black-tailed Godwit, Bar-tailed Godwit, Curlew, Redshank, Black-headed Gull and Lesser Black-backed Gull;
- a breeding population of Little Tern; and
- a post breeding/roosting population of Hen Harrier.

In addition the wetland habitat within the Wexford Harbour and Slobs SPA is listed as an SCI. In the case of Hen Harrier there is no potential for significant spatial overlap with the aquaculture activities included in this assessment and this species has been screened out from further assessment. All other species are considered in the appropriate assessment. The Special Conservation Interests of the Raven SPA are wintering populations of: Greenland White-fronted Goose, Red-throated Diver, Cormorant, Common Scoter, Grey Plover and Sanderling. In addition the wetland habitat within the Raven SPA is listed as an SCI. None of the activities being assessed will cause any change in the permanent area occupied by wetland habitat in either Wexford Harbour and Slobs SPA or the Raven SPA. 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

The SCIs of the **Cahore Marshes SPA** (004143) are wintering populations of: Greenland White-fronted Goose, Wigeon, Golden Plover and Lapwing. In addition the wetland habitat within the Cahore Marshes SPA is listed as an SCI. All of the waterbird SCIs of Cahore Marshes SPA are also SCIs of the Wexford Harbour & Slobs SPA and/or the Raven SPA. Some of the Greenland White-fronted Goose using the Cahore Marshes SPA are known to commute to Wexford Harbour and the Raven to roost each night (NPWS). Wigeon, Golden Plover and Lapwing are species that can have very mobile populations in winter. Therefore, all these SCIs have been screened in for full assessment.

The SCIs of the **Lady's Island Lake SPA** (004009) are a wintering population of Gadwall and breeding populations of Black-headed Gull, Sandwich Tern, Roseate Tern, Common Tern and Arctic Tern. In addition the wetland habitat within the Lady's Island Lake SPA is listed as an SCI. Wexford Harbour and the Raven does not regularly support significant numbers of Gadwall; this SCI has been screened out from further assessment. As the potential that Black-headed Gull, Sandwich Tern, Roseate Tern, Common Tern and Arctic Tern forage within Wexford Harbour during either the breeding season and / or period of post-fledging dispersal cannot be discounted, all species are screened in for full assessment. Wetland habitats within Lady's Island Lake SPA will not be impacted.

The SCIs of the **Saltee Islands SPA** (004002) are breeding populations of Fulmar, Gannet, Cormorant, Shag, Lesser Black-backed Gull, Herring Gull, Kittiwake, Guillemot, Razorbill and Puffin. Based on consultation with NPWS, and consideration of their breeding / foraging ecology, the only SCIs from the Saltee Islands SPA where there was considered to be potential for significant interchange with Wexford Harbour and the Raven are the Cormorant and Shag breeding populations; all other species forage offshore and have been screened out.

The SCIs of the **Tacumshin Lake SPA** (004092) include wintering populations of: Bewick's Swan, Whooper Swan, Wigeon, Gadwall, Teal, Pintail, Shoveler, Tufted Duck, Little Grebe, Coot, Golden Plover, Grey Plover, Lapwing and Black-tailed Godwit. The SCIs also includes post breeding/roosting Hen Harrier. In addition the wetland habitat within the Tacumshin Lake SPA is listed as an SCI. Most of the waterbird SCIs of Tacumshin Lake SPA are also SCIs of the Wexford Harbour & Slobs SPA and/or the Raven SPA; due to the potential for interchange between sites these have been screened in for full assessment. The waterbird SCIs of Tacumshin Lake SPA that are not also SCIs of the Wexford Harbour & Slobs SPA and/or the Raven SPA are: Gadwall, Shoveler and Tufted Duck. As noted, Gadwall do not regularly occur in Wexford Harbour and the Raven; therefore, this SCI has been screened out from further assessment. Shoveler do not regularly occur at Wexford Harbour and the Raven; this SCI has been screened out from further assessment. Tufted Duck regularly occur in significant numbers at Wexford Harbour and the Raven; this SCI has been screened in for full assessment.

Even if there is interchange between the Wexford Harbour and Tacumshin Hen Harrier populations, there is no potential for significant spatial overlap with the aquaculture activities included in this assessment. Therefore, this SCI has been screened out from further assessment.

Aquaculture activities in Wexford Harbour and the Raven will clearly not have any impact on wetland habitat in Tacumshin Lake. Therefore, this SCI has been screened out from further assessment.

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

Potentially significant impacts

The following are potential impacts where the available evidence indicates a high likelihood of significant impacts occurring.

Bottom mussel culture impact on Red-breasted Merganser

Disturbance from bottom mussel-related boat activity may cause significant displacement impacts to Red-breasted Merganser. The mean area potentially disturbed could amount to around 19-27% of the total area of available habitat. High levels of impact could occur on around 80% of days in the October-December period, for periods of up to 55-66% of daylight hours (however, note the assumptions set out in paragraphs 6.63-6.76 regarding predicted levels of boat activity). The population-level consequences of the displacement impact will depend upon whether the displaced birds can find suitable alternative habitat to feed in while they are displaced, or, if this is not the case, whether the undisturbed portion of the day provides sufficient feeding time for the birds to meet their daily energetic requirements. There is no site-specific data available that can be used to address these questions, and we are not aware of any comparable studies in the literature that can be used.

Bottom mussel culture impact on Little Tern

There is potential for significant disturbance impacts to the Little Tern breeding colony. However, these can be avoided through an appropriate adaptive management strategy (see below).

Other potential impacts

The following are potential impacts where the available evidence is not sufficient to rule out significant impacts beyond reasonable scientific doubt. However, this does not mean that all these impacts are considered to be very likely to occur.

Bottom mussel culture impact on Greenland White-fronted Goose

NPWS have raised concerns about the potential for dredger activity close to the North Slob to cause disturbance to Greenland White-fronted Geese feeding on the North Slob. As noted, review of potential disturbance impacts from dredger activity to Greenland White-fronted Goose (Appendix D). The closest vessel activity by the Branding and Laura Anne to the North Slob will be around 400 m from the sea wall, or around 350 m while the Branding is travelling to/from its site. It is not known whether Greenland White-fronted Geese are susceptible to disturbance from dredgers at these distances from the sea wall. Given the current low frequency of dredger activity in sites 46A, 49B and 52A, any disturbance of Greenland White-fronted Geese by dredger activity in these sites is likely to be a rare event and on a comparable scale to disturbance by licensed wildfowling (which occurs on around 5% of days during the October- March period). However, the patterns of site usage, and the locations of dredger access routes, may change in the future as a result of changes in sedimentation patterns in the harbour, and (in the case of site usage) increases in seed supply. It should be noted also that there is an additional site close to the sea-wall (site 57F). This site is licensed to an operator who is currently not active, and has not been active since around 2008. Further information on the distance from the sea wall at which dredging activity causes disturbance to geese on the North Slob would be required to fully assess this potential impact.

Bottom mussel culture impacts on Scaup, Goldeneye, Red-breasted Merganser and Great Crested Grebe

There is potential for night-time dredging to cause disturbance to nocturnal roosts of these species. Further information about the location and seasonal patterns of usage of these nocturnal roosts is required, as well as information about the sensitivity of nocturnally roosting birds to disturbance from marine traffic, is required to fully assess this potential impact.

Bottom mussel culture impact on intertidal mussel beds

In the long term, it is possible that the seed collection method could prevent the regeneration of existing intertidal mussel beds and reduce the quality of the habitat for Oystercatcher, Knot, Curlew and Redshank. Information on the existing extent of intertidal mussel beds, their usage by these wader species, and the impact of seed collection on the mussel bed dynamics would be required to fully assess this potential impact.

Bottom mussel culture impact on high tide roosts

Mussel-related boat activity could cause disturbance to high tide wader and tern roosts on sandbanks in the mouth of Wexford Harbour. Further information on the distribution and usage of wader and tern roost sites under various tidal conditions, and the sensitivity of sandbank roosting waders and terns to disturbance from dredging activity, in Wexford Harbour would be required to fully assess this potential impact.

Intertidal oyster culture impact on Golden Plover, Grey Plover, Knot, Sanderling and Bar-tailed Godwit

Taking all the relevant factors into consideration, it is probable that the displacement impacts for these species will be substantially less than 5%. However, there is a significant uncertainty attached to this assessment due to the very limited low tide count data. Further data on the low tide distribution of these species across the whole of Wexford Harbour (not just the I-WeBS/BWS subsites) would be required to complete the assessment for these species.

Intertidal oyster culture impact on Little Tern

We consider that the distance of site T03/092A from the Bird Island colony site is probably sufficient to prevent disturbance to the colony (providing no dogs are brought out). However, there is some uncertainty about this assessment, given the lack of site-specific data on the response of Little Tern to disturbance in Wexford Harbour, and the perceived high sensitivity of Little Tern breeding colonies to disturbance in remote locations. This uncertainty can be addressed by an adaptive management strategy (see paragraph 6.215).

There is a significant likelihood that oyster cultivation in site T03/092A will increase the activity of gulls and corvids in this area. It is not possible to predict to what extent, if any, this would cause an increased predation risk to the Bird Island tern colony (in the event that it was reoccupied).

Assessment of impacts of suspended mussel cultivation

There are no sites currently licensed for suspended mussel cultivation in Wexford Harbour and the Raven. There are 10 sites (covering a total area of 128 ha) with applications for suspended mussel cultivation in the Raven SPA). There are also another six sites (covering a total area of 68 ha) in Rosslare Bay. The individual sites range in size from 7-15 ha, with a mean size of 12 ha. While the Rosslare Bay sites are outside the Wexford Harbour & Slobs and the Raven SPAs, they are considered in this assessment as they occur in an area that is likely to be used by some SCI populations from these SPAs. Our assessment has not identified any potentially significant impacts from the proposed suspended mussel culture in the Raven and Rosslare Bay. However, the reliability of this assessment for Common Scoter and Red-throated Diver is only moderate due to the high potential sensitivity of these species to disturbance impacts, and the limited quantitative data available on the nature of their disturbance responses. Site-specific data on the disturbance responses of Common Scoter and Red-throated Diver in the Raven and Rosslare Bay would improve the reliability of this assessment.

Management Responses / Measures

The following management measures, research and information compilation is required to complete this assessment: -

- Record comprehensive information on all bottom mussel-related boat activity. At a minimum, this should include daily logs of all vessel activity, including information on the time, duration and location of the activity. This information would be required over a period of years to allow characterisation of typical patterns of activity, and the level of variation around these patterns. Information on mussel relay activity (including the location and sizes of the plots, the dates of the relay and the tonnages relaid) would also be required to relate vessel activity to the scale of production, and, thereby, allow prediction of impacts from any expansion of the activity. As noted this information would further inform the assessment of impacts on Greenland White-fronted geese, Red-breasted Merganser and other diving species.

- Research into the impact of the bottom mussel culture seed collection method on the long-term dynamics of intertidal mussel beds is required to fully assess the impact of this method on habitat quality for Oystercatcher, Knot, Curlew and Redshank in Wexford Harbour.
- In parallel to the recording of patterns of vessel activity, further Red-breasted Merganser disturbance studies are required to determine if there is any seasonal, spatial, or other, variation in the nature of the response, and to refine the prediction of the scale of the displacement impact. Placement of observers on the dredgers would allow more accurate estimation of distances. These studies could also record the disturbance responses of the other potentially sensitive species (Scaup, Goldeneye and Great Crested Grebe).
- Research into the ecology of Red-breasted Merganser in Wexford Harbour. This research is required to allow assessment of the population-level consequences of the displacement of mergansers by boat activity. The scope of the research should include mapping the spatial distribution of mergansers throughout the Harbour Zone, determining their activity budget and how this varies seasonally and with the intensity of vessel activity, and recording their diet.
- Should night-time dredging be permitted, surveys of night-time roosting behaviour by Scaup, Goldeneye, Red-breasted Merganser and Great Crested Grebe would be required.
- Surveys of high-tide wader and tern roosts. This research is required to allow assessment of the potential disturbance impact from bottom mussel-related boat activity. The scope of the research should include recording the distribution of the roosts, and their sensitivity to disturbance by boat activity, and how these vary seasonally, and with the neap-spring tidal cycle.
- Surveys of the use of mussel beds by Oystercatcher, Knot, Curlew and Redshank. This research would be required to allow assessment of the impact of the intertidal seed collection on these species.
- Surveys of the low tide distribution of Golden Plover, Grey Plover, Knot, Sanderling and Bar-tailed Godwit. This research would be required to allow assessment of the potential impact of displacement by intertidal oyster cultivation in site T03/092A.
- Little Tern research. This research would form part of an adaptive management strategy for the Little Tern population (see paragraph 9.14).

It should be noted that a lot of the above bird survey requirements will be logistically challenging (e.g., surveying sandbank areas in the middle of the harbour). Therefore, if the research is to be carried out, adequate lead-in time should be allowed to trial methodologies, etc.

Mitigation recommendations

An adaptive management strategy to protect the Little Tern breeding colony, and the post-breeding flocks of juveniles in the Hopeland area, should be prepared. This would specify: the buffer zones required to protect the colonies/flocks from disturbance (e.g., 340 m around the Fort Bank colony); additional measures (such as prohibiting dogs from accompanying workers in the seed collection site); and monitoring requirements. The strategy would have to allow for the possibility of the terns moving their colony locations: e.g., an assessment could be carried out in April of the suitability of the existing colony sites and, if the existing colony sites were considered to now be unsuitable (due to winter storm damage) buffer zones could be put in place around additional potential sites until it became clear which site(s) are going to be occupied that year. The monitoring carried out as part of this strategy would help to improve knowledge about the sensitivity of Little Terns in Wexford Harbour to disturbance, and may allow relaxation of some of the prescriptions (e.g., reduce the size of the buffer zones required).

Cumulative impacts

This report does not include assessment of the potential cumulative impacts of the aquaculture activities in combination with other activities. The cumulative impact assessment can only be prepared when there is a reasonable level of certainty about the likely impacts arising directly from the activities being assessed, which is not the case for the present assessment. There are likely to be significant impacts arising from the cumulative impact of hunting pressures in combination with impacts from aquaculture activities. Detailed information on the scale of hunting activities in Wexford Harbour and environs were not available to the authors for consideration at the time of writing.

1. Introduction

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

1.2 This report contains an Appropriate Assessment of aquaculture in Wexford Harbour, the Raven and Rosslare Bay. The Wexford Harbour and Slobs SPA (site code 004076) and the Raven SPA (site code 004019) are the primary focus of this assessment. Four other SPAs are also included in this assessment: Cahore Marshes SPA (site code 004143), Lady's Island Lake SPA (site code 004009), the Saltee Islands SPA (site code 004002) and Tacumshin Lake SPA (site code 004092). The boundaries of these SPAs are shown in Figure 1.1.

1.3 This assessment is based on a desktop review of existing information. This included published reports and papers and unpublished data from waterbird surveys. Where relevant, the report identifies information gaps that may affect the reliability of the conclusions of this assessment.

1.4 The research carried out for this assessment also included a preliminary study of the disturbance impacts of marine traffic on Red-breasted Merganser and other subtidal species. The results of this study are presented in Appendix C.

1.5 The data analysis and report writing for this assessment was done by Tom Gittings. Paul O'Donoghue assisted with project design, document preparation and undertook document review. John Deasy assisted with GIS and data management and research, and prepared the literature review on the benthic impacts of bottom mussel culture.

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

Scope of the assessment

Spatial extent

1.7 The areas that are the focus of this assessment are the Wexford Harbour and Slobs SPA, the Raven SPA and Rosslare Bay. These areas are collectively referred to as the assessment site (Figure 1.1). Additional SPAs are only covered in so far as SCI populations from those SPAs may use the assessment site.

1.8 Rosslare Bay is included in this assessment because there are applications for new licences in this area. While these applications are not within any SPA, the populations of some SCI species from the Wexford Harbour and Slobs SPA and/or the Raven SPA are likely to make significant use of this area.

1.9 The boundaries between the Wexford Harbour and Slobs SPA and the Raven SPA are ecologically arbitrary. Therefore, for most purposes in this assessment, we have considered these two SPAs as a single site.

1.10 The Wexford Harbour and Slobs SPA excludes a small area of the harbour around the quays and along the navigation channel as far as the end of the South Training Wall. However, this area is used by several of the Special Conservation Interest species, and there is no ecological reason to exclude it from our analyses. Therefore, we have included the entire tidal area of Wexford Harbour in our analyses.

Activities covered

1.11 The aquaculture activities covered in this assessment are those associated with applications for renewal of existing licences, and for new licences, in the Wexford Harbour and Slobs SPA, the Raven SPA and Rosslare Bay. These are:

- Bottom culture of Blue Mussels (*Mytilus edulis*) in the subtidal zone (referred to as mussel bottom cultivation hereafter).
- Off-bottom culture of Pacific Oysters (*Crassostrea gigas*) using bag and trestles in the intertidal zone (referred to as intertidal oyster cultivation hereafter).
- Suspended culture of Blue Mussels on longlines and rafts in the subtidal zone (referred to as suspended mussel cultivation hereafter).

1.12 The subject of this assessment are areas that have either already been licensed for cultivation, or for which there are applications for such licenses (these are collectively referred to as aquaculture sites).

1.13 Fisheries activities in, and around, Wexford Harbour, the Raven and Rosslare Bay have already been assessed as part of the *Article 6 Assessment of Fisheries, including a Fishery Natura Plan for Seed Mussel (2013-2017), in the Irish Sea* (Marine Institute, 2013). Therefore, the present report does not include a separate assessment of fisheries activities.

Cumulative impacts

1.14 This report does not include assessment of the potential cumulative impacts of the aquaculture activities in combination with other activities. The cumulative impact assessment can only be prepared when there is a reasonable level of certainty about the likely impacts arising directly from the activities being assessed, which is not the case for the present assessment.

1.15 There are likely to be significant impacts arising from the cumulative impact of hunting pressures in combination with impacts from aquaculture activities. Detailed information on the scale of hunting activities in Wexford Harbour and environs were not available to the authors for consideration at the time of writing.

Structure of this report

1.16 The structure of the report is as follows: -

- Section 2 describes the methodology used for the assessment.
- Section 3 contains a preliminary screening assessment that screens out the Special Conservation Interests (SCIs) that do not show any significant spatial overlap with the activities being assessed.
- Section 4 lists the screened-in Special Conservation Interests (SCIs) of the SPAs included in this assessment, and describes the Conservation Objectives, and their attributes and targets, that have been defined for these SCIs.
- Section 5 contains a brief summary of the status and distribution of the SCI species, and their habitats, in the SPAs included in this 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 of relevant activities later in the document.

- Sections 6-8 present detailed assessments of the likely impact of the aquaculture activities considered in this assessment on the screened-in SCIs of the Wexford Harbour and the Raven SPAs and other nearby SPAs.
- Section 9 presents the conclusions of this assessment, and makes recommendations for further research requirements.

Assumptions

1.17 This assessment is based on the details of the existing and proposed aquaculture operations, as provided by BIM and the operators, and as described in the *Scope of activity*, *Description of activity* and *Scale of activity* sections in this report. Any intensification of the activity beyond the levels described in those sections is not covered by this assessment.

1.18 With reference to the bottom mussel cultivation, we note that some of the bottom mussel sites occupy extensive areas of intertidal habitat. However, in practice all bottom mussel cultivation occurs in subtidal waters (below the mean low water spring tide level). For the purposes of this assessment it is assumed that no bottom mussel cultivation will take place in the intertidal zone (above the mean low water spring tide level). Bottom mussel cultivation within the intertidal zone (above the mean low water spring tide level) is not covered by this assessment.

Difficulties encountered in compiling this assessment

Aquaculture activities

1.19 We have carried out extensive consultation with BIM, and with the individual aquaculture operators. However, the mussel relay and dredging activities vary between operators and between years, depending upon a variety of factors such as seed supply, growth, starfish predation and market opportunities. This means that it is difficult for the operators to specify typical levels, and patterns, of relay and dredging activities.

1.20 In order to provide definitive data on mussel relay and dredging activity, which would allow a rigorous assessment, it would be necessary to have complete records of: -

- Mussel relay activity, including the location and sizes of the plots, the dates of the relay and the tonnages relaid.
- Mussel-related vessel activity, including daily records of all vessel activity.

1.21 This level of information was not made available to us for this assessment. The aquaculture sites cover a large area of Wexford Harbour and are subject to a relatively high level of ongoing activity. Several SCI species are potentially sensitive to negative impacts from such activities, in particular: habitat changes due to mussel relay; and/or disturbance impacts from mussel dredging and associated activities. In order to adequately assess these potential impacts, it is necessary to have detailed quantitative, and spatially explicit, data on the distribution of the mussel relay, and the frequency and intensity of mussel dredging and related activities.

1.22 Limited vessel tracking data was made available to us for the purposes of analysing distribution patterns of Greenland White-fronted Goose in relation to vessel activity. However, full vessel tracking data could not be provided due to commercial confidentiality issues.

Bird data

1.24 The subsites used for waterbird counts in the Wexford Harbour and Slobs SPA do not cover the whole SPA and some areas with existing and/or proposed aquaculture activity are not included in any of these subsites. We have had to make assumptions about the likely usage of such areas, based on their habitat characteristics and waterbird distribution patterns.

1.25 The NPWS BWS counts provides a set of complete counts (of the areas covered by the subsites) of waterbirds in Wexford Harbour in the winter of 2009/10. However, I-WeBS coverage has been very patchy in recent winters, with few complete counts.

1.26 The above issues mean that there must be some doubt attached to the trend analyses that have been used to determine the conservation statuses of the SCI species in the Wexford Harbour and Slobs SPA.

1.27 Detailed population trend data for some key species is not included in the SPA Conservation Objectives Supporting Document (NPWS, 2011g). This information was requested from NPWS but was not available to the authors at time of writing. In addition, there must be some limitations to the accuracy of the population trends presented in that document, given the limited coverage in recent winters.

1.28 The research carried out for this assessment included a preliminary study of the disturbance impacts of marine traffic on Red-breasted Merganser and other subtidal species. We consider that the results of the study demonstrate that Red-breasted Mergansers in Wexford Harbour are highly sensitive to disturbance impacts from marine traffic. However, the study was limited to a short period of time in February/March 2015, while logistical issues limited the accuracy of the estimation of distances between birds and the disturbance stimuli, and the recording of disturbance responses (i.e., the distance and duration of flights by disturbed birds).

Impact assessment

1.29 During the course of the assessment a number of data gaps were identified with respect to certain species. In many cases there is not a clear understanding of how certain species interact with bottom mussel cultivation and there is an absence of studies in the published literature examining this question to which we can refer. Where appropriate, such data gaps are therefore highlighted as are associated levels of confidence we can have in the findings of our assessment.

1.30 There are likely to be significant impacts arising from the cumulative impact of hunting pressures in combination with impacts from aquaculture activities. Detailed information on the scale of hunting activities in Wexford Harbour and environs were not available to the authors for consideration at the time of writing.

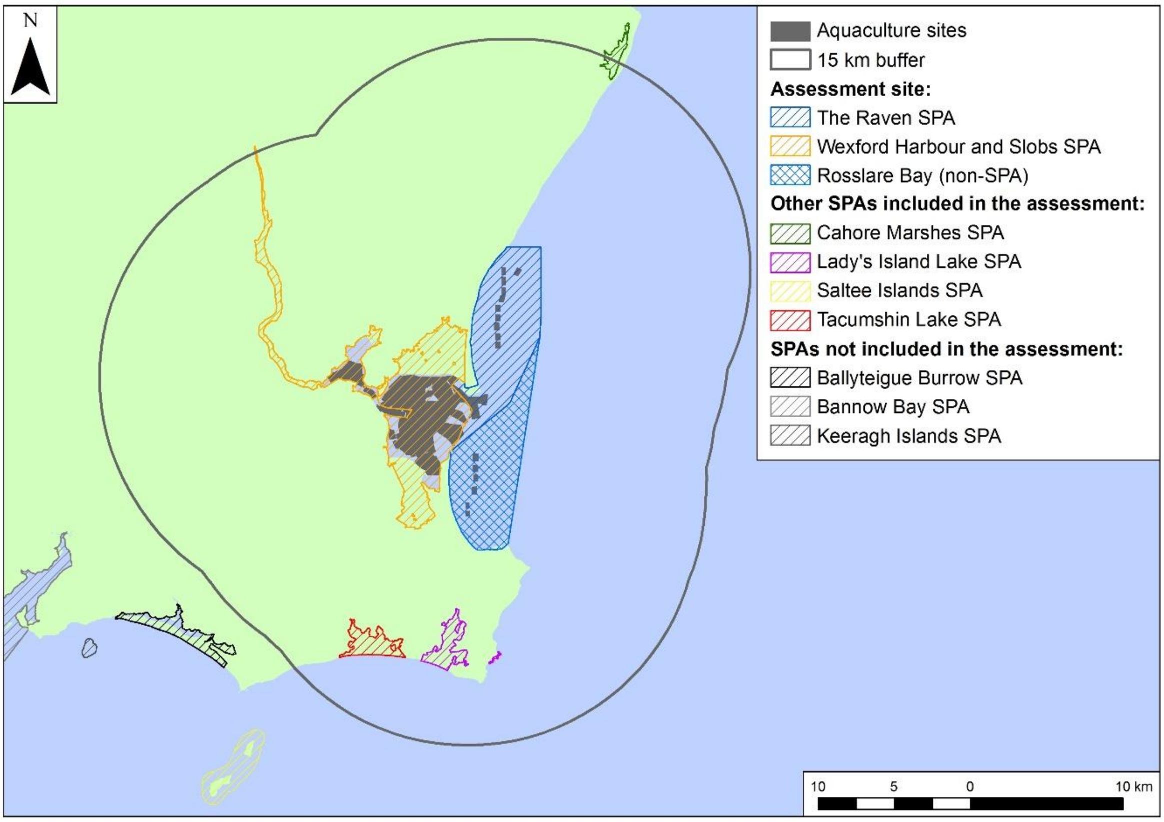


Figure 1.1 - The assessment site and other SPAs included in the assessment.

2. Methodology

General

2.1 This assessment is based on a desktop review of existing information about waterbird population trends and distribution in Wexford Harbour, in addition to a site familiarisation site visit by TG in February 2015, and the results of a preliminary study of the disturbance impacts of marine traffic on Red-breasted Merganser and other subtidal species.

Data sources

2.2 The SPA boundaries are derived from NPWS shapefiles (which were last updated on 15/01/2015).

2.3 The spatial extents of the aquaculture sites have been derived from shapefiles supplied by the Marine Institute (dated 06/08/2014), based upon site lists supplied to the Marine Institute by the Department of Agriculture, Food and the Marine.

2.4 Details of existing and proposed aquaculture activities have been taken from the *Aquaculture_profile_wexford_harbour_draft_3* (prepared by Brian O'Loan, BIM, received 12/03/2015). This information was supplemented by: additional information provided by BIM, based on interview notes with specific operators; and by responses from the operators to specific questions.

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

- Irish Wetland Bird Survey (I-WeBS) counts 1994/95-2011/12.
- Non-Estuarine Waterbird Survey (NEWS) counts 1997/98 and 2006/07.
- NPWS Baseline Waterbird Survey (NPWS BWS) 2009/10 counts.
- Little Tern monitoring reports (NPWS, 2013, 2014, 2015).
- Marine Institute Common Scoter survey, March and December 2014.
- Red-breasted Merganser disturbance study (Appendix C).
- Review of potential disturbance impacts from dredger activity to Greenland White-fronted Goose (Appendix D).
- Miscellaneous information on waterbird distribution in Wexford Harbour and the Raven provided by NPWS staff (Dominic Berridge, Tony Murray, Lorcan Scott and Alyn Walsh; cited as NPWS).

2.6 The distribution of biotopes within the Wexford Harbour and Slobs SPA, and the Raven SPA, is based upon the NPWS biotope map, as shown in Figure 3 of the marine supporting document for the Slaney River Valley SAC (NPWS, 2011f) and Figure 2 of the marine supporting document for the Raven Point Nature Reserve SAC (NPWS, 2011e).

2.7 Information on tidal zones, and the depths of subtidal habitats, was derived from a variety of sources including Admiralty Chart data, the Wexford Harbour chartlets (produced by Brian Coulter), and bathymetry data provided by the Geological Survey of Ireland.

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

Site divisions

Zones

2.9 The assessment site was divided into six zones for the purposes of analysing bird distribution patterns and assessing aquaculture activities (Figure 2.1): -

- The Slaney Zone (SLANEY) covers the River Slaney from Ferrycarrig Bridge to Enniscorthy (the upper boundary of the SPA).
- The Ferrycarrig Zone (FERRY) covers the area labelled Ferrycarrig Reach on the Wexford Harbour Chartlet and includes all the intertidal and subtidal habitat between Ferrycarrig Bridge and Wexford Bridge.
- The Harbour Zone (HARBOUR) covers the main area of Wexford Harbour and includes all the intertidal and subtidal habitat between Wexford Bridge and the outer edge of the harbour. The latter boundary is not clearly defined anywhere. For this assessment, the latter boundary was defined by the outer boundary of the Raven Point I-WeBS subsite (0O493) and a line extending from the southernmost point of this subsite to Rosslare Point.
- The Outer Zone (OUTER) covers the Raven SPA (excluding the area within the Harbour Zone) and Rosslare Bay. The outer boundary of this zone was defined by the outer boundary of the Raven SPA and a line extending from the point where this outer boundary swings in towards Raven Point to Rosslare Harbour.
- The North Slobs Zone (NSLOB) cover the North Slobs.
- The South Slobs Zone (SSLOB) cover the South Slobs.

2.10 There is little reference to the Slaney Zone in this assessment, because there are no aquaculture sites within this zone, and the I-WeBS counts for this zone are not coordinated with the counts of the other zones.

Subsites

2.11 The Wexford Harbour and Slobs SPA and the Raven SPA correspond to two sites that have been used for waterbird monitoring: Wexford Bay (site code 0O901) and the River Slaney (site code 0O301). The Wexford Bay site was also covered by the NPWS BWS survey.

2.12 The River Slaney I-WeBS site has been divided into three subsites for most counts: Ferrycarrig Bridge - Killurin (Deep's) Bridge (0O396); Killurin (Deep's) Bridge - Edermine Bridge (0O397); and Edermine Bridge - R. Urrin Enniscorthy (0O398).

2.13 The Wexford Bay I-WeBS site was divided into nine subsites for the NPWS BWS survey (Figure 2.2). Nine subsites have also been used for I-WeBS monitoring, but there are slight differences between the two sets of subsites: -

- The I-WeBS subsite 0O495 was divided into two subsites (0O485 and 486) for the NPWS BWS survey.
- An additional subsite (0O497) has been counted in I-WeBS counts. The boundaries of this subsite has not been mapped, but it covers the area between 0O485 and 0O490.

- There are also a number of other minor differences in the exact configuration of the subsite boundaries between the two surveys.

2.14 It should be noted that neither I-WeBS, nor the NPWS BWS survey, covered the entire SPAs. The subsites (excluding 0O497) cover a total of 60% of the tidal habitat within the Harbour Zone (Table 2.1). The Ferrybank (Wexford Bridge) - Castlebridge subsite (0O407) cover the entire Ferrycarrig Zone. In the Outer Zone, the Blackwater Head - Raven Point subsite (0O901) extends out around 2.5 km from the shoreline, while the SPA extends up to 4.5 km out from the shoreline. However, in practise, counts are presumably likely to include all visible birds and the area counted may extend significantly beyond the subsite boundary in counts carried out under good conditions (but, conversely, the counts may not include the entire subsite in counts carried out under poor conditions).

2.15 Rosslare Bay has not been covered by any I-WeBS counts and was not included in the BWS counts.

Table 2.1 - Coverage of tidal habitat within the Harbour Zone by I-WeBS/BWS sites.

Tidal zone	Total area in Harbour Zone	Area covered by BWS/I-WeBS	% covered by BWS/I-WeBS
Intertidal (neap)	177 ha	88 ha	50%
Intertidal (mean)	326 ha	250 ha	77%
Intertidal (spring)	924 ha	714 ha	77%
Subtidal	1723 ha	849 ha	49%
All tidal	3150 ha	1902 ha	60%

Calculations based on the mapped boundaries of the I-WeBS sites and excluded subsite 0O497.

Definition of tidal zones

Data sources

2.16 A variety of sources are available with information on tidal zones and bathymetry in, and around, Wexford Harbour. However, because of the rapidly changing nature of the mobile sandbanks at the mouth of the harbour, precise definition of tidal zones is problematic.

2.17 Unofficial mapping of Wexford Harbour has been carried out by Brian Coulter over a number of years and he has produced a series of maps (the Wexford Harbour Chartlets). These are considered to provide reasonably accurate representation of the configuration of broad depth zones, and are particularly useful for mapping the position of the sandbanks at the mouth of the harbour. However, the depth zones mapped in these chartlets cannot be directly related to patterns of intertidal exposure at specified tidal levels. We have used the most recent Wexford Harbour Chartlet (2014) to map the position of permanently exposed sandbanks, for the purposes of assessing potential impacts to breeding and roosting sites that occur on these sandbanks. In addition, examination of the sequence of chartlets provides an indication of the degree of stability of the various sandbank areas.

2.18 The Geological Survey of Ireland (GSI) has produced satellite-derived bathymetry data covering the entire Harbour Zone (Needham and Carroll, 2013). These data map water depth to a precision of 0.1 m and, in theory, allows derivation of detailed maps of tidal zones. However, these data were derived from satellite imagery captured in 2011; the configuration of sandbanks at the mouth of the harbour has, however, changed substantially since 2011 (see e.g. Wexford Harbour Chartlets). Furthermore, based upon ground-truthing undertaken by the GSI, the quality of the data in the inner part of the harbour was classified as unreliable or of limited reliability, due to high levels of turbidity at the time the image was captured. Despite these limitations, the GSI bathymetry data has been used for calculating levels of exposure of intertidal habitat at specified tidal levels. We consider this approach justified, as i) the majority of intertidal habitat occurs in the outer part of the harbour (where the quality of the satellite-derived bathymetry data is considered reliable), and ii) the activities affecting intertidal habitat are in the southern part of the harbour, where comparison of the sequence of Wexford Harbour Chartlets indicates that there has been relatively little change in the configuration of depth zones since 2011.We used Discovery Series mapping to define depth zones within the Ferrycarrig Zone. The area mapped as intertidal in the Discovery Series mapping represents the mean low tide. While this mapping is out of date, there is no more recent mapping available that could be used for this purpose. The Admiralty Chart mapping can only be used to map the lowest astronomical tide (extreme spring tides), while the depth zones mapped in the Wexford Harbour Chartlets cannot be directly related to patterns of intertidal exposure at specified tidal levels. However, our field observations indicated that the Discovery Series mapping may overestimate the exposure of intertidal habitat at mean low tide in the Ferrycarrig Zone, particularly on the southern side of the zone.

2.19 We used Admiralty Chart mapping to map depth zones outside Wexford Harbour. This mapping was used to classify depth zones in the Raven SPA and Rosslare Bay for analysing potential impacts of proposed aquaculture activities in these areas. In addition, the depth zones were mapped for the entire east coast zone from Dublin to Carnsore Point, for analysing waterbird distribution recorded on aerial transects in relation to depth zones. As the species of interest for the analyses in these areas are associated with subtidal habitats, potential inaccuracies in the mapping of intertidal areas in the Admiralty Charts were not an issue.

Classification of depth zones

Ferrycarrig Zone

2.20 The tidal zones within the Ferrycarrig Zone were defined from the Discovery Series mapping. Only two tidal zones were defined: intertidal (representing the mean low tide) and subtidal (including areas exposed on spring low tides).

Harbour Zone

2.21 The tidal zones within the Harbour Zone were defined using GSI bathymetric satellite data for Wexford Harbour. This provides water depths in 0.1 m intervals referenced to Ordnance Data Malin. Tidal data for Wexford Harbour is referenced to Chart Datum (CD). Therefore, the following conversion factors were used to convert from Chart Datum to Ordnance Data Malin: -

- OD Dublin = CD Wexford - 1.43 (source: Admiralty Chart for Wexford Harbour)
- OD Malin = OD Dublin + 2.7 (source: OSI)

2.22 The above conversion factors give figures of -0.27 m OD Malin for the mean low water neap tide (1.0 m CD), -0.52 m OD Malin for the mean low tide (0.75 m CD) and -0.77 m OD Malin for the mean low water spring tide (0.5 m CD).

2.23 For the purposes of mapping intertidal exposure, the following tidal ranges have been used: > 0.875 m CD for neap tides, 0.625-0.875 m CD for mean low tides, and 0.425-0.625 m CD for spring low tides.

2.24 For the purposes of analysing amount of tidal exposure, the weighted mean tidal exposure across all low tides was calculated using the cumulative area exposed at each 0.1 m interval (calculated from the GSI data), weighted by the proportion of low tides on which that level was exposed (calculated from EasyTide data for all low tides between 01/09/2014 and 31/03/2015).

2.25 The extent of shallow subtidal habitat was not mapped or analysed: the GSI bathymetry would define extensive areas within the harbour as shallow subtidal habitat. However, much of this area is within the area where the data quality is considered to be unreliable, or of limited reliability, and in areas where the Wexford Harbour Chartlets indicate deeper subtidal habitat.

Outer Zone

2.26 Depth zones in the Outer Zone were mapped from Admiralty Chart data using the following categories: intertidal/shallow subtidal (above 0 m CD), moderately deep subtidal (0-5 m below CD), deep subtidal1 (5-10 m below CD) and deep subtidal 2 (10-20 m below CD). The rationale for the distinction between the moderately deep and deep subtidal zones is that Red-breasted Merganser and Great Crested Grebe generally do not feed in waters greater than 5 m deep (Kirby *et al*., 2002).

Wintering waterbird data and interpretation

2.27 The main data sources that we used for information on wintering waterbird distribution in Wexford Harbour and the Raven were the I-WeBS and NPWS BWS counts. This was supplemented by data from NEWS and the Marine Institute Common Scoter surveys, particularly for the Raven and Rosslare Bay. Our disturbance study provided detailed information on the disturbance responses of Red-breasted Merganser, and more limited information for some other species.

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

2.29 Details of these data sources are provided below.

I-WeBS

2.30 Waterbird numbers and distribution within the Wexford Harbour and Slobs and Raven SPAs have been monitored as part of the Irish Wetland Bird Survey (I-WeBS) each winter since 1995/96. The I-WeBS scheme aims to carry out monthly counts each winter between September and March in all sites that are important for non-breeding waterbird populations. However, this level of coverage is not always possible to achieve in a volunteer-based scheme.

2.31 Wexford Harbour and the Raven (including the Ferrycarrig, North Slob and South Slob Zones, and parts of the Harbour and Outer Zones) are counted as a single site (Wexford Bay, site code 0O901) under the I-WeBS scheme, while the River Slaney from Ferrycarrig Bridge to Enniscorthy (the Slaney Zone) is counted as a separate site (River Slaney, site code 0O301). The counts of the two sites are not coordinated.

2.32 The River Slaney was counted annually from 1994/1995-1999/2000, with multiple counts in most of these winters (Table 2.2). However, since 2000 there has only been sporadic coverage of this site.

2.33 There have only been three counts of the Wexford Bay site across the entire duration of the I-WeBS scheme with complete coverage of all ten subsites (Table 2.3). There have been another 13 counts with complete coverage, apart from the small subsite adjacent to Wexford Town (0O497). This subsite (0O497) is excluded from all the analyses of I-WeBS data in this assessment.

2.34 Most of the above counts took place in just two winters (1995/96 and 1996/97). Therefore, in order to make the dataset more representative, we have also identified counts which have complete coverage of discrete sections of Wexford Harbour and the Raven relevant to the purposes of our assessment (Table 2.3).

Table 2.2 - Coverage of the River Slaney I-WeBS site.

	Number of core counts	Notes
1994/95	1	Low numbers recorded; possibly a poor quality count
1995/96	6	
1996/97	4	
1997/98	2	
1998/99	5	
1999/00	2	
2000/01-2003/04	no counts	
2004/05	1	
2005/06-2006/07	no counts	
2007/08	1	August count
2008/09	no count	
2009/10	1	May count
2011/12	no count	
2012/13	1	

Table 2.3 - I-WeBS counts with complete, or nearly complete coverage, of discrete sections of Wexford Harbour and the Raven.

Winter	Month	Complete	Harbour	Harbour and Raven	Harbour and Ferrycarrig
1994/95	Jan		√		
	Feb		√		
1995/96	Sep	√*			
	Oct	√*			
	Nov	√*			
	Dec				√*
	Jan	√*			
	Feb	√*			
	Mar	√*			
1996/97	Sep	√*			
	Oct	√*			
	Nov	√*			
	Dec	√*			
	Jan	√*			
	Feb	√**			
2002/03	Nov	√			
	Dec		√		
	Jan	√*			
	Feb				√
2003/04	Sep	√			
	Dec	√			
2004/05	Nov			√	
	Dec			√	
2005/06	Nov			√	

Winter	Month	Complete	Harbour	Harbour and Raven	Harbour and Ferrycarrig
	Jan	√			
2011/12	Nov				√*
2012/13	Oct	√**			
	Nov	√*			

* excluding 0O497; **excluding North Slob (0O499).

NPWS BWS

2.35 In the winter of 2009/10, waterbird counts were carried out as part of the National Parks and Wildlife Service's Baseline Waterbird Survey (NPWS BWS). The survey covered the Wexford Bay I-WeBS site (with minor variations in subsite boundaries; see paragraph 2.13). The survey did not cover the River Slaney I-WeBS site.

2.36 General details of the NPWS BWS methodology are provided by Lewis and Tierney (2014), while details of the NPWS BWS methodology and results at Wexford Harbour and the Raven are described in Cummins and Crowe (2010) and NPWS (2011g).

Counts

2.37 Four low tide and one high tide count were carried out (Table 2.4). The counts were carried out by a coordinated team of six professional counters. Each count was completed in a single day, but subsite 0O490 was not covered in the January high tide count (Cummins and Crowe, 2010). The January count was also affected by bad weather, with poor conditions affecting detectability off offshore species in the 0O901 subsite (Cummins and Crowe, 2010).

2.38 While the general NPWS BWS methodology involves counting feeding and roosting birds separately (Lewis and Tierney, 2014), this was not done systematically in the NPWS BWS counts at Wexford Harbour and the Raven. In any case, we have generally 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.

Table 2.4 - Tidal conditions during the NPWS BWS counts.

Date	Type of count	High tide/m	Low tide/m
15/10/2009	Low tide		0.6
20/11/2009	Low tide		0.8
15/12/2009	Low tide		0.7
21/01/2010	High tide	1.9	
15/02/2010	Low tide		0.7

Source: EasyTide (www.ukho.gov.uk/easytide).

Flock maps

2.39 As part of the NPWS BWS the approximate position of the main flocks encountered were mapped.

2.40 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.

High tide roosts

2.41 As part of the NPWS BWS, a partial high tide roost survey was carried out on 8th March 2010. In NPWS (2011g), information from this survey is combined with information from other sources (including the high tide count, I-WeBS records, and data from NPWS Regional staff) to provide maps of roost locations.

NEWS

2.42 The Non-Estuarine Coastal Waterbird Survey (NEWS) is carried out every 10 years to cover species that occur in dispersed distributions along coastlines away from areas that are regularly monitored by I-WeBS (Colhoun and Newton, 2000; Crowe *et al*., 2012).

2.43 The 1997/98 NEWS included eight sectors covering the entire section of coastline from Rosslare Harbour to north of the northern boundary of the Raven SPA, with the exception of the open water at the mouth of Wexford Harbour (Figure 2.3).

2.44 The 2006/07 NEWS only counted four of these sectors: the northern side of Rosslare Harbour (0O27); Rosslare Town-Rosslare Point (0O29); the southern third of the Raven SPA (0O30); and the section of coastline immediately north of the Raven SPA (0O33) (Figure 2.3).

2.45 In 1997/98, the counts were carried out during 20th-29th January 1998. In 2006/07, the counts were carried out on 8th and 25th January 2007.

Common Scoter survey

2.46 Aerial surveys of seabirds and marine mammals along the southern Irish Sea coast were carried out in March (APEM, 2014) and December 2014 (APEM, unpublished data).

2.47 The March survey included three transects through the Wexford Harbour and Slobs SPA, and two transects through the Raven SPA/Rosslare Bay. The transects in the Raven SPA/Rosslare Bay were carried out between around 12:45 and 13:05 hours, and those in the Wexford Harbour and Slobs SPA were carried out between around 13:10 and 13:20 hours, on 5th March 2014 (low tide of 0.5 m at 16:00 hours).

2.48 The December survey included two transects through the Wexford Harbour and Slobs SPA, and two transects through the Raven SPA. We do not have details of the date/timing of these transects.

Red-breasted Merganser disturbance study

2.49 During our reconnaissance visit to Wexford Harbour on 4th and 5th February 2015 we noted that Red-breasted Merganser appeared to show a very strong disturbance response to marine traffic. On this visit, we recorded some observations of the response of mergansers to a cot and to small inshore potting vessels. We subsequently made two additional visits, on 20th February and 2nd March 2015, with the specific aim of recording the response of mergansers to dredgers. The study also collected limited data on the responses of other subtidal species to marine traffic.

2.50 Full details of the methodology, and results, of this study are presented in Appendix C.

Greenland white-fronted goose disturbance review

2.51 Disturbance from dredger activity to Greenland White-fronted Geese feeding in the North Slob was raised as an issue of potential concern by NPWS. To address this issue, we carried out a desktop review of relevant data. This included: analysis of patterns of geese distribution, analysis of vessel activity patterns close to the North Slob, and analysis of topographic data to assess the potential visibility of dredgers to geese feeding on the North Slob.

2.52 Full details of the methodology, and results, of this study are presented in Appendix D.

Breeding population data and interpretation

2.53 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.

2.54 There is generally little information available on the distribution of foraging waterbirds during the breeding season. Some general information was provided by NPWS. In addition, we used information from the literature to define typical foraging ranges for various species.

2.55 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.

Impact assessment methodology

General approach

2.56 The potential impacts of the activities covered in this assessment were assessed under four broad categories: ecosystem effects, habitat impacts; disturbance; and other impacts.

Structure of the assessment

2.57 An initial screening exercise was carried out to screen out SCI species that did not show any potential spatial overlap with effects from any of the activities being assessed.

2.58 Each individual activity was then assessed in turn. For each activity, a further screening exercise was carried out to identify the SCI species/impact combinations that required full assessment. This exercise could result in some SCI species being fully screened out, other SCI species only requiring assessment under a subset of impact categories, and other SCI species requiring assessment under all impact categories. Detailed assessments were then carried out on all SCI species/impact combinations that were screened-in. SCI species from other SPAs were included in this assessment, but the assessment was limited to the potential impact on their utilisation of Wexford Harbour, the Raven and Rosslare Bay.

Ecosystem effects

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

2.60 Detailed consideration of ecosystem effects and / or ecosystem modelling in order to provide a more robust assessment of potential impacts is beyond the scope of this assessment. The significance of ecosystem effects as an issue is, however, discussed further in Marine Institute (2016; i.e. *Report supporting Appropriate Assessment of Aquaculture in Slaney River Valley SAC (000781) and Raven Point Nature Reserve SAC (*000710)). We have also carried out a preliminary assessment of this potential impact through comparison with the published literature.

Habitat impacts

2.61 Aquaculture causes changes to the physical structure of the habitat (through placement of structures in the habitat and/or nutrient/sediment changes). These effects may affect the suitability of the habitat for waterbird species.

2.62 We have assessed potential habitat impacts by first considering the nature of the habitat changes and the available evidence about the response of waterbird species to these changes. We used the available evidence from the literature, as well as our own knowledge about waterbird ecology in Ireland, to make these assessments.

2.63 Where we identified habitat changes that may cause negative impacts to species covered by this assessment, we assessed the relative scale of the potential impact in terms of the proportion of the site population that would be affected. The effect is usually displacement of birds from the affected area (displacement impact), although it could alternatively be reduction in food resources. For simplicity, the following discussion refers to displacement impacts, although the same criteria apply to impacts from reduction in food resources.

2.64 Where suitable data were available we calculated the potential displacement impact as the number of birds that would be displaced as a proportion of the site population. Where such data was not available, we made a qualitative assessment, based on the proportion of the available suitable habitat that would be affected and the overall distribution of the species within the site.

2.65 Displacement impacts may cause significant impacts to bird populations where there is not sufficient habitat elsewhere within the site for the displaced birds to utilise. This will occur when the site is at its effective carrying capacity, or if the displacement impact causes the site to reach its effective carrying capacity. In this situation, the displaced birds will have to compete with birds elsewhere in the site for food and density-dependent reductions in survivorship and/or body condition may occur. Density-dependent reductions in survivorship means that survival rates decrease as population density increases. Loss of body condition in overwintering bird populations may result in reduced survivorship on spring migration.

2.66 Where displacement impacts are very small, it is unlikely (due to the stochastic element involved in density dependent processes) that measurable impacts on survivorship and/or body condition will occur, even if the site is at its effective carrying capacity. In general, assessments that assume that all displaced birds will die or emigrate "*will be pessimistic because some of the displaced birds will be able to settle elsewhere and survive in good condition*" (Stillman and Goss-Custard, 2010). We have used a 5% displacement level as an indicative threshold to indicate when displacement impacts may be likely to have population-level consequences. Therefore, in this assessment, any displacement impact that affects 5%, or approaching 5%, of the site population, is considered to be significant.

Disturbance impacts

2.67 Husbandry and harvesting activity may cause disturbance to waterbird species. Where such activity is intensive, and/or the species is very sensitive to such impacts, significant energetic and/or displacement impacts may occur.

2.68 We assessed potential disturbance impacts by first collating information on the spatial distribution, intensity and timing of the husbandry and harvesting activities. This involved extensive consultation with BIM and the individual operators. Because of the variable nature of some of the activities, it was difficult to precisely specify their distribution, intensity and timing. Therefore, for some activities, we used the information collated to carry out simulations of likely patterns of activity. Details of the methodologies use for these simulations are provided in the relevant sections of this report.

2.69 We then identified the SCI species whose distribution with the site overlaps significantly with these activities. We used information from the literature and from our own studies at this site (Appendix C), to assess their potential sensitivity to disturbance, expressed as the distance over which the species will show a disturbance response.

Energetic impacts

2.70 To assess potential energetic impacts, we focussed on the number of birds that are flushed, as flying is the most energetically expensive activity. We used data on: the overall density of the species within the relevant area (the zone in which the activity occurs), which was derived from the mean I-WeBS/BWS count for the relevant area, or from our own data (see Appendix C); and the flush distance for the species, which was derived from literature sources, or from our own data (see Appendix C). We were then able to calculate the number of birds that would be flushed by the activity per day, as a proportion of the overall population. As the overall density of the species was used in the calculation of both the number of birds flushed and the calculation of the overall population size, these calculations are, in fact, calculations of the relative area disturbed, and we only used bird numbers in these calculations to make the results more intuitive. This means that our assessment of the energetic impact based on these calculations is not sensitive to the value use for the overall density of the species.

2.71 The calculations do, however, assume that the birds are uniformly distributed through all the available area of suitable habitat. This is not likely to be true, but it is the relative degree of deviation from this assumption that is relevant: if the deviation is small, it is unlikely to significantly affect the results of the assessment based on these calculations. Furthermore, in the case of disturbance related to bottom mussel culture, the fact that the mussel sites are distributed throughout most of the Harbour Zone means that non-uniform patterns of bird distribution should not affect the overall average pattern.

2.72 We assessed the significance of the potential energetic impact of birds being flushed by considering: the energetic cost as a proportion of its daily energy expenditure; and the additional feeding time that would be required to compensate for this energetic cost.

Displacement impacts

2.73 We assessed potential displacement impacts due to disturbance in the same way that we assessed potential displacement impacts due to habitat changes (see paragraphs 2.63-2.66). However, we also considered the duration of the displacement impact. For a displacement impacts due to disturbance to be considered significant, displacement impacts affecting 5%, or approaching 5%, of the site population have to occur over an extended period of time.

Other disturbance impacts

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

Other impacts

2.75 This category covers any potential impacts that are not easily categorised as ecosystem, habitat or disturbance impacts. In the present assessment, the potential impact of increased predation on the Little Tern colony is included under this category.

Scaup

2.76 Scaup currently occurs in very low numbers in Wexford Harbour, with only one count exceeding 15 birds in the last five winters for which data are available, compared to a baseline population of 339 birds. The overarching Conservation Objective "*is to ensure that waterbird populations and their wetland habitats are maintained at, or restored to, favourable conservation condition*" (NPWS, 2011 g). Therefore, we have assessed impacts in terms of their potential to prevent the Scaup population from recovering to its baseline level (i.e., being restored to favourable conservation condition). However, it should be noted that the decline in the Scaup population at Wexford Harbour is likely to be due to a large-scale re-distribution of the wintering population (rather than any site-specific factors). Therefore, it is unlikely that impacts from aquaculture activities (if they occur) would be a major determining factor in preventing the recovery of the Scaup population.

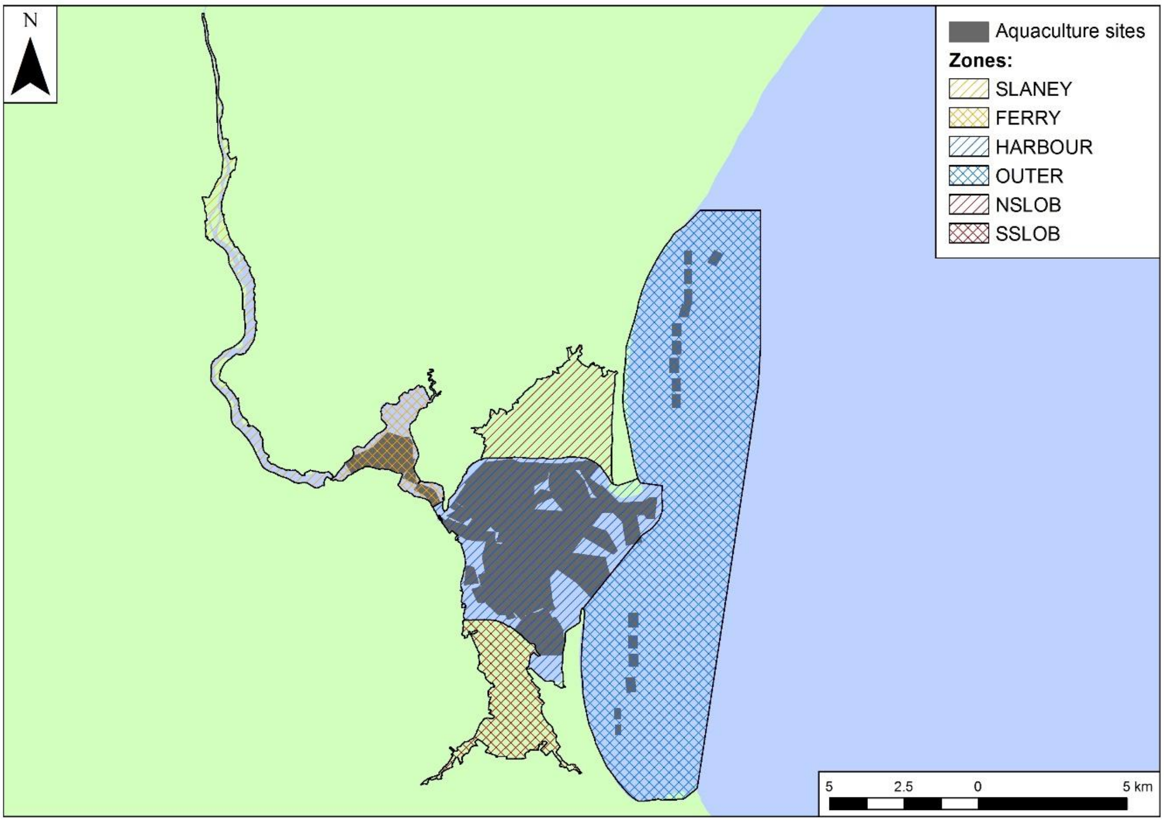


Figure 2.1 - Zones used for broad-scale analysis of waterbird distribution.

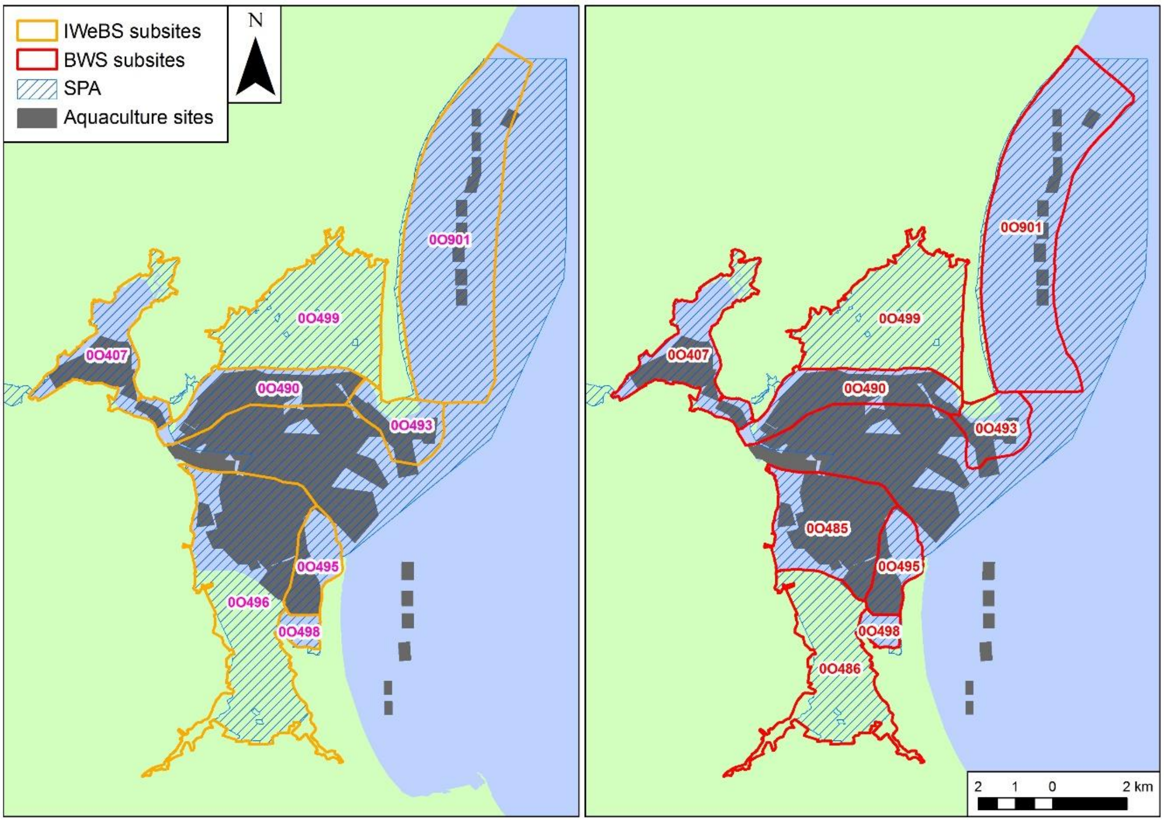


Figure 2.2 - Subsites used for waterbird monitoring in the Wexford Harbour and Slobs and the Raven SPAs.

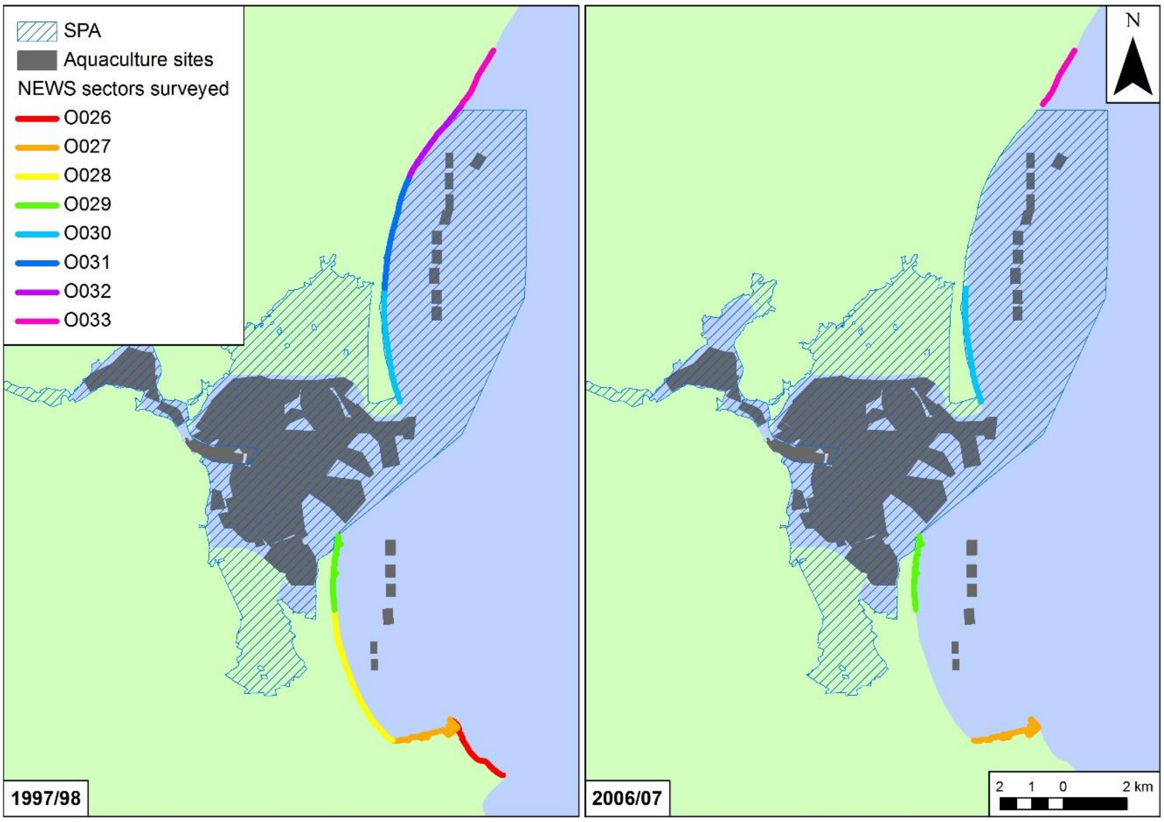


Figure 2.3 - NEWS sectors surveyed in the vicinity of Wexford Harbour and the Raven in 1997/98 and 2006/07.

3. Screening

SPAs included in the screening assessment

3.1 Based on the guidance in DEHLG (2009), the SCIs of all SPAs within 15 km of the aquaculture plots have been screened for inclusion in this assessment. These are: the Wexford Harbour and Slobs SPA, the Raven SPA, Lady's Island Lake SPA, Tacumshin Lake SPA and Cahore Marshes SPA (Figure 3.1).

3.2 In addition, other SPAs further away were considered. Based on consultation with NPWS, the only SCIs from such SPAs where there was considered to be potential for significant interchange with Wexford Harbour and the Raven are the Cormorant and Shag breeding populations in the Saltee Islands SPA (Figure 3.1).

Wexford Harbour and Slobs SPA

Qualifying features

3.3 The SCIs of the Wexford Harbour and Slobs SPA are: -

- non-breeding populations of: Bewick's Swan, Whooper Swan, Greenland White-fronted Goose, Light-bellied Brent Goose, Shelduck, Wigeon, Teal, Mallard, Pintail, Scaup, Goldeneye, Red-breasted Merganser, Little Grebe, Great Crested Grebe, Cormorant, Grey Heron, Coot, Oystercatcher, Golden Plover, Grey Plover, Lapwing, Knot, Sanderling, Dunlin, Black-tailed Godwit, Bar-tailed Godwit, Curlew, Redshank, Black-headed Gull and Lesser Black-backed Gull;
- a breeding population of Little Tern; and
- a post breeding/roosting population of Hen Harrier.

3.4 In addition the wetland habitat within the Wexford Harbour and Slobs SPA is listed as an SCI.

Screening assessment

Waterbird SCIs

3.5 Most of the SCI species make regular use of intertidal and/or subtidal habitat. Therefore, for these species, there is potential for significant spatial overlap with the aquaculture activities included in this assessment.

3.6 Some SCI waterbird species are mainly associated with non-tidal wetland and/or terrestrial habitat within the North Slob and/or South Slob areas. However, some of these species may use tidal habitat as a disturbance refuge and/or for nocturnal roosting. In addition, there is potential for disturbance from dredging activity to birds using the areas of the North Slob and/or South Slob close to the sea wall.

3.7 Therefore, all the waterbird SCIs have been screened in for full Appropriate Assessment.

Hen Harrier

3.8 The Hen Harrier communal roost is at a site which is not considered to be potentially sensitive to disturbance from aquaculture activities.

3.9 Hen Harriers mainly hunt over non-tidal/terrestrial habitat.

3.10 Therefore, for Hen Harrier, there is no potential for significant spatial overlap with the aquaculture activities included in this assessment and this species has been screened out from further assessment.

Wetlands

3.11 The Conservation Objectives define the favourable conservation condition of the wetlands SCI in the Wexford Harbour and Slobs SPA 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.

The Raven SPA

Qualifying features

3.13 The SCIs of The Raven SPA are wintering populations of: Greenland White-fronted Goose, Red-throated Diver, Cormorant, Common Scoter, Grey Plover and Sanderling.

3.14 In addition the wetland habitat within The Raven SPA is listed as an SCI.

Screening assessment

Waterbird SCIs

3.15 All the SCI species make regular use of intertidal and/or subtidal habitat. Therefore, for these species, there is potential for significant spatial overlap with the aquaculture activities included in this assessment and all the waterbird SCIs have been screened in for full Appropriate Assessment.

Wetlands

3.16 The Conservation Objectives define the favourable conservation condition of the wetlands SCI in the Raven SPA purely in terms of habitat area.

3.17 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.

Cahore Marshes SPA

Qualifying features

3.18 The SCIs of the Cahore Marshes SPA are wintering populations of: Greenland White-fronted Goose, Wigeon, Golden Plover and Lapwing.

3.19 In addition the wetland habitat within the Cahore Marshes SPA is listed as an SCI.

Screening assessment

Waterbird SCIs

3.20 All of the waterbird SCIs of Cahore Marshes SPA are also SCIs of the Wexford Harbour & Slobs SPA and/or the Raven SPA.

3.21 Some of the Greenland White-fronted Goose using the Cahore Marshes SPA are known to commute to Wexford Harbour and the Raven to roost each night (NPWS).

3.22 Wigeon, Golden Plover and Lapwing are species that can have very mobile populations in winter.

3.23 Therefore, all these SCIs have been screened in for full assessment.

Wetlands

3.24 Aquaculture activities in Wexford Harbour and the Raven will clearly not have any impact on wetland habitat in Cahore Marshes. Therefore, this SCI has been screened out from further assessment.

Lady's Island Lake SPA

Qualifying features

3.25 The SCIs of the Lady's Island Lake SPA are a wintering population of Gadwall and breeding populations of Black-headed Gull, Sandwich Tern, Roseate Tern, Common Tern and Arctic Tern.

3.26 In addition the wetland habitat within the Lady's Island Lake SPA is listed as an SCI.

Screening assessment

Waterbird SCIs

3.27 Gadwall do not regularly occur at Wexford Harbour and the Raven. In I-WeBS counts, they were only recorded in five of the 25 counts during the most recent five winters for which data is available. They were recorded in very small numbers (totals of two and six birds) in two of the five NPWS BWS counts. Therefore, Wexford Harbour and the Raven does not regularly support significant numbers of Gadwall and this SCI has been screened out from further assessment.

3.28 Black-headed Gulls typically forage within 11 km of their colony, although they have been recorded to forage up to 40 km from their colony (mean foraging range 11 km, mean max 25.5 km, max 50 km; Thaxter *et al*., 2012). The Black-headed Gull diet includes a wide range of terrestrial and coastal/marine prey items (Cramp and Simmons, 2004). The aquaculture sites in Wexford Harbour are, at their closest point, around 11 km from the Lady's Island Lake Black-headed Gull colony. There is also evidence of post-breeding dispersal to Wexford Harbour: as soon as Black-headed Gulls fledge at Lady's Island, they start appearing them on the North Slob and in the general area (NPWS). Therefore, Wexford Harbour may be within the core foraging raging of the colony and the Lady's Island Lake Black-headed Gull SCI has been screened in for full assessment.

3.29 Sandwich Tern regularly commute overland from Lady's Island Lake to feed in Wexford Harbour. The other tern species do not appear to regularly feed in Wexford Harbour and the Raven during the nesting season. However, there is post-breeding dispersal with juveniles of all four SCI tern species gathering on sandbanks in Wexford Harbour. Therefore, the Lady's Island Lake Sandwich Tern, Roseate Tern, Common Tern and Arctic Tern SCIs have all been screened in for full assessment.

Wetlands

3.30 Aquaculture activities in Wexford Harbour and the Raven will clearly not have any impact on wetland habitat in Lady's Island Lake. Therefore, this SCI has been screened out from further assessment.

Saltee Islands SPA

Qualifying features

3.31 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.

Screening assessment

3.32 Based on consultation with NPWS, the only SCIs from the Saltee Islands SPA where there was considered to be potential for significant interchange with Wexford Harbour and the Raven are the Cormorant and Shag breeding populations.

3.33 The aquaculture sites in Wexford Harbour are around 20 km (as the crow flies), and 34 km for a bird travelling around the coastline from the Little Saltee Island (the more northerly of the two islands) at their closest points.

3.34 The aquaculture sites in Rosslare Bay are 20 km (as the crow flies), and 30 km for a bird travelling around the coastline from the Little Saltee Island at their closest points.

3.35 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/). This indicates that the aquaculture sites in Wexford Harbour and the Raven are outside the likely core foraging range of Cormorants from the Saltee Islands SPA, but may provide a peripheral foraging area (note that Cormorants can fly overland). However, given the extent of the aquaculture activity within these areas, we have taken a precautionary approach and have screened in this SCI for further assessment.

3.36 For Shag, the Seabird Wikispace gives a mean foraging range of 6.5 km, a mean maximum of 16 km and a maximum of 20 km from breeding colonies. Shag will not fly overland. Therefore, the aquaculture plots in Wexford Harbour and the Raven are well outside the likely foraging range of Shag from the Saltee Islands SPA and this SCI has been screened out from further assessment.

Tacumshin Lake SPA

Qualifying features

3.37 The SCIs of the Tacumshin Lake SPA include wintering populations of: Bewick's Swan, Whooper Swan, Wigeon, Gadwall, Teal, Pintail, Shoveler, Tufted Duck, Little Grebe, Coot, Golden Plover, Grey Plover, Lapwing and Black-tailed Godwit.

3.38 The SCIs also includes post breeding/roosting Hen Harrier.

3.39 In addition the wetland habitat within the Tacumshin Lake SPA is listed as an SCI.

Screening assessment

Waterbird SCIs

3.40 Most of the waterbird SCIs of Tacumshin Lake SPA are also SCIs of the Wexford Harbour & Slobs SPA and/or the Raven SPA.

3.41 Given the relatively short distance between the two sites (around 7 km at their closest points) there is likely to be significant interchange of the waterbird SCIs between the two sites. Therefore, all the waterbird SCIs of Tacumshin Lake SPA that are also SCIs of the Wexford Harbour & Slobs SPA and/or the Raven SPA have been screened in for full assessment.

3.42 The waterbird SCIs of Tacumshin Lake SPA that are not also SCIs of the Wexford Harbour & Slobs SPA and/or the Raven SPA are: Gadwall, Shoveler and Tufted Duck.

3.43 Gadwall do not regularly occur in Wexford Harbour and the Raven (see paragraph 3.27). Therefore, this SCI has been screened out from further assessment.

3.44 Shoveler do not regularly occur at Wexford Harbour and the Raven. In I-WeBS counts, they were only recorded in three of the 25 counts during the most recent five winters for which data is available. They were also recorded in two of the five NPWS BWS counts. While one of the latter count was a high count (63 birds), the overall pattern across the combined I-WeBS/BWS datasets indicates that this was an exceptional count and that Wexford Harbour and the Raven does not regularly support significant numbers of Shoveler. Therefore, this SCI has been screened out from further assessment.

3.45 Tufted Duck regularly occur in significant numbers at Wexford Harbour and the Raven. Therefore, this SCI has been screened in for full assessment.

Hen Harrier

3.46 Even if there is interchange between the Wexford Harbour and Tacumshin Hen Harrier populations, there is no potential for significant spatial overlap with the aquaculture activities included in this assessment (see paragraphs 3.8-3.10). Therefore, this SCI has been screened out from further assessment.

Wetlands

3.47 Aquaculture activities in Wexford Harbour and the Raven will clearly not have any impact on wetland habitat in Tacumshin Lake. Therefore, this SCI has been screened out from further assessment.

Summary

3.48 The SCIs that have been screened in for full Appropriate Assessment are listed in Table 3.1.

Table 3.1 - SCIs screened in for full Appropriate Assessment.

SCI	Wexford Harbour	The Raven	Cahore Marshes	Lady's Island Lake	Saltee Islands	Tacumshin
Wintering populations						
Bewick's Swan	√					√
Whooper Swan	√					√
Greenland White-fronted Goose	√	√	√			

SCI	Wexford Harbour	The Raven	Cahore Marshes	Lady's Island Lake	Saltee Islands	Tacumshin
Light-bellied Brent Goose	√					
Shelduck	√					
Wigeon	√		√			√
Teal	√					√
Mallard	√					
Pintail	√					√
Scaup	√					
Tufted Duck						√
Common Scoter		√				
Goldeneye	√					
Red-breasted Merganser	√					
Red-throated Diver		√				
Little Grebe	√					√
Great Crested Grebe	√					
Cormorant	√	√				
Grey Heron	√					
Coot	√					√
Oystercatcher	√					
Golden Plover	√		√			√
Grey Plover	√					√
Lapwing	√		√			√
Knot	√					
Sanderling	√	√				
Dunlin	√					
Black-tailed Godwit	√					√
Bar-tailed Godwit	√					
Curlew	√					
Redshank	√					
Black-headed Gull	√					
Lesser Black-backed Gull	√					
Breeding populations						
Cormorant					√	
Black-headed Gull				√		
Little Tern	√					
Sandwich Tern				√		
Roseate Tern				√		
Common Tern				√		
Arctic Tern				√		

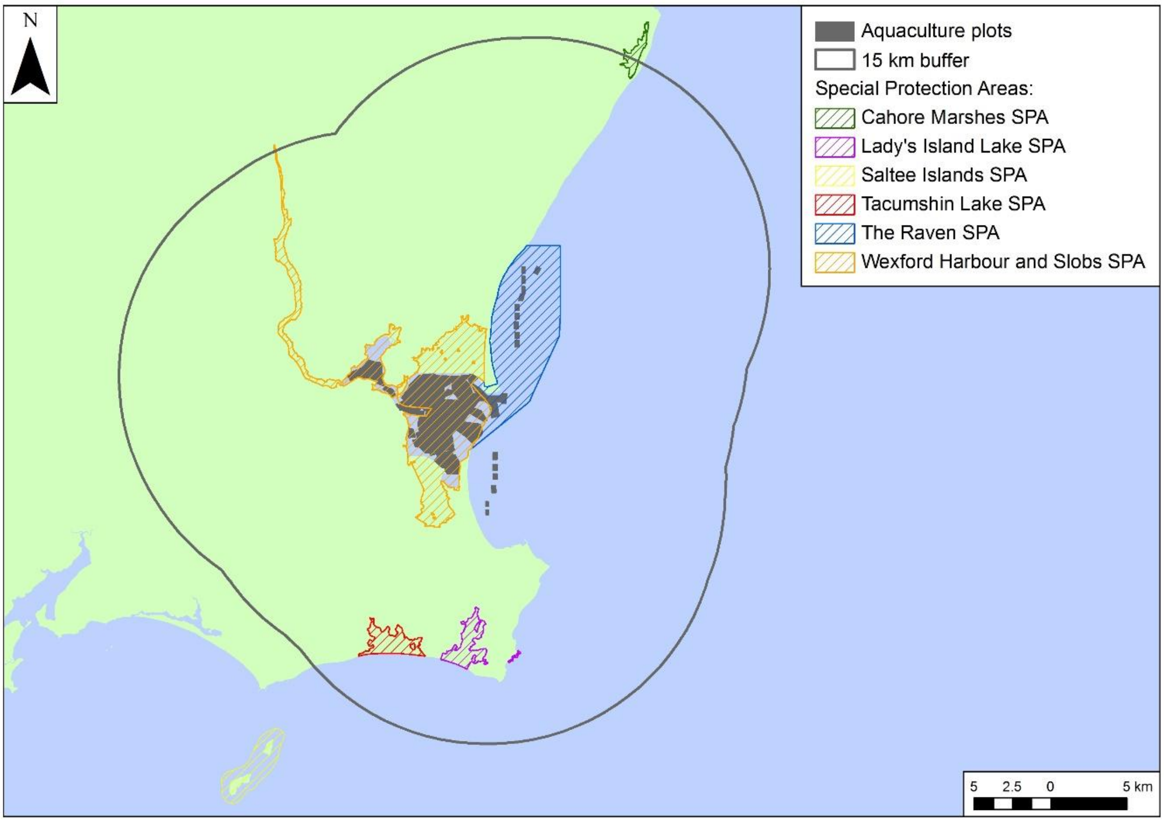


Figure 3.1 - SPAs included in the screening assessment.

4. Conservation objectives

Wexford Harbour and Slobs SPA

Screened in SCIs

4.1 The SCIs of the Wexford Harbour and Slobs SPA that have been screened in for this assessment are:

- non-breeding populations of: Little Grebe, Great Crested Grebe, Cormorant, Grey Heron, Bewick's Swan, Whooper Swan, Greenland White-fronted Goose, Light-bellied Brent Goose, Shelduck, Wigeon, Teal, Mallard, Pintail, Scaup, Goldeneye, Red-breasted Merganser, Coot, Oystercatcher, Golden Plover, Grey Plover, Lapwing, Knot, Sanderling, Dunlin, Black-tailed Godwit, Bar-tailed Godwit, Curlew, Redshank, Black-headed Gull and Lesser Black-backed Gull;
- and a breeding population of Little Tern.

Conservation objectives

4.2 The conservation objectives for the non-breeding populations of Little Grebe, Great Crested Grebe, Cormorant, Grey Heron, Bewick's Swan, Whooper Swan, Greenland White-fronted Goose, Light-bellied Brent Goose, Shelduck, Wigeon, Teal, Mallard, Pintail, Scaup, Goldeneye, Red-breasted Merganser, Coot, Oystercatcher, Golden Plover, Grey Plover, Lapwing, Knot, Sanderling, Dunlin, Black-tailed Godwit, Bar-tailed Godwit, Curlew, Redshank, Black-headed Gull and Lesser Black-backed Gull are to maintain their "*favourable conservation condition*" (NPWS, 2012b). The favourable conservation conditions of these species in the Wexford Harbour SPA are defined by various attributes and targets, which are shown in Table 4.1.

Table 4.1 - Attributes and targets for the conservation objectives for non-breeding populations of SCIs[1].

Attribute	Measure	Target	Notes
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
Distribution	Number and range of areas used by waterbirds	There should be no significant decrease in the numbers or range of areas used by waterbird species, other than that occurring from natural patterns of variation	Waterbird distribution from the 2009/2010 waterbird survey programme is discussed in part five of the conservation objectives supporting document

Source: NPWS (2012b).

[1] SCI species - Little Grebe, Great Crested Grebe, Cormorant, Grey Heron, Bewick's Swan, Whooper Swan, Greenland White-fronted Goose, Light-bellied Brent Goose, Shelduck, Wigeon, Teal, Mallard, Pintail, Scaup, Goldeneye, Red-breasted Merganser, Coot, Oystercatcher, Golden Plover, Grey Plover, Lapwing, Knot, Sanderling, Dunlin, Black-tailed Godwit, Bar-tailed Godwit, Curlew, Redshank, Black-headed Gull and Lesser Black-backed Gull

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

4.3 The conservation objectives for the breeding population of Little Tern is to maintain its "*favourable conservation condition*" (NPWS, 2012b). The favourable conservation condition of this species in Wexford Harbour SPA is defined by various attributes and targets, which are shown in Table 4.2.

Table 4.2 - Attributes and targets for the conservation objective for the breeding population of Little Tern in the Wexford Harbour SPA.

Attribute	Measure	Target	Notes
1. Breeding population abundance: apparently occupied nests (AONs)	Number	No significant decline	Measure based on standard tern survey methods (see Walsh *et al*., 1995). Mitchell *et al*. (2004) provides summary population information for Wexford. The Seabird Monitoring Programme (SMP) also provides background data (JNCC, 2012).
2. Productivity rate: fledged young per breeding pair	Mean number	No significant decline	Measure based on standard tern survey methods (see Walsh *et al*., 1995).
3. Distribution: breeding colonies	Number; location; area (hectares)	No significant decline	Little Tern nest in well-camouflaged shallow scrapes on sand and shingle beaches, spits or inshore islets (Mitchell *et al*., 2004). Due to the dynamic nature of Wexford Harbour, colony locations can vary from year to year.
4. Prey biomass available	Kilogrammes	No significant decline	Key prey items: mainly small, often juvenile, fish; invertebrates, especially crustaceans and insects. Key habitats: very shallow water, advancing or receding tidelines, brackish lagoons and saltmarsh creeks, sand-banks close to the coast. Foraging range: max 11 km, mean max 6.94 km, mean 4.14 km (BirdLife International Seabird Database (Birdlife International, 2012)).
5. Barriers to connectivity	Number; location; shape; area (hectares)	No significant increase	Seabird species can make extensive use of marine waters adjacent to their breeding colonies. Foraging range: max. 11 km, mean max. 6.94 km, mean 4.14 km (BirdLife International Seabird Database (Birdlife International, 2012)).
6. Disturbance at breeding site	Level of impact	Human activities should occur at levels that do not adversely affect the Little Tern population	Little tern nest in well-camouflaged shallow scrapes on sand and shingle beaches, spits or inshore islets (Mitchell *et al*., 2004). Due to the dynamic nature of Wexford Harbour, colony locations can vary from year to year

Source: NPWS (2012b)

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

The Raven SPA

Screened in SCIs

4.4 The SCIs of the Raven SPA that have been screened in for this assessment are wintering populations of: Greenland White-fronted Goose, Red-throated Diver, Cormorant, Common Scoter, Grey Plover and Sanderling.

Conservation objectives

4.5 The conservation objectives for the wintering populations of Greenland White-fronted Goose, Red-throated Diver, Cormorant, Common Scoter, Grey Plover and Sanderling are to maintain their "*favourable conservation condition*" (NPWS, 2012a). The favourable conservation conditions of these species in the Wexford Harbour SPA are defined by various attributes and targets, which are shown in Table 4.3.

Table 4.3 - Attributes and targets for the conservation objectives for the wintering populations of Red-throated Diver, Cormorant, Common Scoter, Grey Plover, Sanderling and Greenland White-fronted Goose in the Raven SPA.

Attribute	Measure	Target	Notes
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
Distribution	Number and range of areas used by waterbirds	There should be no significant decrease in the numbers or range of areas used by waterbird species, other than that occurring from natural patterns of variation	Waterbird distribution from the 2009/2010 waterbird survey programme is discussed in part five of the conservation objectives supporting document

Source: NPWS (2012a)

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

Cahore Marshes SPA

Screened in SCIs

4.6 The SCIs of the Cahore Marshes SPA that have been screened in for this assessment are wintering populations of: Greenland White-fronted Goose, Wigeon, Golden Plover and Lapwing.

Conservation objectives

SCI species

4.7 The conservation objectives for site are to maintain or restore the "*favourable conservation condition*" of the features for which it is designated (NPWS, 2011a).

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

Lady's Island Lake SPA

Screened in SCIs

4.9 The SCIs of the Lady's Island Lake SPA that have been screened in for this assessment are breeding populations of Black-headed Gull, Sandwich Tern, Roseate Tern, Common Tern and Arctic Tern.

Conservation objectives

4.10 The conservation objectives for site are to maintain or restore the favourable conservation condition of the bird species listed as Special Conservation Interests for this SPA (NPWS 2011b).

4.11 NPWS have only published generic conservation objectives for the Lady's Island Lake SPA. Therefore, there are no site-specific attributes and targets to define the favourable conservation condition of these species.

Saltee Islands SPA

Screened in SCIs

4.12 The only SCI of the Saltee Islands SPA that has been screened in for this assessment is the breeding population of Cormorant.

Conservation objective

4.13 The conservation objective for the breeding population of Cormorant is to maintain its "*favourable conservation condition*" (NPWS, 2011d). The favourable conservation conditions of this SCI in the Saltee Islands SPA are defined by various attributes and targets, which are shown in Table 4.4.

Table 4.4 - Attributes and targets for the conservation objective for the breeding population of Cormorant in the Saltee Islands SPA.

Attribute	Measure	Target	Notes
1. Breeding population abundance: apparently occupied nests (AONs)	Number	No significant decline	Measure based on standard survey methods (see Walsh *et al*., 1995). Mitchell *et al*. (2004) provides summary population information. The Seabird Monitoring Programme (SMP) online database (JNCC, 2011) provides population data for this species.
2. Productivity rate	Mean number	No significant decline	Measure based on standard survey methods (see Walsh *et al*., 1995). The Seabird Monitoring Programme (SMP) online database (JNCC, 2011) provides population data for this species.
3. Distribution: breeding colonies	Number; location; area (hectares)	No significant decline	Cormorant colonies are usually sited on flat or rocky islets or sea stack tops, less often on cliffs (Walsh *et al*., 1995).
4. Prey biomass available	Kilogrammes	No significant decline	Key prey items: fish (mostly benthic), some crustaceans. Key habitats: populations use sandy areas, rocky and vegetated substrate. Foraging range: max. 50 km, mean max. 31.67 km, mean 8.46 km (BirdLife International Seabird Database (Birdlife International, 2011))
5. Barriers to connectivity	Number; location; shape; area (hectares)	No significant increase	Foraging Range: max. 50km, mean max. 31.67km, mean 8.46km (BirdLife International Seabird Database (Birdlife International, 2011)).

Attribute	Measure	Target	Notes
6. Disturbance at breeding site	Level of impact	No significant increase	Cormorant colonies are usually sited on flat or rocky islets or sea stack tops, less often on cliffs (Walsh *et al*., 1995).

Source: NPWS (2011d)

Attributes are not numbered in NPWS (2011d), but are numbered here for convenience.

Tacumshin Lake SPA

Screened in SCIs

4.14 The SCIs of the Tacumshin Lake SPA that have been screened in for this assessment are wintering populations of: Little Grebe, Bewick's Swan, Whooper Swan, Wigeon, Teal, Pintail, Tufted Duck, Coot, Golden Plover, Grey Plover, Lapwing and Black-tailed Godwit.

Conservation objectives

SCI species

4.15 The conservation objectives for site are to maintain or restore the "*favourable conservation condition*" of the features for which it is designated (NPWS, 2011c).

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

5. Status and distribution of the SCI species

Wexford Harbour and Slobs and the Raven SPAs and Rosslare Bay

Waterbird status

Breeding populations

5.1 There is one SCI species listed for its breeding population: Little Tern. NPWS have not published a formal assessment of the conservation condition of the breeding Little Tern population in the Wexford Harbour and Slobs SPA.

5.2 Breeding Little Terns have been recorded in Wexford Harbour since 2006 (Table 5.1). Recorded numbers were low until 2011, although full surveys of the harbour for breeding Little Terns were not carried out during those years. Since 2011, a large colony has developed. This colony was located on Bird Island in 2011 and 2012, moving to Dogger Bank in 2013 and 2014, then moving back to Bird Island in 2015.

Table 5.1 - Status of breeding Little Terns in Wexford Harbour.

Year	Status
2006	Bird Island - few adults, probably less than 10 pairs. Status in rest of Wexford Harbour not known.
2007	Bird Island - few adults, probably less than 10 pairs, 3 nests located. Status in rest of Wexford Harbour not known.
2008	Bird Island - c. 20+ adults, but appeared to abandon site, maybe to the north side of the harbour. Status in rest of Wexford Harbour not known.
2009	Only 8 adults, probably did not breed on Tern Island. Status in rest of Wexford Harbour not known.
2010	Bird Island - c. 20+ adults, probably less than 10 pairs. Status in rest of Wexford Harbour not known.
2011	Bird Island - estimated 140 adults, 27 nests counted in the small portion of the colony that was checked; probably 50 -100 pairs overall. Status in rest of Wexford Harbour not known.
2012	162 pairs (estimated) nested on Bird Island.
2013	150-250 pairs present in Wexford Harbour, distributed between colonies on Bird Island and Fort Bank (with the majority in the latter location).
2014	175 pairs (estimated) nested on Fort Bank, with no birds recorded nesting in the Bird Island colony location.
2015	Colony moved back to Bird Island.140 nests on 16th June; however, for some reason minimal activity when revisited on 9th/10th July. Subsequently, some evidence of late breeding on Fort Bank.

Sources: 2006-2011, unpublished data (NPWS); 2012-2015 (NPWS, 2014, 2015).

Wintering populations

5.3 The conservation condition and trends of the wintering SCI species of the Wexford Harbour and Slobs and the Raven SPAs are summarised in Table 5.2. It should be noted that these trends are based on analysis of the data from the Wexford Bay I-WeBS site only. Therefore, they do not include any data from the Slaney Zone of the Wexford Harbour and Slobs SPA. In addition, due to the limited coverage of the Wexford Bay I-WeBS site (see paragraphs 2.33-2.34), the reliability of some of these trends may be limited. In particular, the positive long term trend reported for Scaup is not reflected in the raw count data, with the latter showing the frequent occurrence of flocks of 100s of birds in the 1990s, compared to a maximum count of 65 in the last ten winters.

Table 5.2 – Conservation condition and population trends of wintering SCI species in the Wexford Harbour and Slobs and the Raven SPAs.

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]
Bewick's Swan	Highly Unfavourable	-79.7	-76.3	-94.1	Decline
Whooper Swan	Favourable	+193	+16.2	+49.3	Increase
Greenland White-fronted Goose	Intermediate (Unfavourable)	-7	+7.5	Decline	Decline
Light-bellied Brent Goose	Favourable	+50	+24.2	+58	Increase
Shelduck	Intermediate (Unfavourable)	-15.6	+26.7	+4.46	Stable
Wigeon	Intermediate (Unfavourable)	-7.8	-15.5	-20.1	Stable
Teal	Favourable	+69.8	+6.5	+11.28	Increase
Mallard	Intermediate (Unfavourable)	-16.6	+0.3	-16	Decline/ Stable
Pintail	Favourable	+53	+57.4	+26.8	Stable
Scaup	Favourable	+14.8	+195	+88.7	Stable
Common Scoter	Intermediate (Unfavourable)	-23	n/c	n/c	Stable
Goldeneye	Unfavourable	-42.3	-30.1	-50.7	Stable
Red-breasted Merganser	Intermediate (Unfavourable)	-15	+9	-11	n/c
Red-throated Diver	Intermediate (Unfavourable)	-16	n/c	n/c	Stable
Little Grebe	Intermediate (Unfavourable)	-13.1	+5.8	-5.5	Stable
Great Crested Grebe	Intermediate (Unfavourable)	-8.8	-13	-18	Decline
Cormorant	Favourable	+45	+5	+31.5	Increase
Grey Heron	Favourable	+45.4	-3.4	+29.2	Increase
Coot	Unfavourable	-48	-14.5	-34	Stable
Oystercatcher	Favourable	+5	+10.5	+23.5	Decline
Golden Plover	Favourable	+39.7	-14.6	-2.2	Decline
Grey Plover	Unfavourable	-45.5	-6	-33.1	Decline
Lapwing	Unfavourable	-31	-5	-40.12	Decline
Knot	Unfavourable	-39.9	+47.3	-2.91	Decline
Sanderling	Intermediate (Unfavourable)	-2	+37	+109.3	Stable/ Increase
Dunlin	Highly Unfavourable	-61.7	-18.7	-46.5	Stable (*alpina*)
Black-tailed Godwit	Favourable	+72.1	+13.7	+70.2	Increase
Bar-tailed Godwit	Intermediate (Unfavourable)	-6	-1	+1.5	Stable
Curlew	Unfavourable	-30	-9	-25.7	Decline
Redshank	Favourable	+18.4	-7.4	+22.7	Decline/ Stable
Black-headed Gull	-	n/c	n/c	n/c	n/c

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]
Lesser Black-backed Gull	-	n/c	n/c	n/c	Increase

Source: Tables 4.2 and 4.5 in NPWS (2013g)

n/c = not calculated. [1]site population trend analysis, 12 yr = 1995/96–2007/08 with the exception of Greenland White-fronted Goose, which is the 15-yr trend (1992/93–2007/08), and Common Scoter and Red-throated Diver, which are the difference of the 1995/96-1999/00 and 2003/04-2007/08 five year means; [2] site population trend analysis, 5 yr = 2002/03–2007/08; [3]all-Ireland trend calculated for period 1994/95 to 2008/09; [4] international trend after Wetland International (2006).

Waterbird habitats

Sandbanks

5.4 Permanently exposed sandbanks occur at the mouth of the Harbour Zone (Figure 5.1). These areas consist of ridges of dry sand with dune vegetation developing in the more stable areas. However, these sandbanks are very mobile and their extent and configuration can change dramatically over a period of a few years.

5.5 There are three main sandbank areas: -

- Dogger Bank and the sandbanks associated with the Fort Ruins, in the northern section of the harbour mouth. The Dogger Bank sandbank is the largest of these sandbanks and, in recent years, its position has remained more or less constant, although its extent and configuration has changed significantly.
- Tern Island, in the middle of the harbour mouth. Only small remnants of this sandbank are exposed.
- Bird Island, in the Rosslare Backstrand area. This is the largest, and most stable, sandbank, with a narrow ridge of dune vegetation in its centre. The Wexford Harbour chartlets indicate little change in its configuration since 2011.

Tidal zones

5.6 The overall distribution of tidal habitat within the assessment site is shown in Table 5.3. These figures may overestimate the proportion of intertidal habitat within the Ferrycarrig Zone (see paragraphs 2.18).

Table 5.3 - Distribution of tidal habitat within the assessment site.

Area included	Zone	Intertidal		Subtidal		Total	
		Area (ha)	%	Area (ha)	%	Area (ha)	%
Total area	FERRY	193	28%	324	3%	517	5%
	HARBOUR	499	72%	2513	24%	3012	27%
	OUTER	negligible	-	7590	73%	7590	68%
Area covered by I-WeBS counts	FERRY	193	36%	324	8%	517	11%
	HARBOUR	338	64%	1564	39%	1901	42%
	OUTER	negligible	-	2078	52%	2078	46%

The intertidal refers to the habitat exposed at mean low tides; the subtidal category includes habitat exposed on spring low tides. See paragraphs 2.16-2.26 for details of sources of data and calculations of tidal zones.

5.7 The distribution of tidal zones within the Harbour Zone is shown in Figure 5.2 and Figure 5.3. On neap and mean low tides, most of the intertidal exposure is in the Hopeland/Rosslare Backstrand area and around the sandbanks at the mouth of the harbour. On spring low tides, the GSI bathymetry data indicates extensive exposure of intertidal habitat across much of the southern part of the harbour. However, this extent may be exaggerated due to the data quality issues with the GSI bathymetry data (see paragraph 2.18).

5.8 The distribution of tidal zones within the Outer Zone is shown in Figure 5.4. Most of the subtidal habitat in the Outer Zone is within the 0-5 m and 5-10 m depth zones, but with an area of deeper water (10-20 m depth) extending into the Raven SPA. There is no subtidal habitat greater than 20 m depth within the Outer Zone.

Habitats

5.9 The intertidal and subtidal habitats in the Wexford Harbour and Slobs and the Raven SPAs have been classified into eleven marine community types (hereafter referred to as biotopes) by NPWS (2011e, f). The distribution of these biotopes within the SPAs is shown in Figure 5.5. The following summary of the distribution and characteristics of these biotopes is based on the descriptions in NPWS (2011e, f).

5.10 The *estuarine muds dominated by polychaetes and crustaceans community complex* (referred to hereafter as *estuarine muds*) occurs in intertidal areas in the southern part of the Harbour Zone, and in the Ferrycarrig Zone, where it comprises muddy sediments (mud content > 60%) with a very low gravel content (< 1.5%). This biotope also occurs in subtidal areas at depths of up to 5 m, where the sediment is coarser (mud content > 30%). The Hopeland area in the Harbour Zone was not mapped by NPWS, but, from visual inspection of the area, we presume that this biotope also occurs here.

5.11 The *sand dominated by polychaetes community complex* (referred to hereafter as *sand*) occurs in intertidal areas in the Rosslare Backstrand area, and across the mouth of Wexford Harbour, where it comprises fine to medium sand with these fractions (96% of the sediment composition). The distribution of this biotope shows a close correspondence to the extent of intertidal habitat mapped in these areas from GSI bathymetry data (compare Figure 5.3 and Figure 5.5). This biotope also occurs in subtidal areas at depths of up to 2 m.

5.12 The *mixed sediment community complex* (referred to hereafter as *mixed sediment*) occurs across the northern part of Wexford Harbour, and in part of the Raven SPA, in subtidal habitats. The sediment is comprises sand (>70%) with varying amounts of gravel and mud.

5.13 The *fine sand with Spiophanes bombyx community complex* (referred to hereafter as *fine sand*) occurs in the channels of the outer harbour and across much of the Raven SPA, in subtidal habitats. The sediment comprises fine sand, with varying amounts of medium sand, and low amounts of gravel and mud (< 2.5%). The biotopes in Rosslare Bay were not mapped by NPWS. However, most of the Raven SPA and Rosslare Bay is mapped as *shallow sublittoral sand* in the *MSFD: Predominant Habitat Types* database (accessed via http://atlas.marine.ie/#/Map), indicating that the *fine sand* biotope is likely to extend across most of Rosslare Bay.

Waterbird distribution

Habitat usage

5.14 The habitat usage of the wintering waterbird SCI species, as classified in the SPA Conservation Objectives Supporting Document (NPWS, 2011g) is summarised in Table 5.4.

5.15 The distribution of species that occurred in more than one tidal zone in the BWS low tide counts is summarised in Table 5.5. Whooper Swan, Greenland White-fronted Goose, Wigeon, Pintail, Little Grebe and Lapwing occurred mainly in the non-tidal habitats. Goldeneye and Cormorant occurred across both the non-tidal and subtidal zones. Cormorant were also recorded (less frequently) from the intertidal zone, with these records presumably referring to birds roosting on sandbanks, etc. As would be expected, Great Crested Grebe occurred almost exclusively in the subtidal zone. Golden Plover, Black-tailed Godwit and Curlew made significant use of the non-tidal zone as would be expected for these field-feeding waders. However, the percentages of Oystercatcher (another field-feeding species) and Grey Heron, Dunlin and Redshank (species that can use non-tidal wetland habitats) using the non-tidal zone were low. As would be expected, Grey Plover and Bar-tailed Godwit occurred almost exclusively in the intertidal zone. Black-headed Gull and Lesser Black-backed Gull occurred most frequently in the intertidal zone.

5.16 Of the species not included in Table 5.5, Bewick's Swan, Teal, Mallard, Tufted Duck, Scaup and Coot occurred exclusively in non-tidal habitats in the BWS low tide counts (although 15 Teal were recorded in intertidal habitat during the BWS high tide count). However, it should be noted that very small numbers of Scaup were recorded in the BWS counts and in I-WeBS counts where large numbers have been present, significant numbers occurred in the Harbour Zone (see below). Common Scoter, Red-breasted Merganser and Red-throated Diver occurred exclusively in subtidal habitat. Knot and Sanderling occurred exclusively in intertidal habitat.

Table 5.4 - Habitat usage of SCI wintering waterbirds, as classified by NPWS.

Principal supporting habitat within the side	
North and South Slobs	Lapwing
North and South Slobs (polderland)	Whooper Swan, Greenland White-fronted
North Slobs (polderland)	Bewick’s Swan
North Slobs (main channel)	Wigeon, Teal, Mallard, Pintail, Scaup, Goldeneye, Little Grebe, Coot
North and South Slobs; intertidal mudflats	Golden Plover
North and South Slobs; intertidal mudflats and sandflats	Curlew
North and South Slobs (channels); intertidal	Grey Heron
North Slobs; intertidal mudflats	Light-bellied Brent Goose, Shelduck
Intertidal mud and sand flats	Oystercatcher, Grey Plover, Knot, Dunlin, Black-tailed Godwit, Bar-tailed Godwit, Redshank
Intertidal sand flats	Sanderling
Intertidal flats; sheltered and shallow subtidal	Black-headed Gull, Lesser Black-backed Gull
Sheltered and shallow subtidal	Red-breasted Merganser, Red-throated Diver, Cormorant
Sheltered and shallow subtidal over sandflats	Great Crested Grebe
Shallow subtidal over sand flats	Common Scoter

Source: Table 5.2a and b in NPWS (2011g).

Table 5.5 - Mean habitat usage of species that used more than one tidal zone in the NPWS BWS low tide counts.

Species	Non-tidal	Subtidal	Intertidal	n
Whooper Swan	91%	4%	5%	4
Greenland White-fronted Goose	90%	0%	10%	3
Light-bellied Brent Goose	58%	13%	28%	4
Shelduck	30%	31%	40%	3
Wigeon	92%	5%	3%	4
Pintail	96%	4%	0%	4
Goldeneye	51%	46%	3%	3
Little Grebe	89%	11%	0%	2
Great Crested Grebe	1%	96%	3%	4
Cormorant	43%	41%	16%	4
Grey Heron	19%	4%	77%	3
Oystercatcher	15%	4%	81%	4
Golden Plover	60%	0%	40%	4
Grey Plover	1%	4%	96%	3
Lapwing	87%	0%	13%	4
Dunlin	2%	5%	93%	4
Black-tailed Godwit	42%	1%	57%	4
Bar-tailed Godwit	3%	13%	85%	4
Curlew	55%	1%	44%	4
Redshank	8%	1%	91%	4
Black-headed Gull	21%	11%	68%	4
Lesser Black-backed Gull	29%	15%	56%	3

Data source: BWS low tide counts. Data are means across all low tide counts, excluding counts with atypically low numbers.

Distribution

5.17 The Slaney Zone is counted separately from the other zones of the assessment site. The distribution of SCI species between these two areas is shown in Table 5.6. Tufted Duck, Grey Heron, Black-headed Gull and Lesser Black-backed Gull have been recorded in similar, or greater, numbers, in the Slaney Zone compared to the rest of the assessment site. Wigeon, Teal, Mallard, Goldeneye, Cormorant, Lapwing and Redshank also occur in significant numbers in the Slaney Zone. However, the incomplete coverage of the Harbour Zone will overestimate the relative importance of the Slaney Zone.

5.18 The distribution of waterbird species between the main zones of the assessment site (excluding the Slaney Zone), as recorded by I-WeBS and BWS counts, is shown in Table 5.7. Because of incomplete coverage of the Harbour and Outer Zones, bird usage of these areas will be underestimated compared to the Ferrycarrig and North Slobs Zones.

5.19 Most species occur in relatively low numbers in the Ferrycarrig Zone. The numbers of waders in the Ferrycarrig Zone are relatively low compared to the distribution of intertidal habitat indicated in Table 5.3. However, the latter may overestimate the relative amount of intertidal habitat within the Ferrycarrig Zone (see paragraph 2.20). Furthermore, it is considered that the majority of waders that feed in the Ferrycarrig Zone roost in the Harbour Zone (NPWS).

5.20 Because the I-WeBS counts use a single subsite to cover the South Slob and a section of the Harbour Zone, separate figures for the South Slob and Harbour Zones are not presented in Table

5.6. However, for most species it is possible to state which of the two zones they mainly use. Of the species that occur, or have occurred, in significant numbers in the South Slob/Harbour Zones: Whooper Swan, Pintail, Tufted Duck, Little Grebe and Coot mainly occurred in the South Slob; while, Shelduck, Scaup, Goldeneye, Red-breasted Merganser, Great Crested Grebe, Cormorant, and most of the wader species mainly occurred in the Harbour Zone. Some species, such as Light-bellied Brent Goose, would have occurred in significant numbers in both zones.

Table 5.6 - Distribution of SCI species between the River Slaney and Wexford Bay I-WeBS sites.

	Mean annual peak counts:			
	1995/96-1999/2000		2004/05, 2007/08 and 2012/13	
Species	**Slaney**	**Wexford Bay**	**Slaney**	**Wexford Bay**
Bewick's Swan	0	181	3	104
Shelduck	13	887	4	315
Wigeon	115	2921	96	2922
Teal	534	1067	750	953
Mallard	294	3127	232	1640
Pintail	0	78	0	63
Tufted Duck	160	105	23	83
Goldeneye	46	151	5	76
Red-breasted Merganser	5	231	1	105
Little Grebe	10	77	4	57
Great Crested Grebe	0	125	0	65
Cormorant	100	453	69	390
Grey Heron	31	23	13	15
Oystercatcher	11	1724	0	535
Golden Plover	1	5342	0	9270
Lapwing	336	11944	533	6997
Dunlin	3	3037	0	568
Black-tailed Godwit	37	732	8	1162
Curlew	85	1924	57	762
Redshank	100	535	36	261
Black-headed Gull	3779	2539	1460	779
Lesser Black-backed Gull	1028	55	129	49

Slaney = the River Slaney I-WeBS site (site code 0O301); Harbour/Raven = the Wexford Bay I-WeBS site (0O901).

Whooper Swan, Greenland White-fronted Goose, Light-bellied Brent Goose, Scaup, Common Scoter, Grey Plover, Knot, Sanderling and Bar-tailed Godwit not recorded from the River Slaney I-WeBS site.

Higher mean annual peaks in 1995/96-1999/2000 compared to 2004/05, 2007/08 and 2012/13 may reflect greater number of counts in the former period.

Harbour/Raven mean annual peaks should be interpreted with reference to coverage limitations (see Table 2.3).

Table 5.7 - Distribution of SCI species between the main zones of the assessment site.

Species	FERRY	HARBOUR /SSLOB	NSLOB	OUTER	n
Whooper Swan	0%	62%	38%	0%	14
Bewick's Swan	0%	5%	95%	0%	12
Greenland White-fronted Goose	0%	2%	98%	0%	13
Light-bellied Brent Goose	0%	60%	40%	0%	16
Shelduck	1%	90%	9%	0%	17
Wigeon	0%	12%	87%	1%	20
Teal	4%	10%	86%	0%	16
Mallard	1%	19%	80%	0%	20
Pintail	0%	29%	70%	1%	12
Tufted Duck	9%	29%	62%	0%	16
Scaup	0%	87%	13%	0%	8
Common Scoter	0%	1%	0%	99%	20
Goldeneye	22%	51%	27%	0%	14
Red-breasted Merganser	13%	82%	1%	5%	18
Red-throated Diver	0%	5%	0%	95%	14
Little Grebe	0%	26%	74%	0%	11
Great Crested Grebe	20%	74%	1%	5%	17
Cormorant	11%	72%	2%	14%	20
Grey Heron	25%	57%	17%	0%	7
Coot	0%	39%	61%	0%	11
Oystercatcher	6%	83%	7%	3%	22
Golden Plover	0%	53%	47%	0%	19
Grey Plover	5%	95%	0%	0%	20
Lapwing	4%	42%	53%	0%	15
Knot	0%	100%	0%	0%	7
Sanderling	0%	100%	0%	0%	12
Dunlin	4%	94%	2%	0%	20
Black-tailed Godwit	16%	38%	46%	0%	22
Bar-tailed Godwit	3%	90%	7%	0%	22
Curlew	10%	51%	39%	0%	22
Redshank	21%	68%	11%	0%	22
Black-headed Gull	25%	42%	20%	13%	21
Lesser Black-backed Gull	25%	61%	1%	13%	9

Data source: I-WeBS and BWS counts. For each species, includes all complete counts with a total count of at least 25% of the median count, or 50% if median count is under 100, subject to an absolute minimum of 20.

Roost sites

5.21 The distribution of roost sites recorded during the BWS counts, and supplemented by information from local NPWS personnel, is shown in Figure 5.6. It should be noted that roosting takes place in several ways: night roosts, weather roosts and tidal roosts/daytime roosts (NPWS).

5.22 The Greenland White-fronted Goose/Light-bellied Brent Goose roost site is a nocturnal roost site on Dogger Bank and Fort Ruins, used by the majority of the population from the North Slobs. The exact mapped position may not be accurate, as the mapping in NPWS (2011g) does not include detailed representation of sandbank positions, while the precise roost locations depend on the weather. In any case, the exact position of the roost will change over time in line with movements of the sandbanks. It is also likely that Bird Island and Tern Island are used at times, as well, particularly by geese from the South Slobs (NPWS).

5.23 In the Harbour Zone, Cormorant roosts occur at Dogger Bank, Bird Island and on the North Training Wall. Our observations in February and March 2015, indicate that Dogger Bank is the main nocturnal roost in the Harbour Zone, although no systematic counts have been done (NPWS). All three roost sites can also hold significant numbers of birds during the day. As with the geese, the exact position of the Dogger Bank roost will change over time in line with movements of the sandbanks. There are also Cormorant roosts at Saunderscourt (in the Ferrycarrig Zone), and at Poldarrig (tree roost) in the Slaney Zone, about 7-8 km upstream of Ferrycarrig Bridge (NPWS).

5.24 Great Crested grebe and diving duck roosts were not mapped during the BWS counts, or in the information from local NPWS personnel. Our observations in February and early March 2015, and further observations in the winter of 2015/16, indicate that Goldeneye and Great Crested Grebes gather to form a nocturnal roost just off the north-western shore of the Harbour Zone, close to Ardcavan (see paragraphs 6.127-6.130). This roost may hold all the birds within the Harbour Zone, but it is possible that an additional (smaller) roost might occur within the Ferrycarrig Zone. Only a small number of Red-breasted Merganser were recorded at the Ardcavan roost and the location of additional merganser nocturnal roosts is not known.

5.25 The main mapped wader roost sites occur on intertidal banks at the mouth of the harbour. In addition, many waders roost by day at high tide on the fields in both slobs, including Golden Plover, Grey Plover, Lapwing, Dunlin, Black-tailed Godwit, Bar-tailed Godwit and Redshank (NPWS). The position of the roosts mapped in Figure 5.6, indicates that some roosts occur on intertidal banks that may be flooded on spring tides, in addition to roosts on the permanently exposed sandbanks. Again, the same comments, as for the geese, about the limitations of the mapping, and the movement of the roost positions over time apply. Wader roosts also occur in various locations around the shoreline. The position of the wader roosts in the Ferrycarrig Zone, adjacent to the main area of intertidal habitat suggests that most of the waders using intertidal habitat within the Ferrycarrig Zone roost there at high tide, although it is possible that some birds use the roosts at Ferrybank.

5.26 The gull roosts mapped in Figure 5.6 are daytime roosts. In February 2015, we observed several thousand Black-headed Gulls roosting nocturnally off Ardcavan Beach, with the roost extending from close to the shoreline out to around the position of the Great Crested Grebe/Goldeneye roost. The location(s) of the nocturnal Lesser-Black-backed Gull roost(s) is not known.

Breeding populations

5.27 There is one SCI species listed for its breeding population: Little Tern.

5.28 From 2006-2010, a small colony was recorded on Bird Island (although other areas of the harbour were not fully surveyed). Since 2011, the size of the colony has increased and the colony has moved between Bird Island (2012, 2013 and 2015) and Fort Bank (2013 and 2014) (Table 5.1; Figure 5.7).

5.29 The Seabird Wikispace gives a mean foraging range of 4 km, a mean maximum of 7 km and a maximum of 11 km from breeding colonies, but states that "*Little Terns have very short foraging ranges compared to most seabirds, with most food generally being obtained from within 5 km of the colony, and usually within 1 km of the shore*".

5.30 In Wexford Harbour, adult Little Terns can be seen feeding anywhere within the harbour and can also feed offshore outside the harbour down to Rosslare Point. Juvenile Little Terns may disperse around the harbour and elsewhere as soon as they fledge (NPWS).

Cahore Marshes SPA

5.31 There has been no assessment of the conservation condition of the SCI species in this SPA.

5.32 All the SCI species screened-in for assessment from this SPA are associated with areas of flooded fields within the site.

5.33 The available population data for the screened-in SCI species of this SPA are summarised in Table 5.8. Greenland White-fronted Goose, Golden Plover and Lapwing all appear to have decreased between the 1990s and 2000s, while Wigeon numbers appear stable. However, the apparent decreases for Golden Plover and Lapwing should be treated with caution as trends based on peak counts are not very reliable for these species, due to the wide variation in numbers that can occur.

5.34 Some of the Greenland White-fronted Goose using the Cahore Marshes SPA are known to commute to Wexford Harbour and the Raven to roost each night (NPWS).

Table 5.8 - Population data for the screened-in SCI species of the Cahore Marshes SPA.

Species	Mean annual peaks		Trend
	1994/95-1998/99	2004/05-2008/09	2001/02-2008/09
Greenland White-fronted Goose	312	120	variable
Wigeon	1355	1359	variable
Golden Plover	6117	3010	variable
Lapwing	3982	2150	variable

Trend: the trends in the annual peak numbers from visual inspection of the data.

Sources: 1994/95-1998//99 mean annual peaks (Crowe, 2005); 2004/05-2008/09 mean annual peaks, and 2001/02-2008/09 trends (Boland and Crowe, 2012).

Lady's Island Lake SPA

5.35 There has been no assessment of the conservation condition of the SCI species in this SPA.

5.36 Black-headed Gull, Sandwich Tern, Roseate Tern, Common Tern and Arctic Tern nest on islands in Lady's Island Lake, with the main colonies on Inish and secondary colonies of some species on Sgarbheen (Daly *et al*., 2011, 2012).

5.37 Since 2000, there has been a sustained increasing trend (with some annual fluctuation) in the population size of Black-headed Gull, Sandwich Tern, Common Tern and Arctic Tern (Table 5.9).

Table 5.9 - Post-2000 breeding data for screened-in SCI species at Lady's Island Lake SPA.

Year	Black-headed Gull	Sandwich Tern	Roseate Tern	Common Tern	Arctic Tern
2001	570	1068	nd	322	162
2002	961	825	nd	461	188
2003	nd	1252	nd	nc	
2004	nd	1161	nd	312	361
2005	1042	1122	nd	471	232
2006	1052	1309	nd	484	238
2007	951	1800	nd	585	288
2008	nd	1945	nd	627	313
2009	nd	1958	nd	1160	
2010	nd	nd	nd	nd	
2011	1431	1931	155	1297	
2012	1616	1692	126	968	538

Data are apparently occupied nests, or apparently occupied territories; nd = no data.

Sources: 2001-2009 (JNCC Seabird Colony Data; http://jncc.defra.gov.uk/page-4460); 2011 (Daly *et al*., 2011); 2012 (Daly *et al*., 2012).

Saltee Islands SPA

5.38 There has been no assessment of the conservation condition of the SCI species in this SPA.

5.39 Cormorant colonies occur on both the Little Saltee and Great Saltee Islands.

5.40 There appears to be limited population data available for the Saltee Islands Cormorant population. The available population data (all apparently occupied nests) are: 391 (1988), 352 (1993), 373 (1997) and 273 (2000) (all Little Saltee Island only; JNCC Seabird Colony Data; http://jncc.defra.gov.uk/page-4460), and 145 (2011; Great Saltee only; Tierney *et al*., 2011).

Tacumshin Lake SPA

5.41 There has been no assessment of the conservation condition of the SCI species in this SPA.

5.42 The available population data for the screened-in SCI species of this SPA are summarised in Table 5.10. There has been a dramatic decrease in the numbers of Bewick's Swan, in line with national trends, while Whooper Swan, Pintail, Little Grebe, Coot, Grey Plover, Lapwing and Black-tailed Godwit also appear to have decreased. The decrease in Black-tailed Godwit numbers is in strong contrast to the strongly increasing national trend over the same period, suggesting that a site-specific factor may be involved.

Table 5.10 - Population data for the screened-in SCI species of the Tacumshin Lake SPA.

Species	Mean annual peaks		Trend
	1994/95-1998/99	2004/05-2008/09	2001/02-2008/09
Bewick's Swan	197	7	variable
Whooper Swan	188	113	variable
Wigeon	4488	5005	increasing
Teal	895	611	variable
Pintail	274	196	variable
Tufted Duck	no data	no data	
Little Grebe	64	31	variable
Coot	1573	306	variable
Golden Plover	4984	5154	variable
Grey Plover	85	19	variable
Lapwing	6254	2670	variable
Black-tailed Godwit	523	149	variable

Trend: the trends in the annual peak numbers from visual inspection of the data.

Sources: 1994/95-1998//99 mean annual peaks (Crowe, 2005); 2004/05-2008/09 mean annual peaks, and 2001/02-2008/09 trends (Boland and Crowe, 2012).

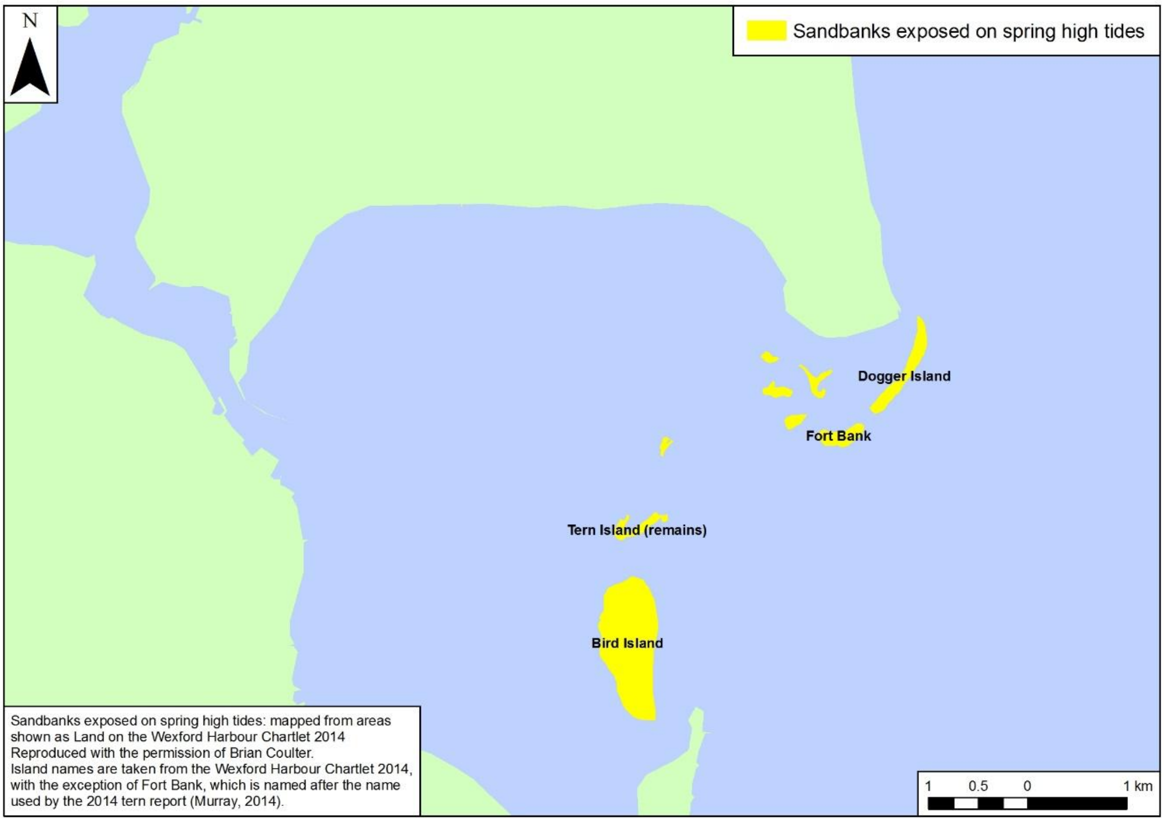


Figure 5.1 - Sandbanks in Wexford Harbour.

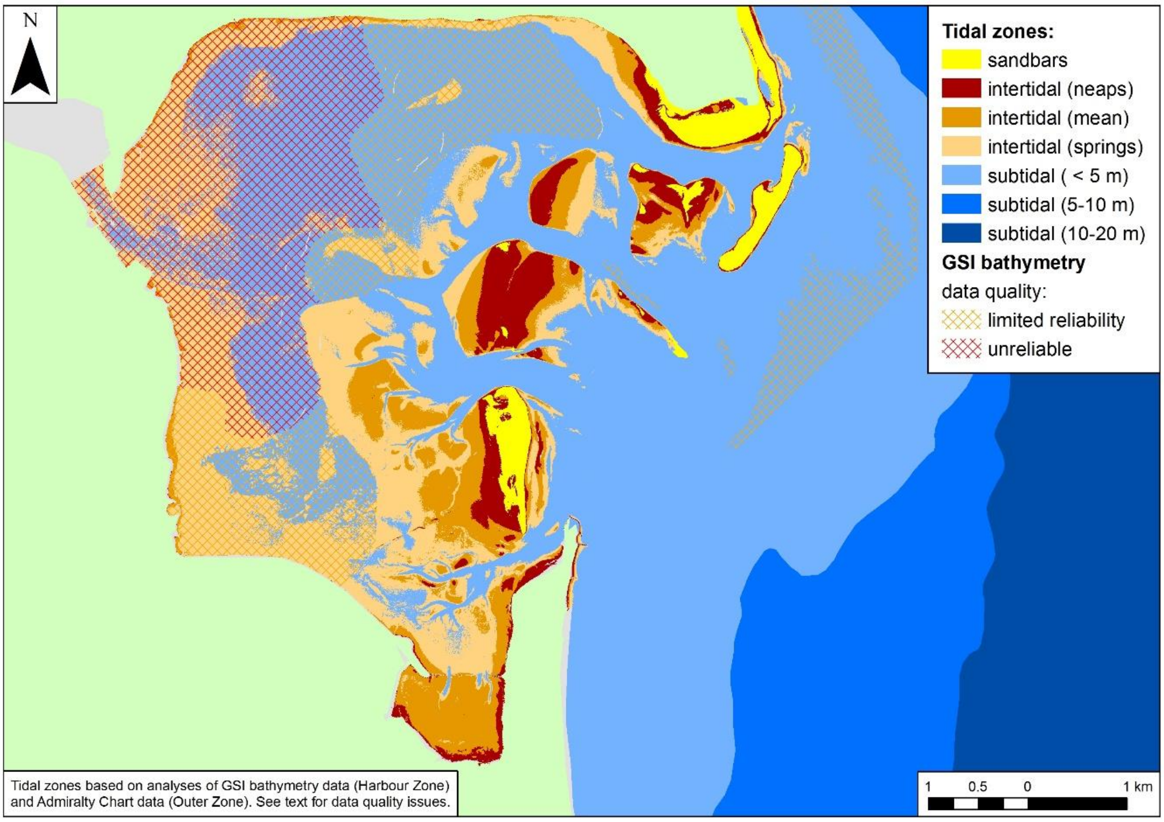


Figure 5.2 - Tidal zones in the Harbour Zone in relation to data quality.

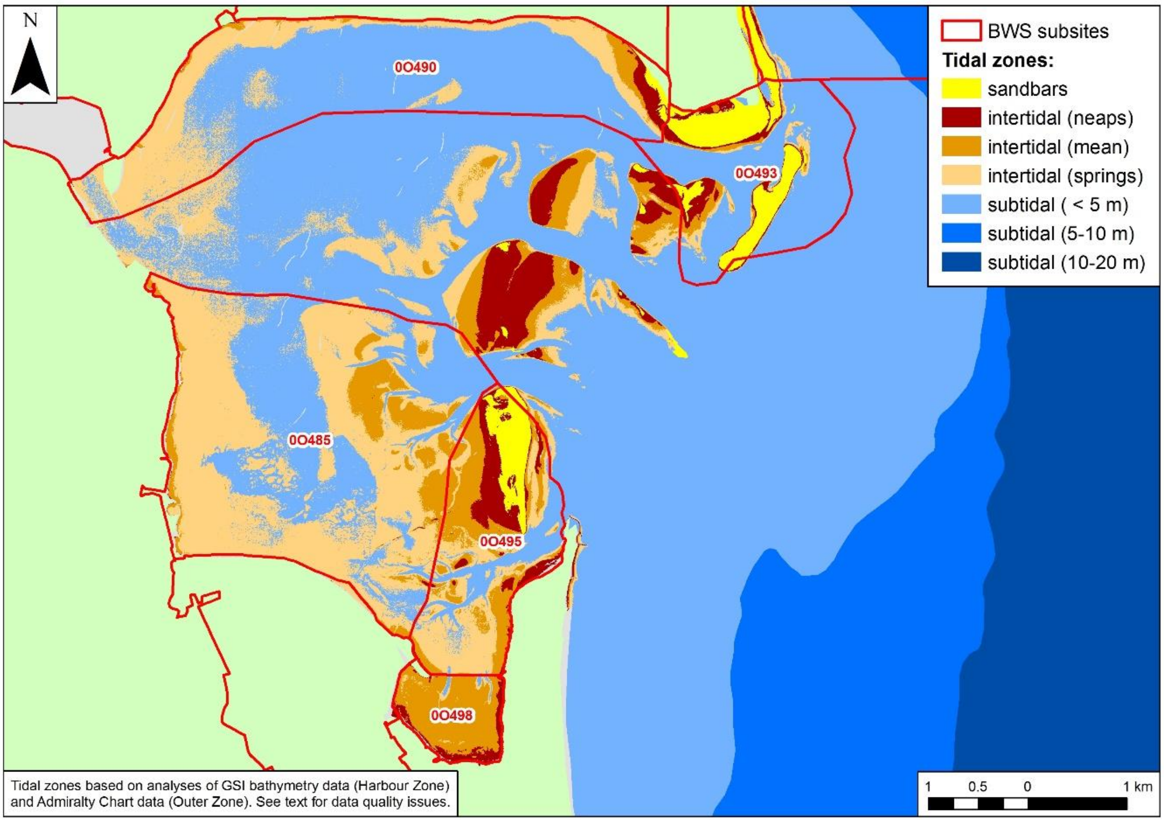


Figure 5.3 - Tidal zones in the Harbour Zone in relation to subsite distribution.

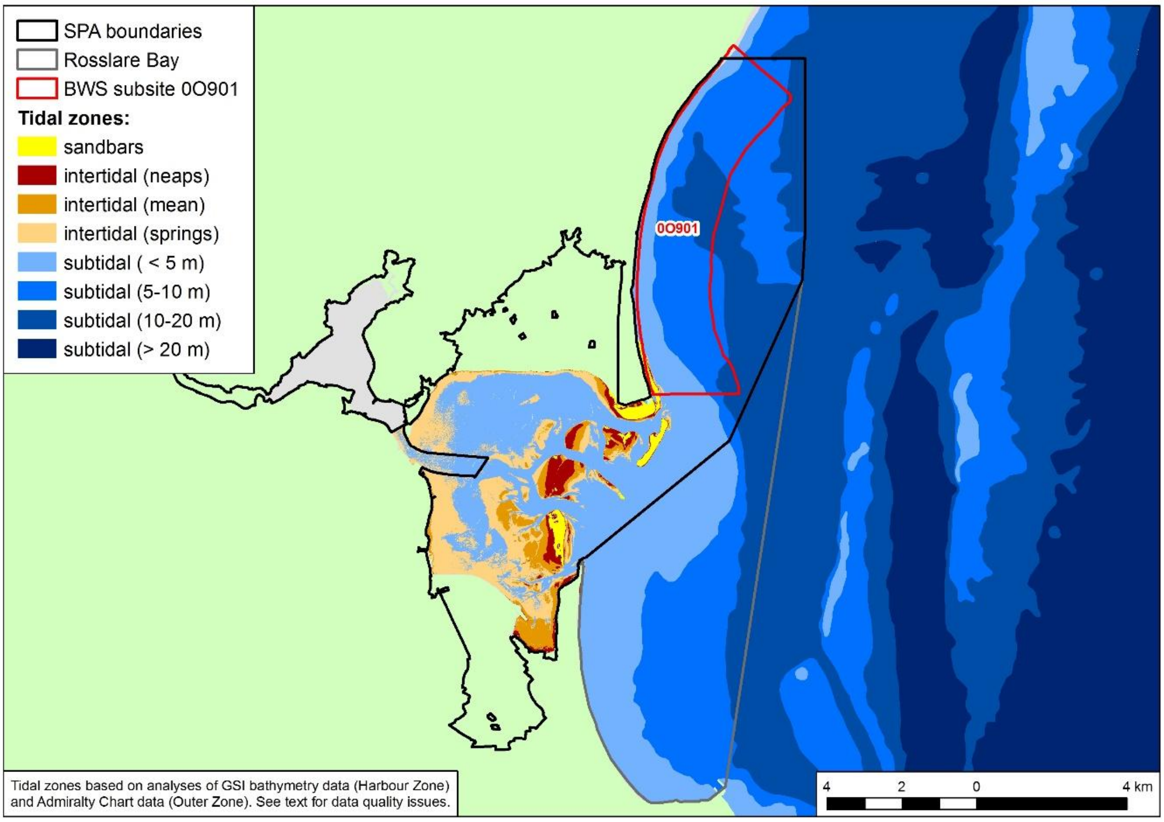


Figure 5.4 - Tidal zones in the Outer Zone.

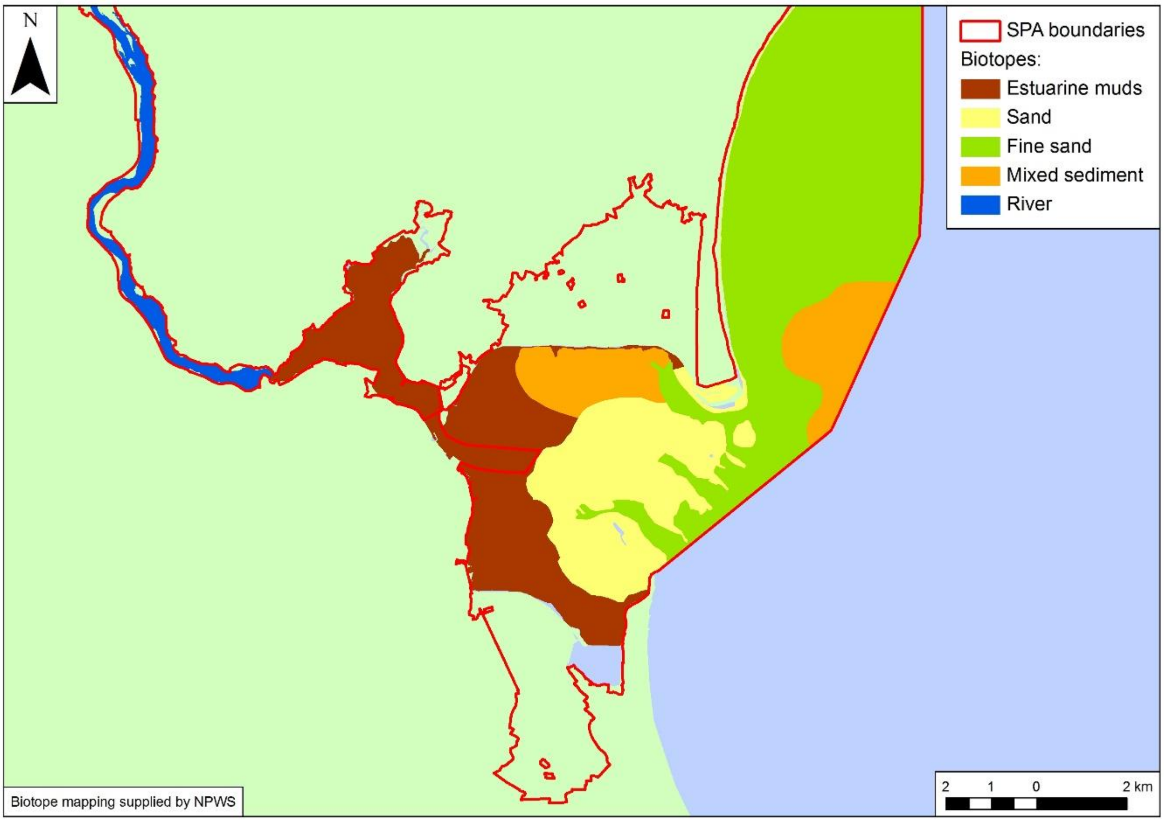


Figure 5.5 - Biotope distribution in the Wexford Harbour and Slobs and the Raven SPAs.

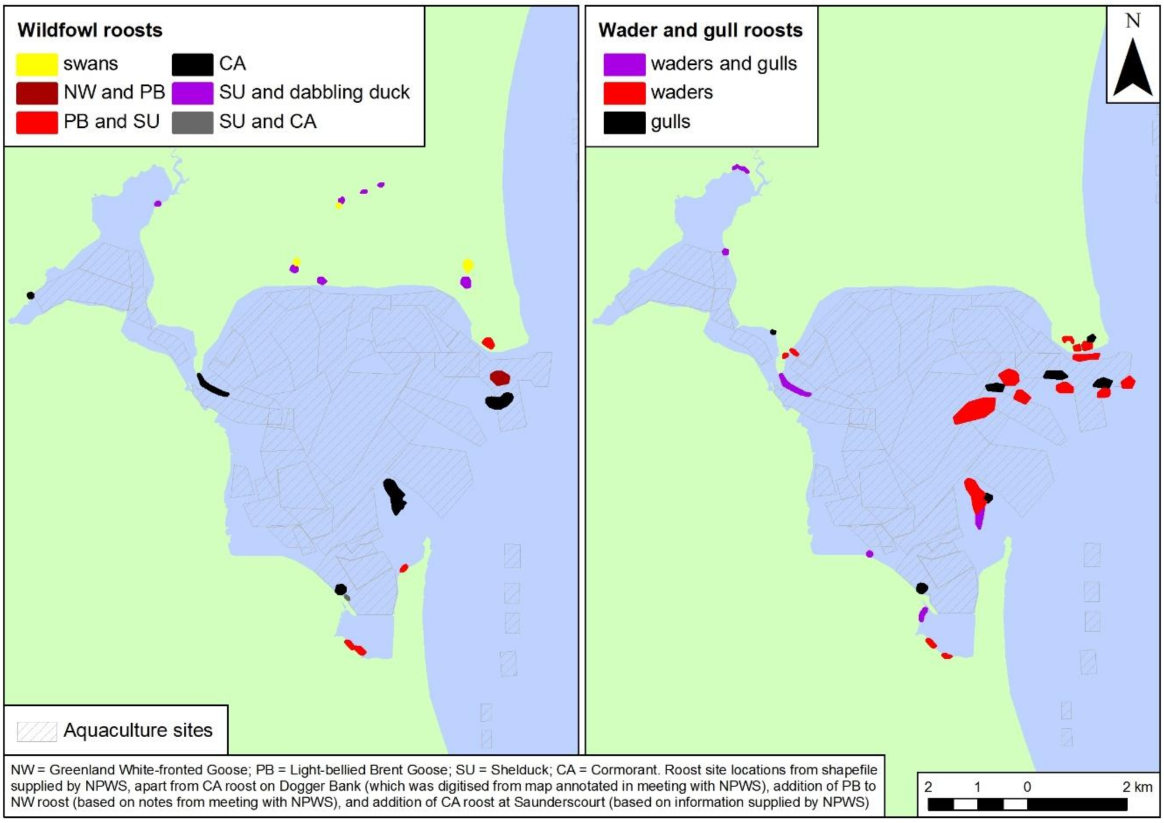


Figure 5.6 - Roost site locations.

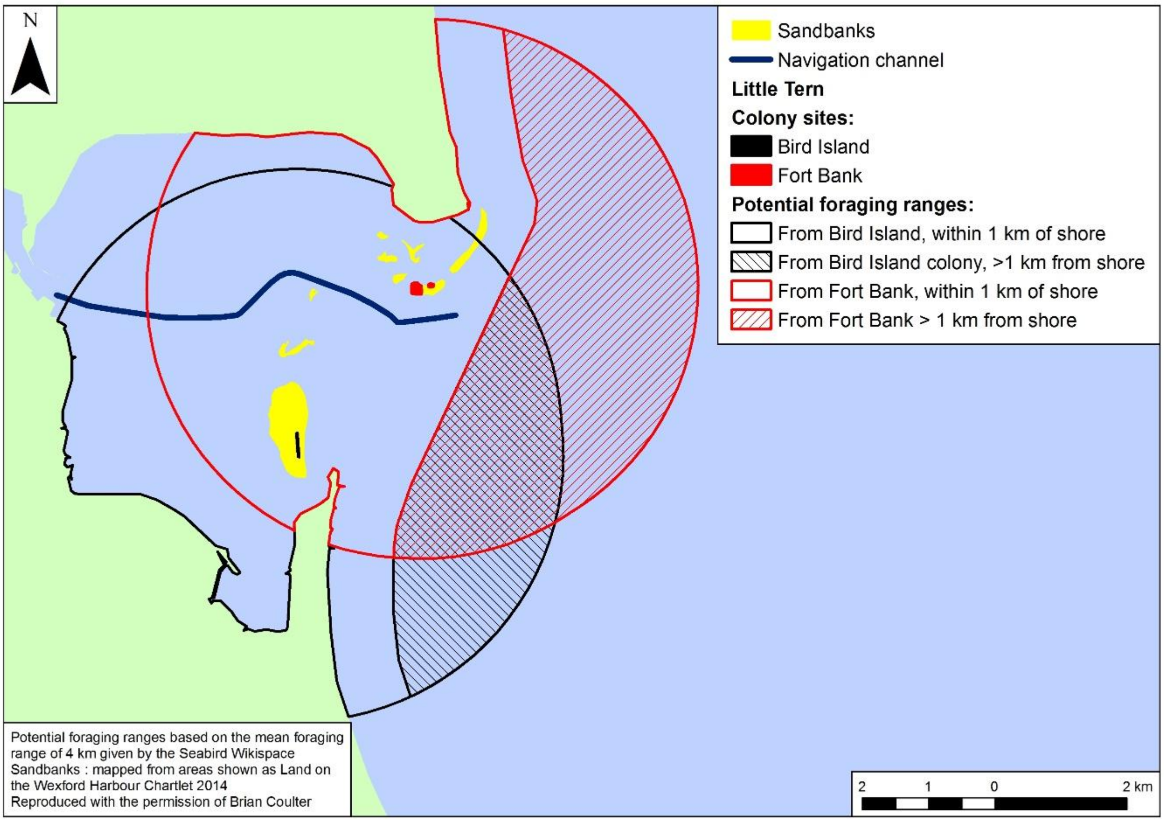


Figure 5.7 - Little Tern colony locations and potential foraging ranges.

6. Bottom mussel cultivation

Scope of activity

6.1 There are 30 currently licensed sites, which are being considered for renewal, for bottom mussel cultivation included in this assessment, covering a total area of 1472 ha (Figure 6.1).

6.2 There are an additional 18 applications for bottom mussel cultivation included in this assessment, covering a total area of 1040 ha (Figure 6.1).

6.3 Three renewal sites, covering a total area of 100 ha, and two application sites, covering a total area of 131 ha, are within the Ferrycarrig Zone. The remainder of the sites are all within the Harbour Zone.

6.4 Mussel cultivation in all of the renewal sites, and most of the application sites, will involve relay of seed mussel from outside Wexford Harbour and harvesting of the ongrown mussels by large dredgers. This is referred to hereafter as the *standard method*.

6.5 Mussel cultivation in four of the applications will involve non-standard methods: -

- Relay of seed mussels from natural settlement within the harbour and harvesting of the ongrown mussels by hand dredging from a cot (referred to as the *seed collection method* hereafter).
- Relay of seed mussel from outside Wexford Harbour and harvesting of the ongrown mussels by dredging from a flat bottom oyster barge boat (referred to as the *oyster boat method* hereafter).

6.6 It is known that one operator is not currently active. This operator has five licensed sites; including one site in the Ferrycarrig Zone, covering a total area of 217 ha (Figure 6.2). It is understood that this operator has not been active since 2008.

Description of activity

Standard method

6.7 The following description is based on the aquaculture profile (O'Loan, 2015), additional information supplied by Brian O'Loan (BIM), and responses from the operators to specific questions, unless otherwise stated. Information referred to from the UISCE stock assessment is limited to that quoted in the aquaculture profile; we were not provide with access to data, or documents, from this assessment.

6.8 Bottom mussel cultivation in Wexford Harbour involves the ongrowing of seed mussels for a period of between 1-2 years. While some of the bottom mussel sites occupy extensive areas of intertidal habitat, in practice all bottom mussel cultivation occurs in subtidal waters (below the mean low water spring tide level). **For the purposes of this assessment it is assumed that no bottom mussel cultivation will take place in the intertidal zone (above the mean low water spring tide level)**.

6.9 All sites mapped in Figure 6.1 may be used, although only a proportion of the total subtidal area within these sites will be used in any one year. The sites in the Ferrycarrig Zone are typically only used in years when there is good seed supply.

Seed mussel relay

6.10 Most of the seed mussels are sourced from the Irish Sea seed mussel fishery. This fishery has been subject to an Article 6 Assessment (Marine Institute, 2013) and is not considered further here. In poor seed years, seed intake may be supplemented by rope seed from Ireland or bottom dredged/hand raked seed from Morecambe Bay. In the future, seed may also be supplied by the suspended mussel cultivation sites in the Raven SPA and Rosslare Bay (see Section 8).

6.11 The size range of seed mussels used for relay in Wexford Harbour is 15-40 mm but the preferred range is 25-35 mm.

6.12 The seed mussel is usually relaid within the sites in Wexford Harbour on the same day as it is fished. The timing of the relay is, therefore, dependent upon the opening of the seed beds. The latter varies, and is dependent on discovery of the seed bed, condition of the seed bed and tidal windows. The main seed fishery periods appear to be spring/early summer (April-June) and early autumn (August/September) and there have been seed fisheries in each of those periods in six of the last nine years (Table 6.1).

6.13 The stocking density of seed mussel within the sites in Wexford Harbour varies across each producer and is site dependent. At present the seed stocking density ranges from 10-60 tonnes/ha. According to the aquaculture profile, the average is around 30 tonnes/ha, while the UISCE stock assessment (as quoted in the aquaculture profile) reported an average of 25.7 tonnes/ha.

6.14 Within each site, the seed will usually be relayed into discrete plots. Therefore, the relayed seed will typically not cover an entire site.

6.15 The seed mussel relay will typically extend over a period of 2-3 weeks, although in a good year this may extend up to 30 days. The seed mussel relay is carried out by the six dredgers based in Wexford Harbour, and up to five additional dredgers may also be hired. The boats travel at a typical speed of 2-3 knots while relaying. Relaying of seed mussels from the hold is done by water jet through holes in the side of vessel.

Table 6.1 - Opening dates for the Irish Sea seed mussel fishery.

Year	Opening date	Area opened	Source
2014	18 August		S.I. No. 386/2014
2013	12 September		S.I. No. 352/2013
2012	12 May		S.I. No. 154/2012
2011	09 May		S.I. No. 204/2011
2010	04 May		S.I. No. 174/2010
	30 August		S.I. No. 413/2010
2009	30 April		S.I. No. 150/2009
	26 August		S.I. No. 341/2009
2008	09 June		S.I. No. 162/2008
2007	20 August	Blackwater Bank	S.I. No. 589/2007
	20 August	south of Blackwater Point	S.I. No. 589/2007
	05 September	All waters except UISCE project	S.I. No. 641/2007
	15 October	UISCE project	S.I. No. 693/2007
	06 June		S.I. No. 213/2007
2006	21 September	off Wicklow Head and Lambay	S.I. No. 495/2006
	31 August	off Carnsore Point	S.I. No. 466/2006
	31 August	off Cahore Point	S.I. No. 465/2006

Ongrowing period

6.16 The growth rate on mussel seed after relaying can vary considerably, depending upon the water temperature, feeding availability and tidal flow. Typical growth rates can vary from 0.5-1.5 mm per month, with up to 3 mm/month when conditions are good. The highest growth rates occur during the summer (May-August/September).

6.17 During the ongrowing period, sampling occurs to keep a track on the progression of the stock quality. This takes place on 1 day/month (three operators), 1-2 days/month (two operators), or 1 day/4-6 weeks (one operator); one operator (with applications only) does not plan to sample for stock quality. The dredgers are used for this sampling.

6.18 Some producers move stock between sites during the ongrowing period. For example, they may have ground that is good for fattening and will move stock to finish on such grounds. However, not all producers do this. Four operators move stock, while a fifth may rarely do so. Information was provided about the timing of stock movements by three of the operators who regularly move stock. The stock movements usually take place in the first half of the year: February-June (one operator) and March-April/May (two operators). The movements can take up to 15-20 days, with each session lasting 3-6 hours. We have assumed that the stock movements will be subject to the same tidal restrictions as harvesting (see paragraph 6.24).

6.19 During the ongrowing period, stock may be fished for starfish although not all producers do this. Starfish are generally confined to the outer sections of the harbour closer to the Raven Point and are fished by starfish mopping using the dredgers. Starfish mopping does not take place in the sites within the Ferrycarrig Zone. Two operators (one with application sites only) may regularly carry out starfish mopping, while the other operators indicated that they rarely needed to do so (only in occasional years with a "*starfish problem*"). Starfish mopping may take place from November-March, on 2-4 days/week. A single session may last 4-6 hours and the dredgers travel at a typical speed of 2-3 knots while starfish mopping.

6.20 Crab potting for green crab regularly takes place on five bottom mussel culture sites, covering a total area of 184 ha, while an additional ten sites, covering a total area of 490 ha, are sometimes used (Figure 6.3). For one fisherman, the peak months are April-June, with a slack period from mid-December to mid-March. The other fisherman may fish all year round, but in the most recent year, fishing only took place from November to March. Fishing normally takes place 5 days/week, weather permitting, reducing to 2-3 days/week during slack periods. A single session normally lasts 5-6 hours. One of the fishermen avoids the low tide period, while the other fisherman does not have any tidal restrictions. The crab potters use small inshore potting vessels (Le Seb Wen and Shadane; Table 6.5). The boats travel at speeds of 7-8 knots while travelling to/from the sites, and at 3 knots while fishing.

Harvesting

6.21 The mussels are harvested 12-24 months after the seed relay (average 18 months). However the time on the relay plot can depend on the productivity of the individual plot within the licensed site, stock level from the previous year, the progression of sales from the previous year's stock, the progression of sales of the current year's stock, the market price and demand and the fluctuations of meat yield levels. At the time of harvesting the size of the mussels can vary from 40-70 mm.

6.22 The peak harvesting season is probably from September to December, but the seasonal pattern of harvesting can vary from year to year, depending upon the timing of the seed relay the previous years, the growth of the mussels and market conditions. The available information of the timing and intensity of harvesting activity is summarised in Table 6.2.

6.23 The duration of each fishing trip will depend partly upon tidal restrictions (see below). In addition, the fishing periods will generally be longer later in the season when it will take longer to achieve the required catch. The available information on the duration of each fishing trip is summarised in Table 6.3.

6.24 Access to tidally restricted sites usually happens between half flood to half ebb where the tidal restriction is 3 hours either side of high tide and for some sites the restriction is greater (1.5 hours before and after high tide). Dredgers do not access sites at low water unless the site is a deep site such as in parts of Wexford Inner Harbour and along the main channel from the bridge down to the end of the training walls.

6.25 During harvesting the dredgers move slowly over the plots (at a speed of 2-3 knots) with dredges trailing about 30 m behind. Dredges do not dig deep into the seabed but rather lift the mussels up off the layer of pseudofaeces that the mussels sit on. Harvesting also has the function of cleaning the plots. After harvesting, the plot that has been harvested will typically be largely bare of mussels, although some operators may return small mussels to the bed for ongrowing. However, other plots within the licenced site may have stock remaining on them.

6.26 The area fished each day varies between operators and across the season. At the beginning of the season, the area fished ranges from 1-6 ha, increasing to up to 60 ha by the end of the season (Table 6.4).

Boats

6.27 Of the eight companies and one sole trader that currently have renewal applications in place, there are six functioning dredgers within the harbour. They are the Edenvale, the Enterprise I, the Hibernia, Cecilia, Laura Anne and Branding (Table 6.5). The number of meters of dredge per boat ranges from 7 m to 14 m (average 9 m). All except one dredger have four dredges operated off the sides. The drafts range from 0.75 m unladen to 2 m laden with an average unladen draft of 1.04 m and an average laden draft of 1.58 m.

6.28 The currently inactive operator does not have a dredger and it is not known what arrangements he would make in the event that he resumed activity.

6.29 There is also one applicant for new sites who has no renewal applications. He does not have a dredger at present and it is it is not known what arrangements he would make in the event that he is granted his applications.

Table 6.2 - Information provided on intensity of mussel harvesting activity.

Source	Details
Aquaculture profile	Most harvesting is done from September to April with many operators finished up by Christmas. Some harvesting can also be done during the summer months also depending on the market. The slack time is normally February to June.
BIM	Harvesting activity could be 5-6 days/week, if stock is there, from September onwards. Some markets are post-Christmas also.
Operator 1	In a typical year, harvesting for 3-4 days/week for a period of four months, with the harvesting period starting anytime during September-December.
Operator 2	Good year: 4-5 days per week during August-December (but not every week), with no harvesting activity after December. Poor year: 1-2 days per week during August-April.
Operator 3	September-March: 18 trips/month. March-July: 10 trips/month. July-September: 15 trips a month.
Operator 4	Harvesting may extend from July-March, or when the mussel bed is exhausted and harvesting intensity may involve 6-7 days/week over a considerable period.
Operator 5	Harvesting periods vary from year to year: e.g., July-October, October-March, December-April. May harvest 7 days/week if sufficient stock.
Operator 6	Harvest season usually from September-March but may finish by December, harvesting 2-3 days/week, or 4 days/week in a busy season.
Operator 7 (applicant only)	No response - may indicate agreement with the BIM response.
Operator 8 (inactive operator)	No response.

This information is summarised from responses to specific questions sent to BIM and the operators.

Table 6.3 - Information provided on the duration of mussel harvesting sessions.

Source	Details
Operator 1	3-6 hours; during first 4-6 weeks of harvest max 3 hours
Operator 2	1.5-2 hours; may be 4-5 hours at end of the season
Operator 3	4 hours
Operator 4	July-September: 2-4 hours October-December: 4-6 hours January-March: 8-20 hours
Operator 5	4 hours total (2 hours fishing); up to 6 hours at end of the season
Operator 6	4-8 hours, depending on tides and mussel density
Operator 7 (applicant only)	No response
Operator 8 (inactive operator)	No response

This information is summarised from responses to specific questions sent to the operators.

Table 6.4 - Information provided on the area fished during each mussel harvesting session.

Source	Details
Operator 1	Mostly 4-6 ha; may fish 8-12 ha if fishing two plots.
Operator 2	Fishing activity generally carried out over 3 ha: 2 ha fished plus 1 ha to allow for turning, etc.
Operator 3	9 ha plots with 3 ha fished per day; the whole 9 ha plot may be fished at the end of the season.
Operator 4	1-2 ha initially, 12-15 ha mid-season and 40-60 ha at the end of the season; but can extend to 20-40 ha even at the beginning of the season.
Operator 5	2-3 ha; 20-30 ha finishing up.
Operator 6	4-6 ha (depending on quantity & seed size relayed).
Operator 7 (applicant only)	No response
Operator 8 (inactive operator)	No response

This information is summarised from responses to specific questions sent to the operators.

Table 6.5 - Boats used in bottom mussel culture (standard method) in Wexford Harbour.

Use	Vessel Name	Code	Overall length (m)	Gross tons	Engine power (hp)
Seed relay, mussel dredging and starfish fishing	Branding	WD4A	35.14	187	520
	Cecilia	WD239A	36	176	742
	Edenvale	WD218A	40	329	714
	Enterprise I	WD137	32.18	128	403
	Hibernia	WD227A	45.44	420	734
	Laura Anne	WD192A	27.84	109	349
Additional boats for seed relay	Eben Haezer	WD188A	32.55	144	522
	Western Adventure II	T87A	32	128	409
	Wings of the Morning	WD210A	44.65	487	662
Crab fishing	Le Seb Wen	WD279A	11.92	4.5	84.5
	Shadane	WD269	9.68	3.98	22.36

Source: Irish Fleet Register 16-02-2015
www.agriculture.gov.ie/media/migration/fisheries/seafisheries/seafisheriesadministration/

Seed collection method

6.30 The following description is based on notes of an interview with the operator, provided by Brian O'Loan (BIM).

6.31 There are applications for two sites using this method: -

- T03/93A, which is a small site (2.1 ha) at the end of the south training wall, used for seed collection only.
- T03/93B, which is a larger site (117 ha) in the Rosslare Back Strand area, used for seed collection and ongrowing.

6.32 The applicant previously carried out this activity, without any licence, in these areas, and is believed to have been active in these sites until 2013. According to the applicant, many years ago 16 cots operated in the area of the T03/93B site, collecting subtidal and intertidal seed annually.

6.33 This method involves identifying natural intertidal mussel settlement within the sites and relocating the seed mussels to positions where they will be subtidal, while natural seed settlement within subtidal areas in site T03/93B will also be exploited. At site T03/93A, seed mussel will be collected from the training wall and brought to site T03/93B. At site T03/93B, naturally settled mussel patches in the intertidal zone will be dredged into subtidal positions. This will be mainly carried out by dredging from a boat, but on occasions, spronging (raking) will be required. Apart from the raked areas, intertidal mussel patches will be marked by buoys and will be dredged when the tide comes in. Therefore, all ongrowing, and harvesting, of mussels will be carried out in site T03/93B.

6.34 The applicant aims to collect 20 tonnes/year of seed mussel from sites T03/93A and T03/93B. The seed mussel will normally be at least 30 mm when collected.

6.35 The intertidal seed mussel patches will be identified, and moved to the subtidal positions, in April-May. There will be an 18 month growing out period and the mussels will usually be harvested between April and September.

6.36 The applicant aims to harvest 1.5-3 tonnes per week, and a total of 80 tonnes per year, but harvesting is highly dependent on the weather. During the main harvesting period (April-September), harvesting could be carried out on four tides per week, if growth and market conditions are correct. However, fishing during good weather in winter may be required if sales have been delayed due to slow growth or poor prices. Winter access can vary from zero to a maximum of three tides per week, depending on the above factors. In total, it is anticipated that the site would be accessed between about 104 to 182 days per year.

6.37 Seed collection and harvesting is carried out over the high tide period (between the mid-flood to mid-ebb tides). The only activity that will be carried out at low tide is marking of the seed mussel patches. No night-time fishing is done.

6.38 The seed collection (apart from raking) and harvesting is carried out by dredging from a 7.9 m cot with an outboard motor. This has a 0.5 m draft when fully loaded. It can carry 2 tonnes but the maximum harvest on a single trip would normally be 750 kg.

6.39 Dredging will be carried out by hand, using a single dredge 1.2 m wide dredge. During harvesting, the catch is passed over a griddle attached to the side of boat and seed mussel passes back onto the bed.

6.40 The harvested mussels will be brought to the southern limit of T03/93B close to an old wall where the mussels will be bagged. The boat may be landed at two locations just to the east of this depending on tides.

6.41 The site will be cleaned through the action of fishing only and there will be no predator control.

Oyster boat method

6.42 The following description is based on notes of an interview with the operator, provided by Brian O'Loan (BIM), and responses from the operator to specific questions, unless otherwise stated

6.43 There are applications for two sites using this method: -

- T03/80A, which is 44 ha in extent and is located in the Rosslare Back Strand area.
- T03/80B, which is 63 ha in extent and is located further north, to the east of Bird Island.

6.44 The applicant will mainly use mussel seed from the Irish Sea and is targeting a relay density of 10 tonnes/ha, with a total of 100 tonnes, or 10 ha, relaid per year. However, according to the applicant, there may be occasions when half-grown mussels will have to be used (the source of this stock is not known).

6.45 The seed relay will take place over ten days at a rate of 10 tonnes/day. The seed relay will probably take place during October/November, but this timing will depend upon when the seed becomes available.

6.46 All mussel relay will take place in subtidal waters: i.e., below the mean low water spring tide level.

6.47 Small seed will require 18 months to ongrow before harvesting, while half-grown mussels will require 11 months. The sites will be split in two to manage separate cohorts of year classes.

6.48 The main harvesting period will be July-September, with September being the optimum time for harvesting. The harvesting will take place over a period of 20-30 days. Harvesting will be carried out by dredging, although there may be some limited use of spronging (raking).

6.49 Seed mussel relay and harvesting will be carried out using a flat bottom oyster barge boat with a single 1 m wide dredge. However, it is possible that two dredges may be used in the future. The boat is 10.9 m long 4 m wide, with a 0.6 m draft and has a diesel hydraulic drive with propeller.

6.50 Seed mussel relay and harvesting will be carried out during the eight hour period centred on high tide. The sites will be accessed from Ferrybank Quay. No seed mussel relay or harvesting will be carried out in hours of darkness.

6.51 The sites will be cleaned through the action of fishing only and there will be no predator control.

Scale of the activity

Production levels

Data quality

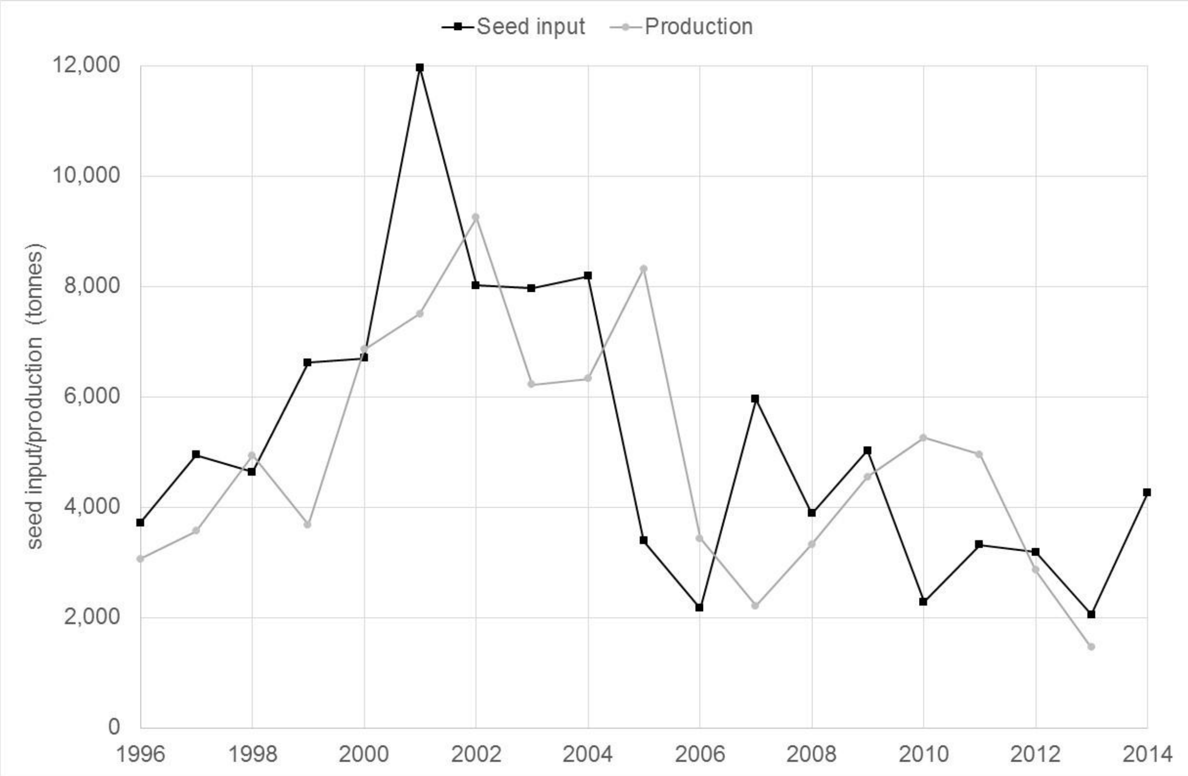
6.52 Data on seed mussel input and mussel production in Wexford Harbour over the period 1996-2014 has been collated by BIM. The production trend shows a 1-2 year lag behind the seed mussel input trend, reflecting the length of the ongrowing period (Text Figure 6.1). In fact the mussel production in any one year shows a very strong correlation with seed mussel input the previous year, with the exception of three outliers (Text Figure 6.2).

6.53 However, for the years 2006 and 2007, it should be noted that there is a very large discrepancy between the seed mussel input figures in the data collated by BIM (8120 tonnes for the two years) compared to the seed mussel input figures reported from the UISCE project (13,240 tonnes; as reported by the aquaculture profile, which was also prepared by BIM). The strong correlation between seed mussel input and total mussel production suggests that the data collated by BIM provides a reliable indication of trends in mussel production, while the discrepancy with the UISCE data suggests that the data collated by BIM may underestimate the absolute levels of mussel production.

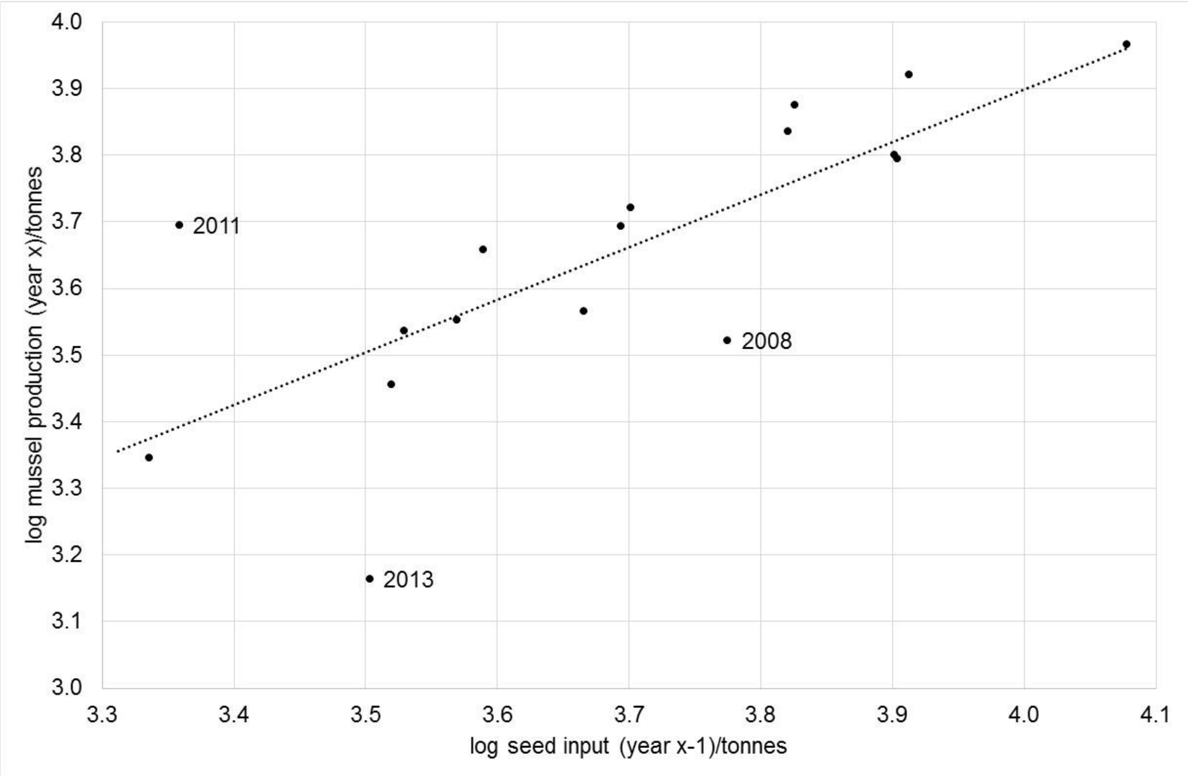
Trends

6.54 During the period 1996-2014, the reported seed input varied from around 2,000-12,000 tonnes, while the reported production has varied from around 1,500-9,000 tonnes. The trends indicate high levels of bottom mussel culture activity in the early 2000s, with lower levels since around 2006.

6.55 If all the applications for renewals and licences are granted, the total area licenced for mussel bottom culture will increase by 70%. If it is assumed that the peak production levels of 6,000-9,000 tonnes in the early 2000s represent the maximum potential utilisation of the renewal sites, and the overall intensity of use in the application sites will be the same as the renewal sites, then the total production levels could increase to around 10,000-16,000 tonnes.



Text Figure 6.1 - Seed input and mussel production in Wexford Harbour, 1996-2014 (data supplied by John Dennis, BIM).



Text Figure 6.2 - Relationship between mussel production and the seed mussel input the previous year in Wexford Harbour, 1997-2014 (analysed from data supplied by John Dennis, BIM)

Spatial extent

6.56 The overall areas occupied by the bottom mussel sites are shown in Table 6.6. The areas of intertidal habitat occupied by these sites are shown for completeness, but these areas will not be used. Therefore, all further analyses only refer to the figures for subtidal habitat. The renewal sites occupy: 29% of the subtidal habitat and 18% of all tidal habitat, within the Ferrycarrig Zone: and 58% of the subtidal habitat, and 35% of all tidal habitat, within the Harbour Zone. The applications for new sites would increase the area of subtidal habitat farmed by the standard method to: 50% of the subtidal habitat, and 31% of all tidal habitat within the Ferrycarrig Zone; and 85% of the subtidal habitat, and 52% of all tidal habitat, within the Harbour Zone. It should be noted that the figures for the Ferrycarrig Zone overestimate the potentially active area of the bottom mussel sites, as the subtidal zone defined for the Ferrycarrig Zone includes areas exposed on spring low tides. Furthermore, the exact areas occupied by the tidal zones in the Harbour Zone are likely to vary from year to year due to the mobile intertidal banks.

6.57 Only a proportion of the subtidal area within the bottom mussel sites will be utilised at any one time. This area will represent the area relaid within the past two years, minus the area that has been harvested.

6.58 A stock assessment, carried out as part of a BIM project (UISCE), showed that there were 13,241 tonnes of seed relayed in 2006 and 2007 over a total area of 515 ha giving an average stocking density of 25.7 tonnes/ha (O'Loan, 2014). 515 ha is around 45% of the subtidal area that was licensed at this time (assuming that the relative distribution of intertidal and subtidal habitat in 2006-2007 was similar to that in 2011).

6.59 The current mussel seed allocation for the companies with their existing ground is 9210 tonnes from the east coast seed beds. Apart from 2001, this figure would be higher than any recorded seed mussel input (but note that the recorded seed mussel input may underestimate the overall seed mussel input; see paragraph 6.53). Assuming the same stocking rate as above, this would imply a maximum utilised area of 717 ha over two years. The projected percentages of tidal habitat occupied in the Ferrycarrig and Harbour Zones (assuming that the relay is distributed between the two zones in proportion to the available area, and that the allocation is increased proportionately if the applications are licensed) is shown in Table 6.7.

6.60 Within the areas where mussels are relaid, the actual cover of mussels is substantially less than 100%. Examples of four plots where clear imagery of the mussel cover is available are shown in Table 6.8. This shows that the typical relay densities usually produce mussel cover of less than 50%.

Table 6.6 - Areas occupied by bottom mussel renewal and application sites.

Zone	Tidal category	Total area	Bottom mussel sites		
			Renewals only	Renewals and Applications	
				standard	standard and non-standard
FERRY	Intertidal	193 ha	7 ha	54 ha	54 ha
	Subtidal	324 ha	94 ha	162 ha	162 ha
HARBOUR	Intertidal	1188 ha	314 ha	511 ha	668 ha
	Subtidal	1823 ha	1054 ha	1557 ha	1625 ha

Note that, because of the nature of the available data, in the FERRY zone the area between the mean and neap spring low tides is included in the subtidal category, while in the HARBOUR zone this area is included in the intertidal category. See paragraphs 2.16-2.26 for details of derivations, and interpretations, of tidal categories.

Table 6.7 - Projected areas occupied by mussels after two years of relay at the maximum current seed allocation.

Category	Zone	% of available subtidal habitat	area occupied	% of habitat occupied	
				% of subtidal	% tidal
renewals	FERRY	8%	59 ha	18%	11%
	HARBOUR	92%	658 ha	36%	22%
renewals and applications	FERRY	14%	101 ha	31%	20%
	HARBOUR	86%	972 ha	53%	32%

Projections assume that the relay is distributed between the two zones in proportion to the available area.

Table 6.8 - Mussel cover in selected plots in relation to relay date and tonnage.

Site	Date of imagery	Mussel cover	Relay date	Details
47A	06/11/2011	< 50%	Sep 2011	300 tonnes in Nov 2011. 400 tonnes harvested in 2012
49B (1)	06/11/2011	50-75%	Sep 2011	6 ha relaid with 204 tonnes (34 tonnes/ha)
49B (2)	06/11/2011	< 50%	Sep 2011	9 ha relaid with 250 tonnes (28 tonnes/ha)
55F&C	21/06/2010	< 50%	unknown	35 ha relaid with 550 tonnes (15 tonnes/ha)

Imagery sources: 21/06/2010, image used for GSI bathymetry map of Wexford Harbour; 06/11/2011, current image for Bing aerial photo of Wexford. Mussel cover was estimated visually.

Boat activity

Summary of activity levels

6.61 There are six dredgers based in Wexford Harbour that are currently used for seed mussel relay and mussel dredging. In addition, some of these dredgers are also used for starfish fishing. There are two operators with applications for renewal sites and/or new sites, who are not currently active, and who have not specified their plans in the event that they start/resume activity. Therefore, it is possible that another two dredgers may become active in Wexford Harbour. In addition there are two boats that are used for crab potting in the bottom mussel sites, and two small boats that will be used in the seed collection and oyster boat sites. Therefore, the total number of boats associated with mussel bottom culture in Wexford Harbour is currently eight (six dredgers and two small inshore potting vessels), while an additional four boats (two dredgers, an oyster barge boat and a cot) could become active in the event that all the applications for renewal and new sites are granted. In addition, during the seed mussel relay period, another five dredgers could be brought in to the harbour. For example, in 2013 and 2014, eleven boats were present during the first few days of the relay period (source: information provided by one of the operators).

6.62 The typical patterns of boat activity associated with bottom mussel culture in Wexford Harbour are summarised in Table 6.9.

Table 6.9 - Typical patterns of boat activity associated with bottom mussel culture in Wexford Harbour.

Activity	Number of boats	Type	Seasonal patterns	Trip durations
Seed relay	11	Dredgers	Apr-Jun: 2-3 weeks Aug-Sep: 2-3 weeks	Early season: 1.5-4 hours Late season: 4-8 hours
Mussel dredging	6	Dredgers	All year: 3-7 days/week (peak periods)	Early season: 1.5-4 hours Late season: 4-8 hours
Stock quality sampling	6	Dredgers	All year: 1-2 days/month	Not known
Stock movements	4	Dredgers	Feb-Jun: 15-20 days	Not known
Starfish mopping	2	Dredgers	Nov-Mar: 2-4 days/week	4-6 hours
Seed relay (seed collection sites)	1	Cot	Apr-May	6 hours
Mussel dredging (seed collection sites)	1	Cot	Apr-Sep: 4 days/week Sep-Mar: 0-3 days/week	6 hours
Seed relay (oyster boat sites)	1	Oyster barge	Oct-Nov: 10 days	8 hours
Mussel dredging (oyster boat sites)	1	Oyster barge	Jul-Sep: 20-30 days	8 hours
Crab potting	2	Small inshore potting vessels	All year: 5 days/week	5-6 hours

See text for more details of seasonal patterns of mussel dredging activity. Trip durations for the seed collection sites based on the plots being accessed between the mid-flood and the mid-ebb tides.

Daily boat activity levels

6.63 Because of the variable nature of mussel harvesting activity, and the lack of full access to the vessel tracking data, we have not been able to precisely quantify the timing and intensity of boat activity associated with the bottom mussel culture.

6.64 During the seed mussel relay period (typically August/September) all the dredgers based in Wexford Harbour, plus any additional dredgers brought in, are likely to be out on the water at the same time. Therefore, there could be 11 dredgers active in the harbour at any one time during this period. The main seed fishery periods appear to be spring/early summer (April-June) and early autumn (August/September). In addition, the two small inshore potting vessels, and the boats associated with the seed collection and oyster boat sites could also be active at these times, making a possible maximum of 15 vessels on the water at the same time.

6.65 The information provided by the operators indicates that, outside the seed relay period, the maximum potential activity will be during the September-December period. However, this will not necessarily occur every year (see responses from Operators 2 and 5) and the timing of the start of the harvesting period may vary (see response from Operator 1). Nevertheless, in order to provide some quantitative level of assessment, we have analysed potential levels of boat activity during the October-December period. We have focused on this period because of the overlap between high levels of potential boat activity and high numbers of the most sensitive species (Red-breasted Merganser).

6.66 These analyses include mussel harvesting, stock sampling, crab potting and activity associated with the seed collection operator. The oyster boat operator is not active during this period (apart from a 10 day relay period), and stock movements do not occur during this period, so these activities have not been included. Starfish mopping will only start towards the end of this period, and, if the operators are fishing mussels intensively, levels of starfish mopping activity will presumably be low. Therefore, we have not included this activity in the analysis.

6.67 We have not included Operators 7 and 8 in these analyses, as we have no information about what arrangements they will make for dredging (i.e., whether they will reach an agreement to use the boat of one of the other operators, or have their own boats), nor the pattern of their activity.

6.68 For our analyses, we used the information provided by the operators to estimate the number of days/4 week period for each operator and each activity. The details of the estimates, their sources and any assumptions made are listed in Table 6.10. We carried out Monte Carlo-type simulations to examine the potential frequency distribution of daily boat activity, based on these estimates. These simulations randomly distributed the specified levels of daily activity of each operator across a 28 day period: e.g., in each simulation Operator 1 would be active on 15 days, randomly chosen from the 28 day period, etc. Tidal restrictions may limit activity on certain days, but such restrictions will not apply to all sites. Therefore, we applied a correction factor to days with low tide in the middle of the day (11:00-13:00; n = 5 days). If one of these days was selected, we applied a 50% random factor to determine whether it would be accepted, and if the day was rejected, an alternative day was randomly selected.

6.69 Because of the nature of the simulation, the mean daily activity rate is fixed at 5.9 boats/day. However, it is the distribution of different levels of activity that is of more interest (Text Figure 6.3). The daily boat activity ranges from 1-9 boats/day, with the peak levels at 6-8 boats/day (65% of simulated days). There is also a smaller peak at 2-3 boats/day (18% of simulated days), which reflects the effects of the tidal restrictions.

6.70 If all the applications for renewals and licences are granted, the total area licensed for mussel bottom culture will increase by 70%. This will presumably result in an increase in boat activity. In part this will increase the number of boats (the addition of the oyster barge boat and the cot, and, possibly two additional dredgers). However, the existing active operators also have applications for new sites and will, presumably, have to increase the frequency of their activity if they are to operate these sites on top of their renewal sites. Excluding the inactive operator, the total area of renewal sites is 1255 ha, and the total area of applications for new sites by these operators (excluding overlaps) is 562 ha. Therefore, there will be a 45% increase in the area farmed by these operators, which would suggest a substantial increase in boat activity. None of these operators have any plans to take on additional dredgers (apart from, in some cases, the existing practice of taking on additional dredgers for seed relay). Therefore, the increase in boat activity will presumably be reflected in an increase in the frequency of mussel dredging and associated activities: i.e., each dredger will be out on the water on more days. Therefore, the probability of all six dredgers being out on the water together will increase.

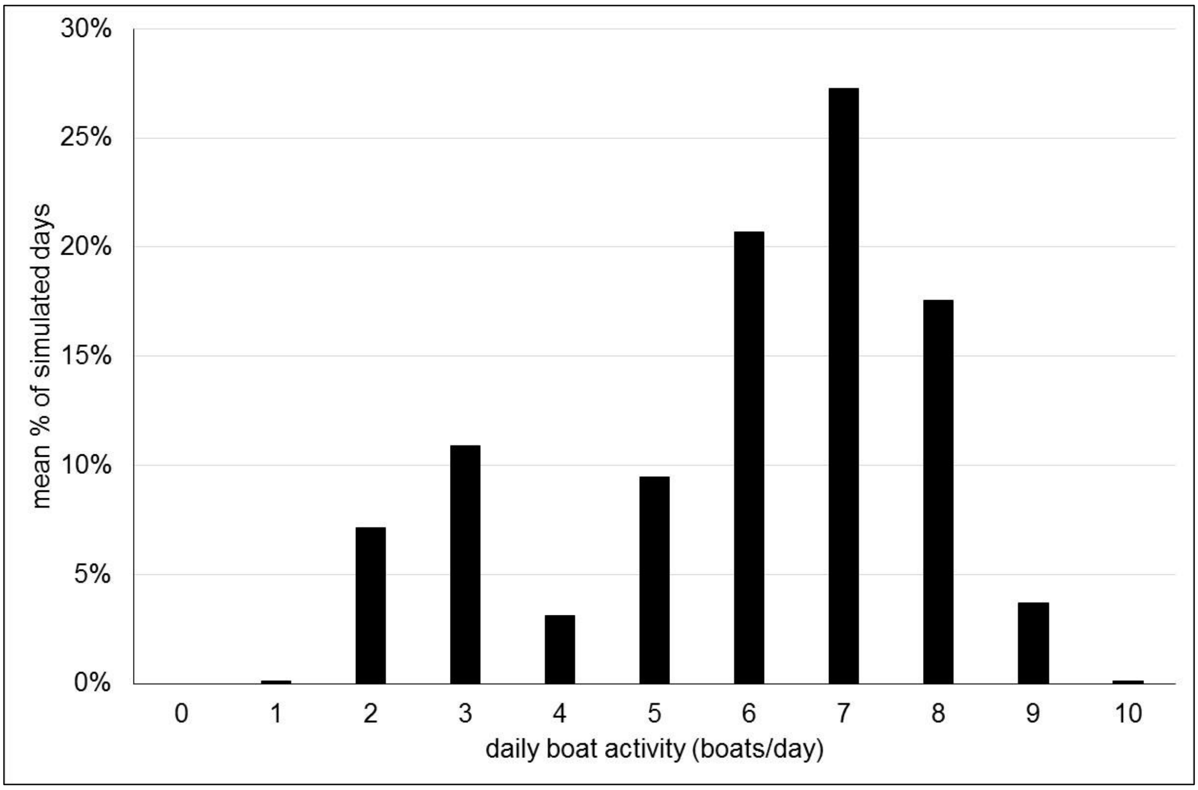
6.71 The sites in the Ferrycarrig Zone are likely to be subject to less intensive activity, compared to the sites in the Harbour Zone as these sites are only used in years of good seed supply, and no starfish mopping takes place in these sites. Therefore, we have assumed that the maximum levels of daily boat activity in Text Figure 6.3 will take place within the Harbour Zone.

6.72 There are five separate operators with sites in the Ferrycarrig Zone. However, due to the low level of activity likely to take place within this zone it is unlikely that more than one dredger will regularly be out on the water at the same time within this zone.

Table 6.10 - Data sources used, and assumptions made, for the analysis of patterns of vessel activity during the October-December period.

Operator	Fishing activity	Stock sampling	Notes
Operator 1	14 days/4 weeks	1 day/4 weeks	3-4 days/week
Operator 2	18 days/4 weeks	1 day/4 weeks	Good year: 4-5 days/week
Operator 3	17 days/4 weeks	1 day/4 weeks	September-March: 18 trips/month
Operator 4	26 days/4 weeks	2 days/4 weeks	6-7 days/week
Operator 5	28 days/4 weeks	0 days/4 weeks	7 days/week
Operator 6	12 days/4 weeks	1 day/4 weeks	Busy season: 4 days/week
Seed collection operator	6 days/4 weeks	-	0-3 days/week
Crab potter 1	20 days/4 weeks	-	5 days/week
Crab potter 2	20 days/4 weeks	-	5 days/week; restricted to week days

See text for further details of data sources and assumptions.



Text Figure 6.3 - Frequency distribution of daily boat activity in simulations of bottom mussel culture-associated boat activity during the October-December period.

Hourly boat activity

6.73 On any one day, the hourly boat activity will depend upon the trip durations and the timings of the trips.

6.74 The duration of each dredging session can vary depending upon tidal restrictions and mussel density. In general, the duration will lengthen across the season as the mussel beds become progressively more fished out. Typical durations are 1.5-4 hours early in the season, to 4-8 hours late in the season, with one operator reporting durations of 8-20 hours in January-March. The mean of the median durations reported by the six operators who provided information was 3.6 hours for the early part of the season (range 1.75-6 hours) and 5.1 hours for the mid/late part of the season (range 4-6 hours)[1]. The operator in the seed collection sites fishes between the mid-ebb and mid-flood tides, indicating a typical trip duration of around six hours. The two crab potters have trip durations of 5-6 hours. The mean trip duration across all ten boats during the October-December period (assuming the mussel dredging trip durations for the early part of the season apply) is 4.1 hours.

6.75 Trip durations will presumably be shortest during periods of peak dredging activity. If all the boats are out at the same time, then there will be high levels of boat activity over a period of up to six hours, but there will be a period of 3-5 hours with no boat activity (Table 6.11). If boat trips are randomly distributed across all daylight hours, the maximum hour boat activity will be lower, but the total boat activity will extend across all daylight hours (Table 6.11). In practise, the true picture will be between these two extremes: tidal restrictions will tend to concentrate boat activity, but not all sites have tidal restrictions, while there are presumably a variety of other factors that can affect the timing of boat activity by individual operators.

6.76 The data in Table 6.11 is presented only to illustrate the possible range of variation in hourly boat activity levels. There are likely to be very few days when all nine boats are out on the same day (see Text Figure 6.2). However, simulation of realistic levels of hourly boat activity levels, taking into account the individual variation in daily boat activity, would be very complex. Therefore, for the purposes of this assessment, we have derived hourly boat activity levels from the simulated daily boat activity levels in Text Figure 6.2 and assuming all boats are out at the same time for a period of 4.1 hours.

Table 6.11 - Simulated patterns of hourly boat activity levels on days of maximum boat activity.

Hours	October		November		December	
	Clustered	Random	Clustered	Random	Clustered	Random
1	9	6	9	6	9	7
2	9	6	9	6	9	6
3	8	6	8	6	8	6
4	6	5	6	5	6	6
5	4	5	4	5	4	5
6	4	3	4	3	4	3
7	0	3	0	3	0	3
8	0	2	0	2	0	2
9	0	2	0	2	0	1
10	0	2	0	1		
11	0	1				

Clustered: all boats out at the same time.

Random: boat trips randomly distributed across all daylight hours (mean values, rounded to integers, across 1000 simulations).

[1] Two of the operators did not report any seasonal variation, so the same values for the early and mid/late parts of the season are used. The 8-20 hours duration reported by one operator for the January-March period is not included in these calculations, as this is an extreme value.

Potential impacts

Ecosystem effects

6.77 Aquaculture could, 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). Any such impacts could potentially reduce the food resources for fish-eating SCI species.

6.78 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). This study found that the modelled system could support a mussel biomass production of 65 tonnes/km^2, "without significantly changing flows and biomass of other components within the system and this may be thought of as an estimate of the ecological carrying capacity". However, Jiang and Gibbs's findings will not be directly applicable to Wexford Harbour, due to differences in the nature of the ecosystems and the cultivation methods, In particular, they note that "*since the culture will be suspended it will compete directly with zooplankton for the resources*", suggesting that bottom mussel culture may have reduced competitive effects on zooplankton. Furthermore, It is also noted that the Jiang and Gibbs's (2005) model is "mass balance (with limited factors) and does not account for residence time and flushing in the bay which can completely dominate any steady-state ecological interaction modelling" (Francis O'Beirn, Marine Institute, pers. comm.).

6.79 Other studies have reported mixed or positive impacts. 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.

6.80 The *Report supporting Appropriate Assessment of Aquaculture in Slaney River Valley SAC* (Marine Institute, 2016) includes a review of the potential ecosystem impacts of aquaculture activities in Wexford Harbour. This report states that "in Wexford Harbour, mussel culture practices result in a mottled distribution of mussels on the seabed forming in a heterogenous habitat structure" and "such a structural arrangement is likely to benefit overall system diversity". Therefore, while "zooplankton and larval fishes which depend on phytoplankton can compete with bivalves" and "mussels have the ability to reduce the abundance of zooplankton by filtering", "any impact on fisheries might be offset by the value of heterogeneous habitats created by mussel patches to fishes". The report concludes that "that bottom mussel culture, at current levels, does likely have a positive role in ecosystem function in terms of nutrient and phytoplankton mediation as well as provision of habitat" and that "the addition of more mussels to the system (with new applications) may have additional benefit in terms of reducing effects of eutrophication, and may further improve status in the outer parts of Wexford Harbour relative to the Lower Slaney waterbody; however, this remains to be determined/confirmed and is subject to availability of additional seed".

6.81 Therefore, in this report, we have based our assessment of potential ecosystem impacts on the conclusions of the SAC assessment (Marine Institute, 2016) and have assumed that potential negative ecosystem impacts, if any, will be offset by positive impacts from habitat alteration (see below). On this basis, we have screened out potential negative ecosystem impacts from any further assessment.

Habitat alteration

6.82 The only activity that will take place in the intertidal zone will be the collection of seed mussels in sites T03/93A and T03/93B. This will remove food resources from the intertidal zone to the subtidal zone, making these food resources inaccessible to waders. In the long-term, it is possible that sustained seed collection could prevent the regeneration of existing intertidal mussel beds.

6.83 Bottom culture of mussels can be disturbing to certain subtidal biotopes, due to extirpation of the characteristic infaunal species from the area covered by mussels, and, in some cases, the sensitivity of characteristic species to organic enrichment, smothering and/or physical disturbance from dredging (Marine Institute, 2012).

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

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

6.86 The aerial imagery analysed above (see Table 6.8), which is considered to be typical of the cultivated mussel beds in Wexford Harbour, shows that the second scenario applies to cultivated mussel beds in Wexford Harbour. Furthermore, the SAC assessment (Marine Institute, 2016) states that: "*in Wexford Harbour, mussel culture practices result in a mottled distribution of mussels on the seabed forming in a heterogenous habitat structure" and that "such a structural arrangement is likely to benefit overall system diversity*" in line with the conclusions of other studies "*that mussel reef systems (on sedimentary habitats), as found in Wexford, enhance habitat heterogeneity and species diversity at the ecosystem level*". Therefore, it can be concluded that bottom culture of mussels is unlikely to reduce food resources for benthic invertebrate eating, and/or fish-eating, species.

Disturbance

6.87 The only potential disturbing activity that will take place in the intertidal zone will be the collection of seed mussels in sites T03/93A and T03/93B. This will take place in April and May, which is outside the main season of occurrence of the wintering waterbird species. Therefore, the only potential impact of this activity will be to the breeding Little Tern population.

6.88 Potentially disturbing activities will take place in the subtidal zone throughout the year. These activities include: dredgers carrying out seed relay, stock sampling, stock movements, mussel harvesting and starfish mopping; small inshore potting boats carrying out crab potting; an oyster barge boat carrying out seed relay and harvesting; and a cot carrying out seed relay and harvesting.

6.89 These activities have the potential to cause disturbance impacts both when the boats are travelling to and from the sites, and when the boats are carrying out husbandry and harvesting activity within the sites. Birds that use subtidal habitats will be most vulnerable to such disturbance impacts, but birds in the intertidal zone and in adjacent terrestrial habitats may also be vulnerable to disturbance impacts if the boats are travelling, or working, close inshore.

Screening

6.90 Bottom mussel culture could potentially cause ecosystem impacts to fish-eating species and species that feed on subtidal benthic invertebrates. Therefore, potential ecosystem impacts are assessed for these species.

6.91 Bottom mussel culture could potentially cause habitat impacts to species that feed on subtidal benthic invertebrates. Therefore, potential habitat impacts are assessed for these species.

6.92 The seed collection method will remove intertidal food resources (mussel seed) that could potentially be consumed by Oystercatcher and Knot. In the long term it is possible that sustained seed collection could prevent the regeneration of existing intertidal mussel beds affecting additional wader species that show a preference for mussel beds (Curlew and Redshank). Therefore, these wader species have been screened-in for assessment of habitat impacts.

6.93 The bottom mussel sites occur within the Ferrycarrig and Harbour Zones. Therefore, all species that regularly occur in these zones are included in the assessment of potential disturbance impacts from bottom mussel culture.

6.94 A number of species that do not regularly occur within the Ferrycarrig and Harbour Zones, may use the Harbour Zone as a disturbance refuge when hunting takes place on the North or South Slobs. These species are also included in the detailed assessment.

6.95 Common Scoter and Red-throated Diver occur almost exclusively within the Raven Zone (means of 99% and 95%, and ranges of 93-100% and 73-100%, of the total counts, respectively). Therefore, these species have been screened out from the detailed assessment.

6.96 Tufted Duck, Little Grebe and Coot mainly occur within the North and South Slobs. They do not regularly occur in significant numbers within the Harbour Zone. There are no direct observations, or evidence, indicating that the birds that occur on the North and South Slobs are affected by disturbance from dredging activity in adjacent areas of the harbour (NPWS). Therefore, these species have been screened out from the detailed assessment

6.97 The species, and potential impacts, screened in for detailed assessment are listed in Table 6.12.

Table 6.12 - Species and potential impacts screened-in for detailed assessment of bottom mussel culture.

Species	Ecosystem impacts	Habitat impacts	Disturbance impacts
Whooper Swan	x	x	√
Bewick's Swan	x	x	√
Greenland White-fronted Goose	x	x	√
Light-bellied Brent Goose	x	x	√
Shelduck	x	x	√
Wigeon	x	x	√
Teal	x	x	√
Mallard	x	x	√
Pintail	x	x	√
Scaup	x	√	√
Goldeneye	x	√	√
Red-breasted Merganser	x	x	√
Great Crested Grebe	x	x	√
Cormorant	x	x	√
Grey Heron	x	x	√
Oystercatcher	x	√	√
Golden Plover	x	x	√
Grey Plover	x	x	√
Lapwing	x	x	√
Knot	x	√	√
Sanderling	x	x	√
Dunlin	x	x	√
Black-tailed Godwit	x	x	√
Bar-tailed Godwit	x	x	√
Curlew	x	√	√
Redshank	x	√	√
Black-headed Gull	x	x	√
Lesser Black-backed Gull	x	x	√
Little Tern	x	x	√
Sandwich Tern	x	x	x
Roseate Tern	x	x	x
Common Tern	x	x	x
Arctic Tern	x	x	x

See text for details.

Species assessments: Bewick's Swan, Whooper Swan, Light-bellied Brent Goose and Shelduck

Distribution within Wexford Harbour and the Raven/Rosslare Bay

6.98 Bewick's Swan and Whooper Swan mainly occur within the slobs, with only small numbers and/or infrequent occurrences within intertidal and subtidal habitat.

6.99 Light-bellied Brent Goose and Shelduck utilise both the North and (Light-bellied Brent Goose only) South Slob, as well as intertidal and subtidal habitat within the Harbour Zone.

6.100 Wigeon, Teal, Mallard and Pintail mainly occur within the North and South Slob. They occur irregularly, and usually in small numbers, in intertidal and subtidal habitats within the Ferrycarrig and Harbour Zones, although occasional large counts do occur.

6.101 When shooting occurs on the slobs, all these species may use tidal habitats as a disturbance refuge. When birds are flushed to the harbour area, they can occur anywhere within the harbour and can sit on the edge of sandbanks (NPWS).

Disturbance: normal conditions

6.102 Within the Harbour Zone, Light-bellied Brent Goose and Shelduck will feed in intertidal and shallow subtidal habitat, mainly at low tide and mainly in the south-eastern section of the harbour. Therefore, they are unlikely to be subject to frequent disturbance from dredgers, as the only dredging/fishing activity at low tide will be in the deeper areas of the harbour, away from the areas where the geese feed.

Disturbance: shooting on the slobs

6.103 If shooting on the slobs coincided with high levels of dredging activity, it is possible that the availability of suitable disturbance refuges could be affected.

6.104 The open season for wildfowl and pheasants is from 1st September-31st January. However, numbers of most of these species will only begin to build-up in October.

6.105 Shooting on the North Slob takes place on alternate Saturday mornings (i.e., once per fortnight) (NPWS). In addition a single walked-up Pheasant shoot takes place each year (NPWS). Because of tidal limitations, high levels of dredging activity are only likely to take place around the high tide period. In 2013/14, there were 18 Saturdays between 1st October and 31st January. Hunting on the North Slob would have taken place on nine of these Saturdays. In each set of fortnightly Saturdays, four of the nine Saturdays had low tide in the morning. Therefore, at a maximum, hunting on the North Slob could have coincided with high levels of dredging activity on five Saturdays.

6.106 Shooting on the South Slob takes place every Sunday morning, with additional shoots for Pheasants (NPWS). In 2013/14, there were 17 Sundays between 1st October and 31st January, with morning low tides on six of these Sundays. Therefore, at a maximum, wildfowling on the South Slob could have coincided with high levels of dredging activity on 11 Sundays, while additional Pheasant shoots could have coincided with high levels of dredging activity.

6.107 The response of birds to the shoots can vary depending upon the type of the shoot. Waterfowl shoots deploy widespread guns simultaneously and so create more disturbance. In addition, wildfowl shooting commences before dawn and therefore will affect roosting congregations of waterfowl. Birds will not necessarily be flushed to the harbour area, but may find alternative refuges within the slobs. When birds are flushed to the harbour area, they can occur anywhere within the harbour and can sit on the edge of sandbanks (NPWS).

6.108 The distance at which these species are disturbed by boat activity is not known, but is highly unlikely to be greater than the 750 m buffer distance used in the analyses of potential disturbance impacts to Red-breasted Merganser (see paragraphs 6.159-6.165). The latter show that under a worst-case scenario with very conservative assumptions, bottom mussel-related boat activity could disturb around 20-25% of the available habitat within the Harbour Zone. As the swans are not considered to have any particular preferences for areas within the Harbour Zone (NPWS), it is reasonable to assume that the swans would be able to find suitable disturbance refuges within the 75%-80% of the Harbour Zone that is not disturbed. Therefore, bottom mussel-related boat activity is not likely to significantly affect the usage of the Harbour Zone as a disturbance refuge from hunting by these species.

Species assessments: Greenland White-fronted Goose

Distribution within Wexford Harbour and the Raven/Rosslare Bay

6.109 During the day, Greenland White-fronted Geese mainly occur within the slobs, with only small numbers and/or infrequent occurrences within intertidal and subtidal habitat. However, at night the majority of the Greenland White-fronted Geese on the North Slobs use a nocturnal roost site on Dogger Bank and Fort Ruins (Figure 5.6). The exact mapped position may not be accurate, as the mapping in NPWS (2011g) does not include detailed representation of sandbank positions. In any case, the exact position of the roost will change over time in line with movements of the sandbanks. It is also likely that Bird Island and Tern Island are used at times, as well, particularly by geese from the South Slobs (NPWS).

6.110 Greenland White-fronted Geese may use tidal habitats as a disturbance refuge during the day when shooting occurs on the slobs. When birds are flushed to the harbour area, they can occur anywhere within the harbour and can sit on the edge of sandbanks (NPWS).

Disturbance: nocturnal roost

6.111 The position of the main Greenland White-fronted Goose roost, as mapped by NPWS (2011g) is within the application site 74A. The applicant has stated that there will be no night-fishing in this site. The information provided by the operators of, or applicants for, the other sites that occur in the vicinity of sandbanks that may be used by roosting geese indicates that night-fishing will be of rare occurrence, if it occurs at all, in these sites[2]. Therefore, it is unlikely that night-fishing will occur with sufficient frequency in the vicinity of Greenland White-fronted Goose nocturnal roost sites to cause significant disturbance impacts.

Disturbance: shooting on the slobs

6.112 Based on the assessment above (paragraphs 6.103-6.108), bottom mussel-related boat activity is not likely to significantly affect the usage of the Harbour Zone as a disturbance refuge from hunting by Greenland White-fronted Geese.

Disturbance: dredger activity close to the North Slob

6.113 NPWS have raised concerns about the potential for dredger activity close to the North Slob to cause disturbance to Greenland White-fronted Geese feeding on the North Slob. NPWS do not have any specific records of disturbance on file but state that their concerns are based on “*casual*

[2] No information was received from the operator of site 57H.

observation based over a very long period of time" (NPWS). The disturbance impact may be cause by the appearance of a mast above the sea wall and/or by noise from the dredgers.

6.114 A desk based review was carried out to address this issue. This included: analysis of patterns of geese distribution, analysis of vessel activity patterns close to the North Slob, and analysis of topographic data to assess the potential visibility of dredgers to geese feeding on the North Slob. Full details of the methodology, and results, of this desk review are presented in Appendix D. The following is a summary of the main findings.

6.115 According to NPWS, Greenland White-fronted Geese are considered to be potentially affected by disturbance from vessel activity when they (the geese) are within 200-300 m of the sea-wall, to the east of the observation tower (the sensitive zone). The maximum distance of dredgers from the sea-wall beyond which the potential for disturbance by dredgers is not considered to be significant is not known. Analysis of topographic data indicates that (for geese in the fields adjacent to the observation tower) the distance from the sea wall (at mean high tide) at which the mast of a dredger will be visible over the sea wall ranges from around 100-150 m for geese at 50 m from the sea-wall; through 450-600 m for geese at 200 m from the sea-wall; to 700-900 m for geese at 300 m from the sea-wall.

6.116 Analysis of NPWS management count data for the winters of 2011/12, 2012/13 and 2013/14 show that the mean percentage of Greenland White-fronted Geese on the North Slob using fields within the sensitive zone was 7.6% (95% C.I. = 5.9-9.2%, n = 37).

6.117 Three dredgers operate in the vicinity of the North Slob: the Branding, the Hibernia and the Laura Anne. The closest vessel activity by the Branding and Laura Anne to the North Slob will be around 400 m from the sea wall while dredging, or around 350 m while the Branding is travelling to/from its site. It is not known whether Greenland White-fronted Geese are susceptible to disturbance from dredgers at these distances from the sea wall. The Hibernia operates in sites (46A, 49B and 52A) that extend to within 200 m of the sea wall. Currently, the frequency of activity by the Hibernia in these sites is very low, so any disturbance of Greenland White-fronted Geese by dredger activity in these sites is likely to be a rare event and on a comparable scale to disturbance by licensed wildfowling. However, the patterns of site usage, and the locations of dredger access routes, may change in the future as a result of changes in sedimentation patterns in the harbour, and (in the case of site usage) increases in seed supply. It should be noted also that there is an additional site close to the sea-wall (site 57F). This site is licensed to an operator who is currently not active, and has not been active since around 2008.

6.118 If Greenland White-fronted Geese are only susceptible to disturbance from dredgers when the dredgers are within 350 m of the sea wall, then, based on current activity patterns, dredging will not cause significant disturbance impacts. If Greenland White-fronted Geese are susceptible to disturbance from dredgers when the dredgers are more than 350 m of the sea wall, then there is potential for dredging to cause regular disturbance to Greenland White-fronted Geese. The significance of any such disturbance would then need to be assessed using the criteria discussed above (see paragraphs 2.67-2.73).

Species assessments: Scaup, Goldeneye, Red-breasted Merganser, Great Crested Grebe and Cormorant

Distribution within Wexford Harbour and the Raven/Rosslare Bay

Distribution patterns

6.119 Historically, most Scaup occurred within the Harbour Zone with a mean percentage occurrence of 87%. In recent winters, Scaup have mainly occurred on the North Slob (24 records since 2003/04, compared to just two records from the Harbour Zone). However, numbers in these winters have been very low, with only four counts exceeding 20 birds. Therefore, it may be the case that if the Scaup numbers were to recover, significant numbers would again occur within the Harbour Zone.

6.120 Red-breasted Merganser, Great Crested Grebe and Cormorant mainly occur within the Harbour Zone with mean percentage occurrences of 82%, 74% and 72% within this zone, respectively. The percentage occurrence of Goldeneye within the Harbour Zone is lower (51%), reflecting its occurrence within the North Slob (mean percentage occurrence of 27%). As with most species, these figures will underestimate the true numbers that occur within the Harbour Zone, as the I-WeBS and BWS counts only covered 60% of this area.

6.121 All four species also regularly occur within the Ferrycarrig Zone with mean percentage occurrences of 11-22%.

6.122 Within the Harbour Zone, the highest numbers of Scaup, Goldeneye, Red-breasted Merganser and Great Crested Grebe occur along the northern side of the harbour (subsite 0O490) (Table 6.13). Relatively high numbers of these species, compared to the available habitat, occur at Rosslare Backstrand (0O495) and, for Red-breasted Merganser, Hopeland (0O498). The Inner South Harbour (0O485/496) generally holds relatively low numbers compared to the available habitat.

6.123 Within the Harbour Zone, the highest Cormorant numbers occur at Raven Point (0O493) with a mean of 67% of the total high tide count. However, this reflects the occurrence of the main Cormorant roost site within this subsite (on Dogger Bank). Similarly, the other two subsites with relatively high numbers of Cormorants (means of 15% of the total high tide counts in each case) also hold roost sites: on the North Training Wall (0O490) and on Bird Island (0O493).

6.124 During the BWS counts, the behaviour of the Cormorants counted was recorded as feeding, or roosting/other. The distribution of feeding birds in these counts suggests that the majority of birds feed in the open sea outside the harbour, although the data is limited and the interpretation is complicated by the lack of behaviour details for the birds counted in subsite 0O490 on three of the dates (Table 6.14). However, this does accord with the impression we gained from our visits in February and March 2015, when we did not see large numbers of feeding birds within the harbour.

6.125 If bottom mussel culture has negative effects on any of these species, it is possible that the above distribution patterns may have already been influenced by the impact of this activity. The renewal sites (where the activity will have occurred during the period covered by the I-WeBS/BWS counts), occupies large areas in subsites 0O490 and 0O485/496 and part of the Ferrycarrig Zone. There are no renewal sites in subsites 0O493, 0O495 and 0O498.

Table 6.13 - High tide distribution of Goldeneye, Red-breasted Merganser, Great Crested Grebe and Cormorant in relation to available habitat within the Harbour zone.

Subsite	Habitat	Scaup	Goldeneye	Red-breasted Merganser	Great Crested Grebe	Cormorant
0O490	27%	50%	41%	37%	53%	15%
0O493	10%	0%	< 1%	12%	1%	67%
0O495	12%	12%	33%	27%	28%	15%
0O485/496	47%	33%	25%	11%	18%	2%
0O498	3%	5%	< 1%	11%	1%	2%

Mean distribution across all I-WeBS and BWS counts with complete coverage of the Harbour Zone, excluding counts with atypically low numbers.

Table 6.14 - Distribution of feeding Cormorants recorded during the 2009/10 NPWS BWS counts.

Code	Subsite	15/10	20/11	15/12	15/02
0O407	Ferrybank (Wexford Bridge) - Castlebridge	5	2	15	2
0O485	Inner South Harbour	0	7	2	
0O490	Raven Pt. - Ferrybank (Wexford Bridge)	*	*	11	1*
0O493	Raven Point	27	20	0	0
0O495	Rosslare Backstrand	0	2	0	0
0O498	Hopeland Wexford Harbour	0	1	0	0
0O901	Blackwater Head - Raven Point	11	42	18	76

* Behaviour of some/all birds not recorded, with total counts of 61 on 15/10, 21 on 20/11 and 7 on 15/02.
Note: no feeding birds were recorded on the January high tide count, where the total count was very low (25).

Roost sites: Scaup

6.126 The roosting habits of Scaup when they occurred in Wexford Harbour are not known. In general, Scaup appear to be predominantly nocturnal foragers (Nilsson, 1970; Campbell *et al*., 1978; Evans and Day, 2001; McNeill *et al*., 1992) and may commute from daytime roosts on inland waters to coastal areas to feed at night (Nilsson, 1970; Campbell *et al*., 1978). However, the occurrence of large flocks of Scaup in the Harbour Zone during I-WeBS counts in the 1990s and early 2000s is a possible indication that daytime roosts occurred within the Harbour Zone.

Roost sites: Goldeneye, Red-breasted Merganser and Great Crested Grebe

6.127 Rafts of Goldeneye, Red-breasted Merganser and Great Crested Grebe gather to form large nocturnal roosts. This behaviour has been reported for Goldeneye (King, 1961; Linsell, 1969) and Red-breasted Merganser (Nilsson, 1965, quoted by Nilsson, 1970). Nocturnal rafting by Great Crested Grebe does not appear to be widely recognised in the scientific literature (but see Campbell *et al*., 1978), but appears to be typical behaviour at several Irish coastal sites (T. Gittings, unpublished data).

6.128 Our observations in February and early March 2015 indicate that Goldeneye and Great Crested Grebes gather to form a nocturnal roost just off the north-western shore of the Harbour Zone, close to Ardcavan. A roosting flock of 81 Goldeneye was recorded on the evenings of 4th and 5th February 2015, with 61 here in the early morning of 20th February and 50 here on the evening of 2nd March 2015. These numbers are relatively high, compared to the numbers recorded on recent I-WeBS counts, indicating that birds from a wide area gather together to roost here.

6.129 A roosting flock of 115 Great Crested Grebe was recorded off Ardcavan on the evening of 4th February 2015, with at least 95 here the following evening (counted in poor light) and around 50 here on the evening of 2nd March 2015. Observations in Cork Harbour indicate that Great Crested

Grebes may travel 3-4 km from their feeding areas to their roost sites, but that discrete roosts may form where feeding areas are separated by geographical barriers. Therefore, it is possible that the Ardcavan roost holds all the birds within the Harbour Zone, but that an additional (smaller) roost might occur within the Ferrycarrig Zone.

6.130 Small numbers (less than 20 in total) of Red-breasted Merganser were recorded at the Ardcavan roost in February 2015, with none here on the evening of 2nd March 2015. Therefore, it is likely that there are additional Red-breasted Merganser roost sites elsewhere within the Harbour Zone.

Roost sites: Cormorant

6.131 The main Cormorant roost site occurs at Dogger Bank with other roost sites at Bird Island and on the North Training Wall. Dogger Bank is the main nocturnal roost site, but all three roost sites can also hold significant numbers of birds during the day.

Habitat impacts

6.132 Bottom culture of mussels is likely to cause reduced abundances of other bivalves within the relaid areas, but may cause increased abundances of various crustaceans.

6.133 In marine habitats Scaup appear to feed predominantly on molluscs (Cramp and Simmons, 2004). Therefore, for the period of time after the relaid mussels have grown out of the size range consumed by Scaup, there is likely to be a reduction in available food resources for Scaup within the relaid mussel beds. This time period will be all, or part, of the first winter following relay and the entire second winter following relay (because even after harvesting it will take a period of time for recovery to occur).

6.134 Goldeneye may feed on a wider range of food resources, compared to Scaup, and crustaceans can be an important component of their diet. However, in contrast to Scaup, the relaid mussels are unlikely to be available as a significant food resource for Goldeneye, even at the beginning of the season. Therefore, the impacts of bottom mussel culture on the food resources for Goldeneye within the relaid beds is likely to be complex and depend on the interplay of the negative impacts on bivalves and the positive impacts on crustaceans.

6.135 The current seed mussel allocation (which is close to the maximum recorded seed mussel input), if fully utilised and extended to cover the application sites as well, is projected to occupy around 56% of the subtidal habitat, and 31% of all tidal habitat, within the Harbour Zone (Table 6.7). Given this scale of potential impact, habitat impacts which could have significant negative impacts on food resources for Scaup and Goldeneye in Wexford Harbour cannot be ruled out.

6.136 Habitat impacts to Red-breasted Merganser, Great Crested Grebe and Cormorant have been screened out.

Disturbance impacts

6.137 Our observations on disturbance impacts focused on Red-breasted Merganser, as this species appears to be the most sensitive to disturbance from marine traffic in Wexford Harbour. Therefore, we discuss this species first.

Response to disturbance: Red-breasted Merganser

6.138 Observations made during survey work for this assessment indicate that Red-breasted Mergansers in Wexford Harbour are very sensitive to disturbance (see Appendix C). A disturbance response was noted in 32 out of the 45 interactions between mergansers and boats that we observed, with birds being flushed on 22 occasions. The disturbance response was related to the lateral distance of the birds from the path of the boat, with 90% of observations within 250 m showing a disturbance response, compared to only 29% of the observations at distances of over 500 m from the path of the boat (Table 6.15). Overall 84% of observations within 500 m showed a disturbance response. The birds that did show a response often flushed at long distances from the boat, with some birds flushing at distances of over 1 km, but these were mainly birds that were close to the path of the boat (i.e., the boat was heading straight towards them). While our dataset includes responses to three types of boat (a cot, small inshore potting vessels and dredgers), there was no detectable difference in the responses to these boat types (although our analysis is constrained by limited data for the disturbance response to cots at large lateral distances).

Table 6.15 - Summary of incidence of disturbance response type by lateral distance.

Lateral distance	% of observations with		n
	any disturbance response	flush response	
< 250 m	90%	70%	20
250-500 m	73%	36%	11
> 500 m	29%	14%	7
All	71%	49%	45

see Appendix C for the full results.

6.139 Most of the responses to dredgers were recorded while the dredgers were travelling to/from the fishing sites. Only six interactions were recorded while the boats were dredging for mussels or starfish mopping: two no responses at around 500 m, one no response at more than 500 m, one alert response at more than 500 m and two flushes at more than 500 m (note, these are the response distances, not the lateral distances; lateral distances were not recorded while the birds were dredging as the boats do not follow a defined route). This reflects the fact that very few mergansers were observed in the vicinity of boats while they were dredging: during 11 hours 45 minutes of watching boats dredging or starfish mopping, these were the only observations of mergansers within around 0.5-1 km of the boats (although in some cases the boats were very distant and birds on the far sides of the boats could have been missed). It is notable that during all this time we made no observations of mergansers in close proximity (within a few 100 m) to boats while they were dredging for mussels or starfish mopping. The mean encounter rate that we recorded of one bird/38 ha (see Appendix C) would predict that, on average, two mergansers would occur within 500 m of a dredger. Therefore, while some mergansers appear to be able to tolerate close approach while the boats are travelling to/from the dredging sites, sustained fishing activity in one area appears to cause complete exclusion of mergansers from within at least 500 m of the fishing activity.

Response to disturbance: Scaup

6.140 Only a few Scaup were present in Wexford Harbour in February and March 2015, and no interactions with marine traffic were observed.

6.141 There are indications in the literature that Scaup may be relatively sensitive to disturbance by marine traffic. In a literature review, Borgmann (2011) noted that Scaup were one of the species that showed relatively high flush distances, while Furness *et al*. (2012) classified its sensitivity to disturbance from ship traffic as 4 on a scale of 1 to 5, where 5 represents “strong escape behaviour, at a large response distance”. In one study reviewed by Furness *et al*., Scaup are described as being “*disturbed by passing ships up to 400 m away*” (Platteeuw and Beekman, 1994, quoted by Furness *et al*. 2012).

Response to disturbance: Goldeneye

6.142 Our data on Goldeneye response to marine traffic is limited because Goldeneye did not occur in the vicinity of the main navigation channel where most of the observations were made. However, a disturbance response was only noted in one of the seven interactions between Goldeneye and boats that were observed during daytime observations. One of the observations involved birds actively feeding within 200-300 m of a boat that was dredging for mussels. In addition, on the evening of 2nd March 2015 the Goldeneye roosting flock gathered in a position that was around 400 m from the edge of the area where the Laura Anne was dredging for mussels (the Laura Anne continued dredging until at least 18:00 hours, well after the roosting flock had assembled). These observations suggest the Goldeneye may be able to tolerate close approach while the boats are travelling to/from the fishing sites. However, across 11 hours 45 minutes of watching boats dredging for mussels or starfish mopping, we only made two observations of Goldeneye within around 500 m of the boats. Therefore, it is possible that sustained fishing activity in one area may cause exclusion of Goldeneye from within a few 100 m of the fishing activity.

Response to disturbance: Great Crested Grebe

6.143 Great Crested Grebe appear to be relatively tolerant of disturbance by marine traffic in Wexford Harbour. We observed numerous instances of boats travelling past grebes within a few hundred metres without any discernible response from the grebes. We did observe one instance of grebes being flushed by a boat: this occurred on 20th February 2015 when the Branding was returning from starfish mopping and drove through an area with Great Crested Grebes, Red-breasted Mergansers and Goldeneye all directly on its path. However, we also observed several instance of grebes being passed by boats within the navigation channel, when they were more or less directly in the path of the boat, without any obvious reaction.

6.144 While boats were actively dredging for mussels or starfish mopping, we recorded two instances of Great Crested Grebes within a few hundred metres of the boats showing no response to the activity. In addition, on the evening of 2nd March 2015 the Great Crested Grebe roosting flock gathered in a position that was around 400 m from the edge of the area where the Laura Anne was dredging for mussels (the Laura Anne continued dredging until at least 18:00 hours, well after the roosting flock had assembled). However, across 11 hours 45 minutes of watching boats dredging or fishing for starfish, these were the only observations of grebes within around 500 m from the boats. Therefore, while Great Crested Grebes appear to be able to tolerate close approach while the boats are travelling to/from the dredging sites, it is possible that sustained dredging/fishing activity in one area may cause exclusion of grebes from within a few 100 m of the dredging/fishing activity.

6.145 Great Crested Grebe may be more sensitive to disturbance at their nocturnal roost. On 15th October 2015, we observed roosting grebes at Ardcavan show a disturbance response to a cot. The cot was travelling slowly into the bay at dusk and the grebe roost (which had formed into a tight flock) broke up and started swimming away. We have also observed similar disturbance responses by roosting grebes to boats in Cork Harbour.

Response to disturbance: Cormorant

6.146 Cormorant appears to be relatively tolerant of disturbance by marine traffic in Wexford Harbour. We observed numerous instances of boats travelling past Cormorants within a few hundred metres without any discernible response from the birds. Most of these instances involved birds roosting on the North Training Wall, or feeding in, or around, the navigation channel close to this roost.

6.147 On 2nd March 2015, the Hibernia was dredging for mussels in site T03/049A within 400-500 m of the North Training Wall. We did not observe any disturbance response from Cormorants roosting on the North Training Wall, or feeding in the adjacent section of the navigation channel. Apart from this case, we did not observe any instances of Cormorants in close proximity to boats that were actively dredging for mussels or fishing for starfish. However, even when there was no boat activity, we did not observe many Cormorants on the water in the northern section of the Harbour Zone.

6.148 Therefore, Cormorants appear to be able to tolerate close approach while the dredgers are travelling to/from the fishing sites, but their response to sustained fishing activity in one area is not clear.

Potential impacts of disturbance

6.149 Our observations indicate that Red-breasted Mergansers in Wexford Harbour are routinely disturbed by mussel dredgers and they may be completely displaced from areas where dredging is taking place causing them to avoid these areas until cessation of dredging activity. Goldeneye, Great Crested Grebe and, possibly, Cormorant may also be disturbed by dredging, but to a lesser extent.

6.150 Therefore, the potential disturbance impact of mussel dredging and starfish mopping on these species in Wexford Harbour can be divided into three components: -

- The energetic impact of the response to disturbance, which occurs mainly when boats and travelling to/from their fishing sites.
- The temporary displacement of birds from the fishing sites for the duration of the fishing activity.
- The potential disturbance impact to roosting birds when night-fishing takes place.

Assessment of energetic impacts: Red-breasted Merganser

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

6.152 From the recording of pre-disturbance behaviour in our disturbance study, the Red-breasted Mergansers in Wexford Harbour spent a mean percentage of 55% of their time feeding (Appendix C). This is in the middle of the range of values reported in the literature (23-77%; Bowles, 1980, quoted by Miller, 1996; Miller, 1996; Nilsson, 1970; Richner, 1988). Red-breasted Mergansers typically feed on fish around 10-15 cm long and 10-20 g weight (Kolbe, 1989, quoted by Miller, 1996; Lingle and Schupbach, 1977, quoted by Miller, 1996; Miller, 1996). The energy content of fish typically ranges from around 1000-3000 cal/g wet weight (around 4-8 kJ/g wet weight) (Davis, 1993). So the energy cost for a single disturbance flight would be a maximum of 10% of the energy content of a typical single fish taken by a merganser.

6.153 Therefore, given that mergansers in Wexford Harbour do not appear to be under severe food limitation (as indicated by the percentage of time feeding), and the small energy expenditure involved in a single disturbance flight, it is not scientifically plausible to assume that a single disturbance incident per bird per day would have a significant impact on the condition of the birds. Therefore, it is necessary to determine the likely number of disturbance incidents per bird per day.

6.154 From observations of boats travelling along defined routes during our disturbance study (Appendix C), the overall encounter rate with mergansers was one bird every 38 ha (range 7-191 ha) [3]. The mean distance travelled by dredgers to access dredging sites is estimated to be around 4.1 km[4]. These figures, in combination with the observed flush rates, can be used to calculate that a single boat would flush 14.5 mergansers on an average round-trip (Table 6.16). Assuming a total population within the Harbour Zone of 79 birds (based on the observed encounter rate), and median daily boat activity levels of seven boats (Text Figure 6.3), the mean flush rate would be 1.3 flushes per bird per day[5].

6.155 These calculations are obviously sensitive to the accuracy of the observed flush rate. The calculations also assume that mergansers are uniformly distributed throughout available habitat within the Harbour Zone. While the latter is unlikely to be the case, the fact that the mussel sites are distributed throughout most of the Harbour Zone means that non-uniform patterns of merganser distribution should not affect the overall average pattern (although non-uniform patterns would affect calculations of disturbance rates along specific routes).

Table 6.16 - Calculations of the number of mergansers flushed by an average boat trip to a bottom mussel site in the Harbour Zone of Wexford Harbour.

Lateral distance from boat	Area	Number of birds encountered	Flush rate	Number of birds flushed
0-250 m	410 ha	10.8	70%	7.6
250-500 m	410 ha	10.8	36%	3.9
500-1000 m	820 ha	21.6	14%	3.0

Calculations based on observed encounter rates (one bird/38 ha) and flush rates (see Appendix C). The observed > 500 m lateral distance band has been conservatively assumed to have an upper limit of 1000 m for the purposes of these calculations.

Assessment of energetic impacts: Scaup

6.156 It is not possible to assess the potential energetic impacts to Scaup due to the lack of site-specific data on their disturbance response.

Assessment of energetic impacts: Goldeneye and Great Crested Grebe

6.157 Goldeneye and Great Crested Grebe were rarely observed to flush in response to passage of marine traffic (although the data is limited for Goldeneye). Therefore, the mean flush rate will be orders of magnitude below one per bird per day and the energetic impact of disturbance to these species will not be significant.

Assessment of energetic impacts: Cormorant

6.158 Cormorant were not observed to flush, or show any obvious disturbance reaction, in response to passage of marine traffic.

Assessment of displacement impacts: Red-breasted Merganser

6.159 Our observations indicate that mussel dredging and starfish mopping may cause complete exclusion of mergansers within around 500 m of the boat, while mergansers that are flushed by

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[3] In fact Red-breasted Mergansers typically occur in small groups. However, the calculations are mathematically equivalent if an even distribution of groups is assumed.
[4] Calculated from the mean of the distances between the centroid of each site and the quay, with a correction factor of 1.5 to account for the fact that the boats will not necessarily travel in a straight line.
[5] These calculations are, in fact, calculations of the relative area disturbed. The total population number is calculated from the encounter rate. Therefore, the total population number is simply a mathematical function of the encounter rate and the calculated flush rate per bird will be the same whatever encounter rate is used. However, bird numbers are used in these calculations to make the results more intuitive.

boats typically flush before the boat comes to within around 500 m of the birds. In addition, our observations of the reactions of mergansers to the approach of boats indicate that they show a behavioural response (alert reaction and/or swimming away) for a short period of time before they actually flush. Most of these observations were of birds responding to boats travelling at speeds of 5-10 knots (2.5-5 m/s). Therefore, there is an additional disturbance distance of up to 150 m on top of the flush distance (i.e., a boat approaching for 30 seconds at a speed of 10 knots). Given our limited data, and the constraints on the accuracy of our distance estimation in the field, it is prudent to add another 100 m as a margin of error. This gives a total disturbance distance of 750 m.

6.160 Applying a 750 m buffer, the instantaneous area disturbed around a boat is 176 ha. However, depending upon the position of the plot being fished, some of this area may be land, etc. Across 628 plots defined using information on the typical size of areas fished at the start of the season (Table 6.4), the mean area disturbed (excluding land, sandbanks, and areas outside the Harbour Zone) is 165 ha (with 80% of the areas > 150 ha). This amounts to around 5.5% of the total area of available habitat within the Harbour Zone at high tide, and 6.6% of the total area of available habitat at mean low tide.

6.161 At the median daily boat activity levels of seven boats (Text Figure 6.3), the mean area disturbed (if all the boats are 750 m apart) would be 1155 ha. However, in practice, it would be extremely unlikely that all seven boats would be 750 m apart. Therefore, to quantify the typical degree of overlap, we carried out simulations of the spatial distribution of boat activity. We randomly selected plots from each of the five operators with the highest levels of fishing activity, and from the two crab potters, and drew 750 m buffers around the centroids of each plot. We then merged the buffers and clipped out areas occupied by land or sandbanks, and areas outside the Harbour Zone. The area included in the buffer then represents the total area potentially disturbed by all seven boats. Figure 6.4 shows examples of the results of these simulations of fishing activity and shows that there tends to be a high degree of overlap. Across 25 such simulations, the mean area potentially disturbed was 670 ha (range 569-803 ha). These areas would amount to around 19-27% of the total area of available habitat within the Harbour Zone at high tide.

6.162 If there is a recovery period (i.e., a period of time before which habitat can be reoccupied following cessation of the disturbance; see Smit and Visser, 1993), then the area disturbed will be greater. However, we noted that birds that showed an alert response and/or swam away, typically resumed their normal behaviour as soon as the boat had passed, indicating that the recovery period is negligible.

6.163 The above estimates of displacement impacts are based on conservative assumptions, and may overstate the actual impact. However, they do accord with our general observation that it was very hard to find mergansers anywhere near mussel dredging or starfish mopping activity (despite the fact that the northern section of the harbour, where we observed the activity, typically holds 50% or more of the total merganser count within the Harbour Zone[6]).

6.164 Under a worst-case scenario, where all operators are harvesting at maximum levels during the October-December period (see paragraphs 6.63-6.72), and the timing of boat activity each day is clustered (see paragraphs 6.73-6.76), high levels of impact would occur on around 80% of days (i.e., days with five or more boats active), for periods of up to 55-66% of daylight hours (six hours in Table 6.11).

6.165 The actual impact of displacement due to disturbance by mussel dredging/starfish fishing will depend upon whether the displaced birds can find suitable alternative habitat to feed in while they are displaced, or, if this is not the case, whether the 33-45% of the daylight hours when there is no

[6] But note that the counts do not cover all of the Harbour Zone.

displacement provides sufficient feeding time for the birds to meet their daily energetic requirements. There is no site-specific data available that can be used to address these questions, and we are not aware of any comparable studies in the literature that can be used.

Assessment of displacement impacts: Scaup

6.166 It is not possible to assess the potential displacement impacts to Scaup due to the lack of site-specific data on their disturbance response.

Assessment of displacement impacts: Goldeneye, Great Crested Grebe and Cormorant

6.167 Goldeneye, Great Crested Grebe and, possibly, Cormorant may also be displaced by dredging activity, but to a lesser extent than Red-breasted Merganser. Therefore, any impact to these species will be substantially less than the displacement impact assessed above for Red-breasted Merganser.

Assessment of disturbance impacts to nocturnal roosts: Red-breasted Merganser

6.168 The location(s) of the main Red-breasted Merganser roost(s) in Wexford Harbour are not known.

Assessment of disturbance impacts to nocturnal roosts: Goldeneye and Great Crested Grebe

6.169 The main Goldeneye and Great Crested Grebe roost occurs off Ardcavan Beach. Regular observations of roosting grebes in Cork Harbour shows that they are faithful to particular areas of open water, but the precise location of the roost can move around. Therefore, to be precautionary, all bottom mussel sites within an arbitrary 1 km of the mapped roost locations are considered as potentially overlapping with the roost. These are: T03/030B, T03/035A, T03/046A, T03/047C, T03/048A, T03/049A and T03/052B.

6.170 From the information supplied by the operators, night fishing does not occur, or is of rare occurrence, in most of the sites in the vicinity of the mapped roost site locations (Figure 6.5). Therefore, it is unlikely that several dredgers would be out at the same time, and it would seem likely that if roosting birds were disturbed they would be able to move a short distance to a nearby undisturbed area of open water. However, the reason why diving duck and grebes roost communally at night, and the significance of the particular areas that they choose, is not known. It is possible that the birds select areas in relation to factors such as tidal-related currents: the mapped roost locations in Wexford Harbour are in an area with relatively slack tidal currents, compared to elsewhere in the northern half of the harbour (cf. Figure 2 and Figure 3 in O'Loan, 2015), which would explain why the precise locations vary. If this is the case, disturbance by night dredging could displace birds into less favourable roosting locations.

6.171 It should be noted that our information about the roosting behaviour of Goldeneye and Great Crested Grebe in Wexford Harbour is based on a limited number of observations. It is possible that there is seasonal variation in the occurrence of communal roosting behaviour and/or the locations used.

Assessment of disturbance impacts to nocturnal roosts: Cormorant

6.172 The nocturnal Cormorant roost occurs on Dogger Bank, within site T03/074A. The applicant has confirmed that he will not be carrying out any night-time dredging in this site.

Species assessments: Grey Heron

6.173 Grey Heron in Wexford Harbour and the Raven occur mainly within the Ferrycarrig and Harbour Zones and on the North Slob.

6.174 Within the Harbour Zone, Grey Heron feed in intertidal and shallow subtidal habitat, scattered widely around the harbour. Therefore, they are unlikely to be subject to frequent disturbance from dredgers, as the only dredging/fishing activity at low tide will be in the deeper areas of the harbour, away from the areas where the Grey Heron feed.

Species assessments: Oystercatcher, Golden Plover, Grey Plover, Lapwing, Knot, Sanderling, Dunlin, Black-tailed Godwit, Bar-tailed Godwit, Curlew and Redshank

Distribution within Wexford Harbour and the Raven

6.175 Oystercatcher, Knot, Sanderling, Dunlin, Bar-tailed Godwit and Redshank occur mainly within the Harbour Zone (and the Ferrycarrig Zone for Redshank). Golden Plover, Lapwing, Black-tailed Godwit, and Curlew also occur in significant numbers in the North Slob, where they feed on fields.

6.176 Within the Harbour Zone, the main concentrations of most of the wader species occur in the south-eastern section of the harbour, where they feed on the intertidal habitat in Hopeland and Rosslare Backstrand at low tide. There are a number of wader roosts on intertidal banks and sandbanks across the mouth of the harbour at high tide, while there are a few shoreline roosts along the southern shore, and adjacent to Ferrybank.

Habitat impacts

6.177 The standard method of bottom mussel culture will not significantly affect the habitats that are used by these species. However, the seed collection method (in sites T03/093A and T03/093B) will remove food resources that may be consumed by some of these species.

6.178 The seed collection method involves identifying natural intertidal mussel settlement within the sites and relocating the seed mussels to positions where they will be subtidal. Therefore, this will remove seed mussels from intertidal habitat, where they would potentially be available to Oystercatcher and Knot, to the subtidal zone, where they would be inaccessible to these species. Furthermore, in the long term, it is possible that the seed collection method could prevent the regeneration of existing intertidal mussel beds and reduce the quality of the habitat for additional species that show associations with mussel beds (Curlew and Redshank).

Short-term impact on food resources for Oystercatcher and Knot

6.179 Both Oystercatcher and Knot often specialise on bivalve prey and mussels can be a major component of their diet. Oystercatchers typically feed on larger mussels (above 20-25 mm shell length; Zwarts *et al*., 1996) while Knot typically feed on smaller mussels (5-24 mm shell length; Goss-Custard *et al*., 1996). The seed mussel will normally be at least 30 mm when collected. Therefore, the seed mussels removed from the intertidal zone, will be too large for consumption by Knot and their removal will not have any direct impact on the prey resources for Knot. However, the seed mussels will be within the size range consumed by Oystercatchers, so their removal will have a direct impact on the prey resources for Oystercatchers.

6.180 Site T03/093A is located along the outer part of the South Training Wall at the northern edge of the Inner South Harbour subsite (0O485/496). However, as it occupies only a very small proportion of the subsite, the overall occurrence of birds within the subsite does not provide any useful indication of the usage of this site. During our site visits in February and March 2015, small numbers of Oystercatchers were regularly observed feeding along the North and South Training Walls when they were exposed. Based on the characteristics of the site, and the general habitat preferences of the two species, it seems likely that site T03/09A is regularly used by small numbers of Oystercatchers, but rarely, or never, by Knot.

6.181 Site T03/093B is located to the south-west of Bird Island, with parts in the Rosslare Backstrand subsite (0O495) and the south-eastern corner of the Inner South Harbour subsite (0O485/496). During the NPWS BWS low tide counts a mean of 48% of the total Oystercatcher count occurred within the Rosslare Backstrand subsite (0O495), indicating a concentration of this species in the area around the T03/093B site. The numbers of Knot recorded during the NPWS BWS low tide counts were very low. However, the Rosslare Backstrand/Hopeland area is considered to hold the main concentrations of most waders within Wexford Harbour, so it seems likely that, when significant numbers are present within the harbour, the Rosslare Backstrand subsite (0O495) will hold significant numbers.

6.182 The operator is aiming to harvest 20 tonnes of mussels per year. If it is assumed that this represents the biomass of mussels that would have been available in the intertidal zone if the seed had not been collected, then an indicative estimation of the removal of food resources can be made. The annual Ecological Food Requirement (EFR) for Oystercatchers feeding on mussels at two British sites has been calculated as 50-61 kg AFDM/bird (Goss-Custard *et al*., 2004)[7]. Applying the conversion factor of 4.6% for the AFDW/WW ration from Ricciardi and Bouget (1988), these EFR figures are equivalent to biomasses of 1.1-1.3 tonnes. If these EFR figures apply in Wexford Harbour, 20 tonnes of mussels would support 15-18 Oystercatchers. This probably represents around 1-2% of the Wexford Harbour Oystercatcher population.

6.183 If they were not harvested, the seed mussels would grow over the summer. Therefore, in theory, the biomass available to Oystercatchers the next autumn/winter could be higher than the biomass harvested in spring. However, mortality will also occur over the summer. There is an approximately 1:1 ratio between the seed mussel relaid and subsequent mussel production (91,915 tonnes relaid 1996-2011, compared to 84,672 tonnes harvested 1997-2013; BIM data), indicating that, in subtidal habitats at least, the combined effects of growth and mortality does not result in a net increase in biomass.

Long-term impact on mussel beds

6.184 In the long term, it is possible that the seed collection method could prevent the regeneration of existing intertidal mussel beds and reduce the quality of the habitat for both Oystercatcher and Knot, as well as for Curlew and Redshank.

6.185 During the BWS low tide counts, the mean percentages of the total count recorded in subsite 0O495 (which largely contains the seed collection site) were 39% (Oystercatcher), 38% (Curlew) and 17% (Redshank); Knot were not recorded in sufficient numbers for meaningful analysis.

6.186 Information on the existing extent of intertidal mussel beds, their usage by these wader species, and the impact of seed collection on the mussel bed dynamics would be required to fully assess this potential impact.

Disturbance impacts

6.187 At low tide, waders are unlikely to be subject to frequent disturbance from dredgers, as the only dredging/fishing activity will be in the deeper areas of the harbour, away from the areas where the waders mainly feed. The seed collection method will involve marking areas of mussel seed at low tide, but this will take place in April and May, outside the main season of occurrence of these species.

[7] Calculations of food requirements for overwintering wader populations distinguish between the physiological food requirement (the food consumption required to maintain physiological condition; PFR) and the ecological food requirement (the amount of food that must be present at the beginning of the winter to allow birds to satisfy their physiological food requirements; EFR). The EFR is typically a multiple of many times the PFR. This difference is due to interference competition, unexploitable stocks (due to small size or low density) and overwinter decline in stocks.

6.188 Several of the high tide wader roosts occur within, or adjacent to, bottom mussel sites. Therefore, it is possible that dredging/fishing activity will occur in close proximity to some wader roosts. In general waders are relatively tolerant of passing marine traffic, as long as it is not heading directly towards the birds. However, sustained activity within 100-200 m of a wader roost could potentially cause the roost to be abandoned. The susceptibility of the roost sites to disturbance impacts will depend, in part upon the bathymetry of the habitat around the roost: where the roost is surrounded by habitat that is intertidal at low tide no dredging will take place close to the roost. In addition, birds using roost sites that are subject to regular disturbance (at Ferrybank and on the North Training Wall) will be habituated to disturbance and will be unlikely to be affected by dredging. This may also apply to a lesser extent to roost sites on intertidal banks and sandbanks adjacent to the main navigation channel. However, several high tide roost sites are on sandbanks in areas where there is currently no bottom mussel culture activity, but where there are applications for sites. In these areas, birds may not be habituated to disturbance.

6.189 The high tide roost sites were mapped as part of the preparation of the Conservation Objectives Supporting document (NPWS, 2011g). This was based on survey work carried out during the 2009/10 BWS counts, as well as local knowledge from NPWS staff. However, the configuration of the intertidal banks and sandbanks in the northern half of the harbour mouth has changed substantially since then.

6.190 It seems likely that on neap and mean high tides there would be sufficient roost sites available that any waders displaced from a roost by dredging activity would be able to find a nearby, undisturbed, alternative roost site. On spring high tides, presumably the only non-shoreline roost sites available would be the sandbanks (i.e., the areas marked as land on the Wexford Harbour chartlet). The map of the distribution of these areas in relation to the bottom mussel culture sites (Figure 6.6) shows that three application sites in the north-east section of the harbour (T03/072B, T03/074A and T03/078A) overlap, or are in close proximity, to several of these areas. Birds disturbed from these areas would have limited alternative nearby roost sites and might have to travel 2-4 km to alternative roost sites at Bird Island and Tern Island. The Bird Island sandbank is large enough that any disturbance from nearby dredging would only affect a limited section of the sandbank and birds should be able to find alternative roost sites elsewhere within the sandbank. The Tern Island sandbank is overlapped by a renewal site (T03/057H), but birds displaced from this area would probably be able to find a suitable alternative roost site on Bird Island.

6.191 Based on figures for Knot in Rehfisch *et al*. (1996), a 4 km flight could increase daily energy expenditure by 2.4%, the equivalent of 16 minutes extra feeding time. While these figures may seem low, waders wintering in intertidal habitats are often at the extreme limits of their metabolic requirements (Rehfisch *et al*., 1996). Furthermore, during periods of cold weather, this type of impact may exacerbate the already stressed condition of the wader populations. However, Rehfisch *et al*. (1996) do note that the energy expenditure due to disturbance may be most critical under neap tidal conditions, when feeding time is most limited. As discussed above, it is likely that on neap tides, there will be sufficient roost sites available that disturbed waders will not have to make long flights.

6.192 While the above discussion indicates that, on the balance of probabilities, mussel bottom culture is not likely to cause significant disturbance impacts to high tide wader roosts, the available information does not allow such impacts to be ruled out beyond reasonable scientific doubt. Further information on the distribution and usage of wader roost sites under various tidal conditions, and the sensitivity of sandbank roosting waders to disturbance from dredging activity, in Wexford Harbour would be required to fully assess this potential impact.

Species assessments: Black-headed Gull and Lesser Black-backed Gull

Distribution within Wexford Harbour and the Raven

6.193 Around 65-70% of the Black-headed Gull and Lesser Black-backed Gull populations occur within the Ferrycarrig and Harbour Zones. Within the Harbour Zone, in the BWS low tide counts, Black-headed Gull were distributed fairly uniformly across the subsites, while Lesser Black-backed Gull mainly occur along the northern side of the harbour, particularly at Raven Point (0O493).

6.194 The main daytime gull roosts occur at Raven Point and on the sandbanks across the mouth of the harbour. In February 2015, several thousand Black-headed Gulls roosted nocturnally off Ardcavan Beach, with the roost extending from close to the shoreline out to around the position of the Great Crested Grebe/Goldeneye roost. The location(s) of the nocturnal Lesser-Black-backed Gull roost(s) is not known.

6.195 The breeding Black-headed Gull population from Tacumshin Lake is also included in this assessment. The extent to which Black-headed Gulls from this population visit the assessment site in summer, and their distribution within the assessment site is not known.

Disturbance

6.196 Gull species are generally not very sensitive to disturbance impacts from marine traffic and often follow vessels. Black-headed Gulls were observed following some of the dredgers while they were dredging for mussels on 2nd March 2015.

6.197 Flocks of roosting gulls can be flushed by human activity, but the birds will generally resettle nearby (unless there is a high level of very intense activity). In Cork Harbour, the main gull roost (which can hold in excess of 20,000 Black-headed Gulls and several thousand Lesser Black-backed Gulls) occurs in Lough Mahon, extending from the lower part of the River Lee channel, adjacent to Tivoli Docks, across Lough Mahon to the outer part of the Douglas Estuary and the Little Island and Rochestown shores. This roost occurs around the shipping channel into Tivoli Docks. Passage of large ships through the roost causes some localised movements of birds, but does not cause any major spatial displacement of birds and does not cause significant disturbance effects to the roost (T. Gittings, personal observations).

6.198 Therefore, mussel dredging and starfish mopping is not likely to cause significant disturbance impacts to these species.

Species assessments: Little Tern

Distribution within Wexford Harbour and the Raven

6.199 In recent years, the Wexford Harbour Little Tern colony has moved between Fort Bank and Bird Island, with Fort Bank occupied in 2014 and Bird Island occupied in 2015 (see paragraphs 5.27-5.30 and Figure 5.7).

6.200 Post-breeding Little Tern flocks of juveniles gather in the Hopeland area (in the south-eastern corner of the harbour).

Disturbance

Response to disturbance

6.201 There is little specific information available on the response of Little Terns to disturbance. However, a number of studies have examined the responses of the Least Tern to disturbance. This North American species is closely related to the Little Tern (in the past it has been considered a subspecies, rather than a full species). These studies have found that Least Terns are relatively tolerant of human disturbance.

6.202 Erwin (1989, cited by Carney and Sydeman, 1999) reported that Least Terns flushed at an average distance of 64 m when colonies were approached on foot (compared to 142 m for Common Terns). Rodgers and Smith (1995) reported that Least Terns flushed *en masse* at an average distance of just under 60 m when colonies were approached on foot , although individual birds within colonies flushed at an average distance of just under 30 m (once the human had entered the colony). Based on their results they recommended a minimum set-back distance of 154 m to protect Least Tern colonies from disturbance by humans approaching on foot.

6.203 Rodgers and Smith (1995) also reported that nesting Least Terns can show acclimatisation to tangential vehicle traffic, with average flush distances of only 11 m (range 7-15 m) to a tangentially moving vehicle. They also reported that the terns rarely flushed in response to nearby (10-15 m) tangential vehicular traffic such as large noisy tractor-trailers.

6.204 Rodgers and Schwikert (2002) reported that Least Terns flushed at an average distance of 20 m (range 5-46 m) when foraging and/or loafing birds were approached by powered watercraft (jet skis, etc.) and recommended a minimum set-back distance of 86 m to protect foraging and/or loafing Least Terns from disturbance by personal watercraft.

6.205 There is no published information on the response of Little Terns to disturbance in Ireland. However, according to NPWS, the "*general consensus … is that at mainland sites such as Baltray, Kilcoole etc. they are habituated or more tolerant than at remote sites such as Wexford Harbour*".

6.206 In Wexford Harbour, the response of Little Terns to boats may be complex. They are reported to flush when directly approached by boat, but to tolerate boats as long as they keep moving, although very small boats like canoes may be able to approach closer, while larger boats in the channels or over the mussel beds in deeper water have not been a problem (NPWS). The 2014 tern monitoring report describes how, on one visit, an observer was able to approach within c. 100 m of the main colony and that "*while there were many dreads and much activity, Tony was able to get three Apparently Occupied Nest (AON) counts done*". However, when he tried to do the same at the other colony "*they didn't seem as comfortable and an accurate AON count was not possible*" (NPWS, 2014). It is also noted that "*for some later observations we found that the birds were unsettled if we were on land but OK with us if we moored off shore in shallow water with the tripods standing on the sand in a foot or so of water*" (NPWS).

Assessment: disturbance to breeding colonies

6.207 The available literature indicates that Little Terns are relatively tolerant of human disturbance. However, responses to disturbance will always be influenced by site-specific factors. The colony locations in Wexford Harbour are in remote areas with little regular access, so the birds are unlikely to be habituated to high levels of disturbance. Therefore, in the absence of detailed site-specific information on the response of Little Terns in Wexford Harbour a precautionary approach is required. NPWS have stated that *larger boats in the channels or over the mussel beds in deeper water have not been a problem*. However, the licensed mussel bottom culture sites are not in close proximity to the tern colony locations: the nearest license is over 700 m at its closest point from the Bird Island colony location (Figure 6.7). The Fort Bank colony location is, at its closest point, around 340 m from the main navigation channel. As there will be regular boat traffic along this channel, it is reasonable to assume that the Little Terns are not significantly disturbed by boat traffic at this distance.

6.208 The Fort Bank colony location (which was occupied in 2013 and 2014) overlaps with one of the applications (T03/074A). The smaller eastern portion of the colony is within the application, while the larger western portion is around 50 m from the edge of the application. However, the portion of the application that contains areas of sandbank and intertidal habitat will not be used for mussel bottom culture. Therefore, in practice the closest potential dredging activity to the colony location will depend upon the configuration of sandbank and intertidal habitat in the vicinity of the colony location. This is not possible to predict as it is likely to vary from year to year. A 340 m buffer around the Fort Bank colony locations occupies 22% of this application site. Taking a precautionary approach, any boat activity within this area during the May-July period can be assumed to have the potential to cause significant disturbance to the Fort Bank colony.

6.209 The Bird Island colony location held the main colony in 2012, with small numbers present in 2013, was unoccupied in 2014, but held the main colony again in 2015. It should be noted that the Bird Island sandbank appears to be more stable than the sandbanks in the Dogger bank/Fort Bank area with little change in its configuration between 2011 and 2014 (from comparison of the Wexford Harbour chartlets).

6.210 The Bird Island colony location, and a 340 m buffer around the colony location, is outside any of the licences or applications. Therefore, this colony location will not be affected by disturbance from boat activity associated with bottom mussel culture.

6.211 The Bird Island colony location is around 650 m from application T03/093B. This application will be cultivated using the seed collection method. This method will involve pedestrian activity in the intertidal zone (during the identification of seed mussel patches in April-May). It is likely that the Little Terns are more sensitive to disturbance from pedestrians than they are from boats. The pedestrian activity will occur in an area of intertidal habitat that is contiguous with Bird Island. Therefore, comparisons with their response to existing pedestrian activity around Rosslare Back Strand are not relevant as the latter is separated from Bird Island by a deep subtidal channel. However, even given these considerations, it seems unlikely that pedestrian activity at a distance of 650 m from the colony could cause significant disturbance. The only likely risk factor would be if the persons working in the plot brought dogs with them (as has been observed to be the case with aquaculture husbandry activity in other sites), as the dogs could then run off and disturb the colony.

6.212 Given the mobile nature of the sandbanks in Wexford Harbour, it is also possible that additional colony locations would be used in the future. In the event that the two known colony locations become unsuitable, it is possible that mussel dredging activity could prevent Little Terns from occupying suitable locations elsewhere and/or cause significant disturbance to colonies in such locations. However, this risk can be addressed by an adaptive management strategy (see paragraph 6.215).

Assessment: disturbance to foraging/roosting birds

6.213 Tern species are generally very tolerant of human disturbance when foraging. Therefore, bottom mussel-associated boat activity will not cause significant disturbance to foraging Little Terns in Wexford Harbour.

6.214 Post-breeding flocks of juveniles gather in the Hopeland area, which is adjacent to one of the seed collection sites (T03/093B). Therefore, there is potential for boat activity (during the harvesting of mussels, which takes place from April to September) within the site to cause disturbance to flocks of roosting Little Terns within the Hopeland subsite. An 86 m buffer from the edge of the seed collection site (see above) would occupy 7.1 ha within the Hopeland subsite (around 8% of the subsite). This would suggest that there would be ample area within the Hopeland subsite that would not be disturbed by boat activity within site T03/093B. However, at high tide (when the boat activity will occur), there will only be limited areas available for roosting terns within the Hopeland subsite, so further information on the exact locations used by the roosting Little Terns within this subsite is required to complete this assessment.

Mitigation recommendations

6.215 An adaptive management strategy to protect the Little Tern breeding colony, and the post-breeding flocks of juveniles in the Hopeland area, should be prepared. This would specify: the buffer zones required to protect the colonies/flocks from disturbance (e.g., 340 m around the Fort Bank colony; see paragraph 6.209); additional measures (such as prohibiting dogs from accompanying workers in the seed collection site); and monitoring requirements. The strategy would have to allow for the possibility of the terns moving their colony locations: e.g., an assessment could be carried out in April of the suitability of the existing colony sites and, if the existing colony sites were considered to now be unsuitable (due to winter storm damage) buffer zones could be put in place around additional potential sites until it became clear which site(s) are going to be occupied that year. The monitoring carried out as part of this strategy would help to improve knowledge about the sensitivity of Little Terns in Wexford Harbour to disturbance, and may allow relaxation of some of the prescriptions (e.g., reduce the size of the buffer zones required).

Species assessments: Sandwich Tern, Roseate Tern, Common Tern and Arctic Tern

Distribution within Wexford Harbour and the Raven/Rosslare Bay

6.216 These species are SCIs of the Lady Island Lake SPA. Sandwich Tern regularly commute overland from Lady's Island Lake to feed in Wexford Harbour and elsewhere. The other tern species do not appear to regularly feed in Wexford Harbour and the Raven during the nesting season. However, there is post-breeding dispersal with juveniles of all four SCI tern species gathering on sandbanks in Wexford Harbour, although there has been no systematic monitoring of this. (NPWS).

Disturbance

6.217 Tern species are generally very tolerant of human disturbance when foraging. Therefore, bottom mussel-associated boat activity will not cause significant disturbance to foraging terns in Wexford Harbour.

6.218 Roosting terns may be more susceptible to disturbance from human activity. The distribution of bottom mussel-related boat activity in relation to sandbank habitat is discussed above in the assessment of potential disturbance impacts to roosting waders (see paragraphs 6.188-6.190). Further information on the distribution and usage of tern roost sites under various tidal conditions, and the sensitivity of sandbank roosting terns to disturbance from dredging activity in Wexford Harbour would be required to fully assess this potential impact.

Conclusions

Potentially significant impacts

6.219 The following are potential impacts where the available evidence indicates a high likelihood of significant impacts occurring.

Red-breasted Merganser

6.220 Disturbance from bottom mussel-related boat activity may cause significant displacement impacts to Red-breasted Merganser. The mean area potentially disturbed could amount to around 19-27% of the total area of available habitat. High levels of impact could occur on around 80% of days in the October-December period, for periods of up to 55-66% of daylight hours.

6.221 While it is likely that some degree of significant displacement impact will occur, further information on the spatial and temporal patterns of bottom mussel-related boat activity, and more research on the nature of the mergansers' disturbance response and their distribution within Wexford Harbour, would allow a more precise assessment of the scale of the impact. This further information would determine whether or not the displacement impact causes regular disturbance of a significant proportion (e.g., 5%) of the Wexford Harbour population, allowing a definitive assessment as to whether or not the displacement impact is significant.

6.222 The population-level consequences of the displacement impact will depend upon whether the displaced birds can find suitable alternative habitat to feed in while they are displaced, or, if this is not the case, whether the undisturbed portion of the day provides sufficient feeding time for the birds to meet their daily energetic requirements.

Little Tern

6.223 There is potential for significant disturbance impacts to the Little Tern breeding colony. However, these can be avoided through an appropriate adaptive management strategy (see paragraph 6.215).

Other Potential Impacts

6.224 The following are potential impacts where the available evidence is not sufficient to rule out significant impacts beyond reasonable scientific doubt. However, this does not mean that all these impacts are considered to be very likely to occur.

Greenland White-fronted Goose

6.225 NPWS have raised concerns about the potential for dredger activity close to the North Slob to cause disturbance to Greenland White-fronted Geese feeding on the North Slob. As noted for merganser, above, further information on the spatial and temporal patterns of bottom mussel-related boat activity, and more research on the sensitivity of Greenland White-fronted Geese to disturbance in the context of their use of the site across the winter would allow for a definitive assessment as to whether or not disturbance is significant.

6.226 Further information on the distance from the sea wall at which dredging activity causes disturbance to geese on the North Slob would be required to fully assess this potential impact.

Scaup, Goldeneye, Red-breasted Merganser and Great Crested Grebe

6.227 There is potential for night-time dredging to cause disturbance to nocturnal roosts of these species. To complete the assessment of this potential impact, further information about the location and seasonal patterns of usage of these nocturnal roosts would be required, as well as information about the sensitivity of nocturnally roosting birds to disturbance from marine traffic.

Long-term impact on mussel beds

6.228 In the long term, it is possible that the seed collection method could prevent the regeneration of existing intertidal mussel beds and reduce the quality of the habitat for Oystercatcher, Knot, Curlew and Redshank. Information on the existing extent of intertidal mussel beds, their usage by these wader species, and the impact of seed collection on the mussel bed dynamics would be required to fully assess this potential impact. Furthermore, the potential disturbance to terms must also be considered here.

Disturbance to high tide roosts

6.229 Mussel-related boat activity could cause disturbance to high tide wader and tern roosts on sandbanks in the mouth of Wexford Harbour. Further information on the distribution and usage of wader and tern roost sites under various tidal conditions, and the sensitivity of sandbank roosting waders and terns to disturbance from dredging activity, in Wexford Harbour would be required to fully assess this potential impact. It is, however, noted that the value of such locations (outside of the main navigational channel) as aquaculture sites is questionable given the shallow depth (Francis O'Beirn, Marine Institute, pers. comm).

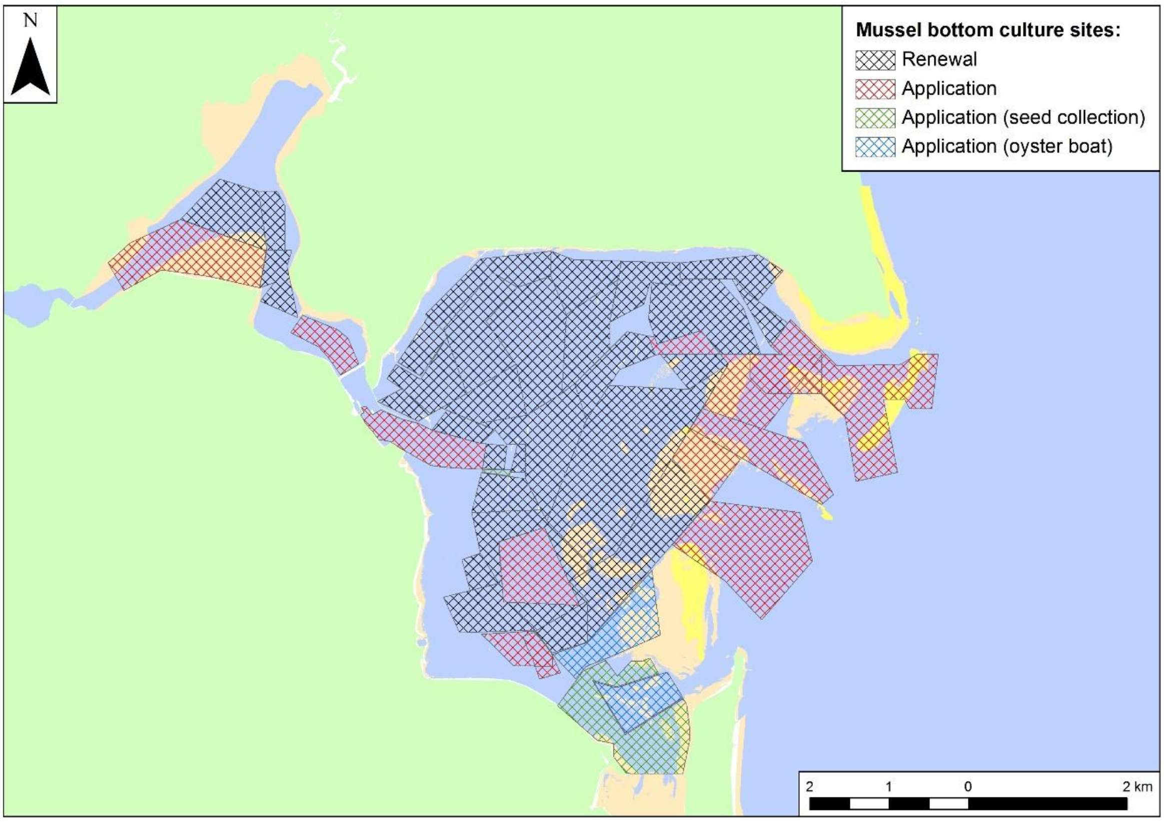

Figure 6.1 - Mussel bottom culture applications and renewals.

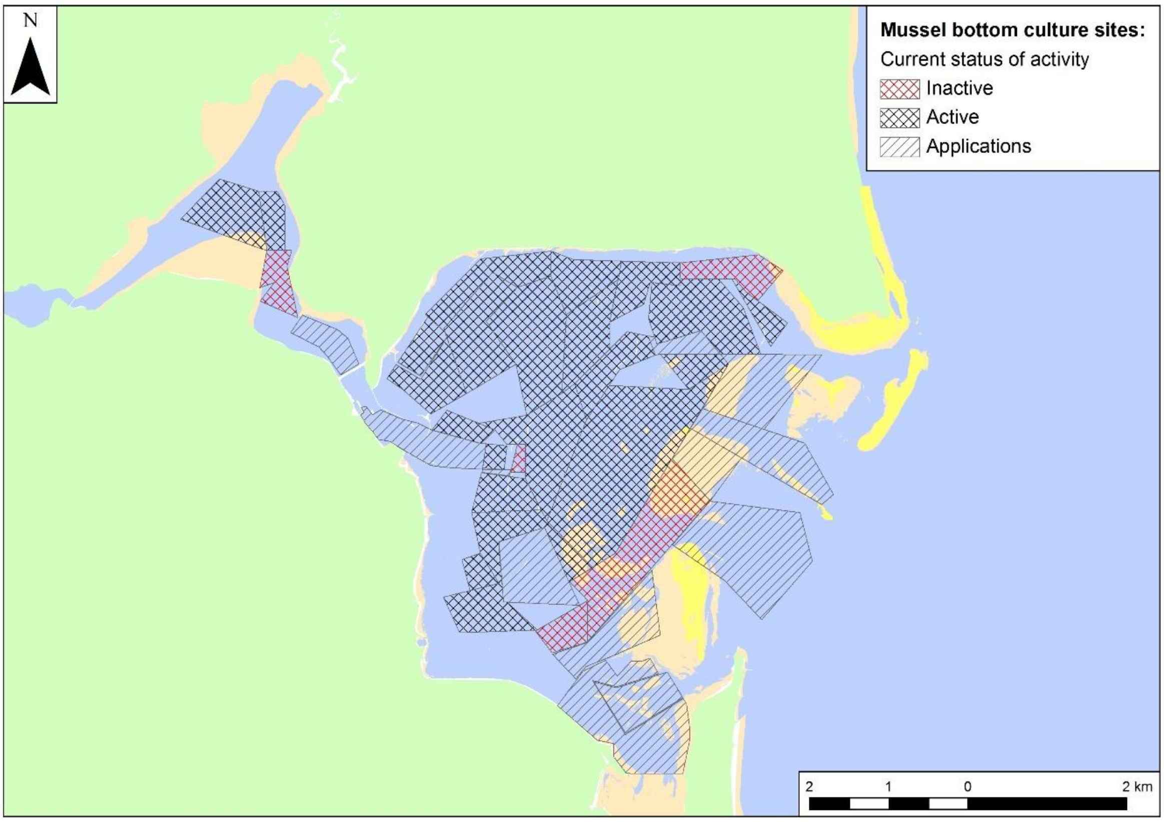

Figure 6.2 - Current status of mussel bottom culture activity in Wexford Harbour.

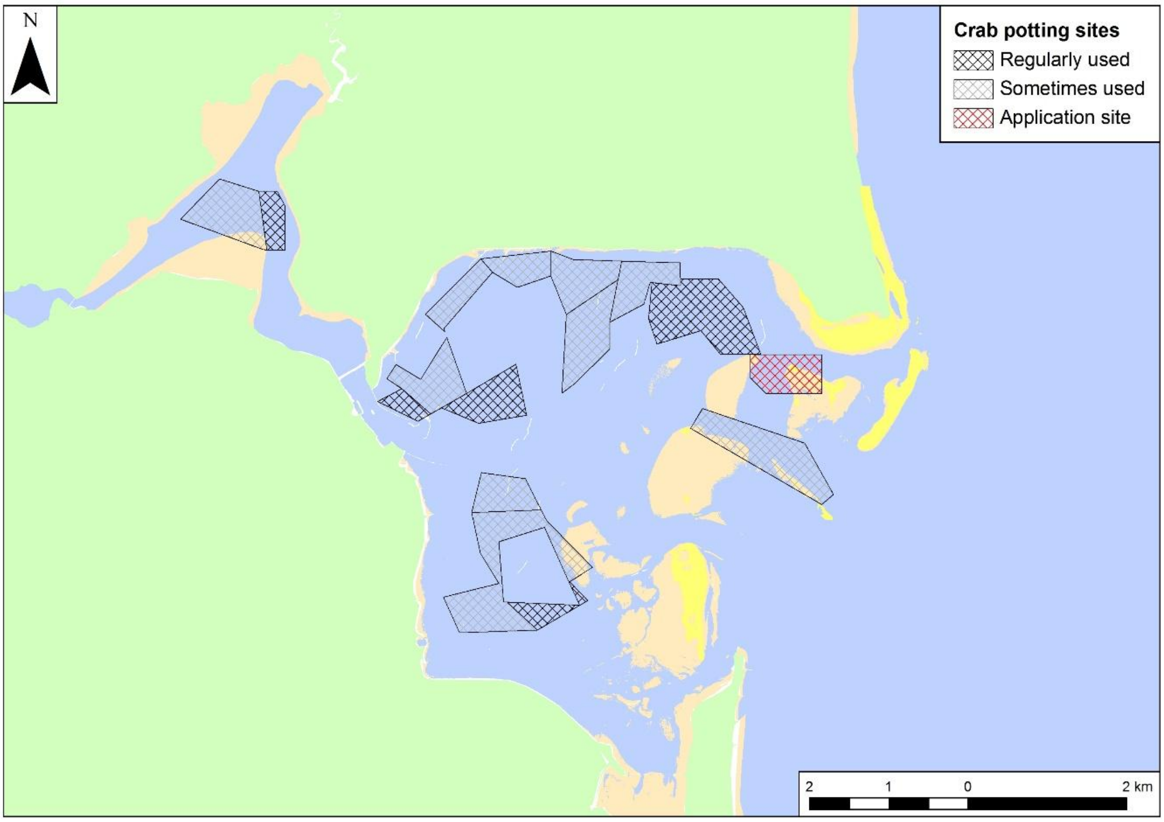

Figure 6.3 - Mussel bottom culture sites used for crab potting.

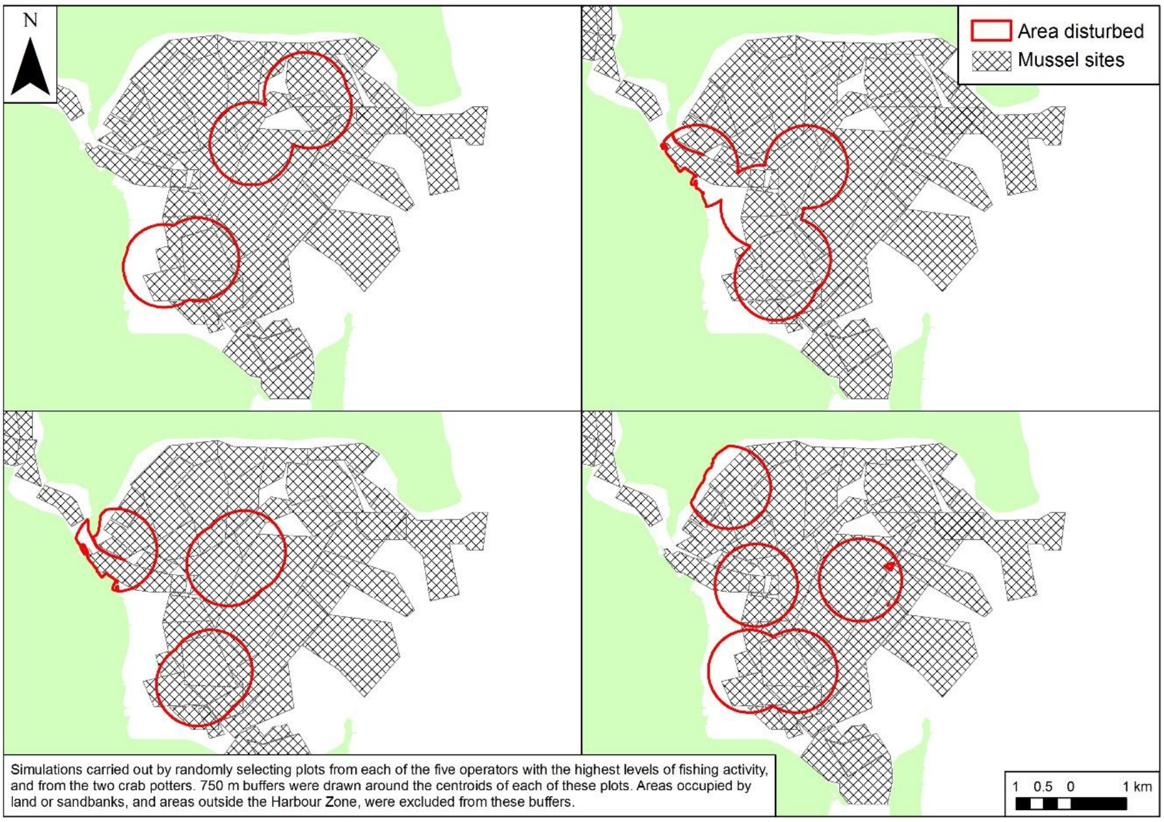

Figure 6.4 - Examples of simulations of areas potentially disturbed with seven boats (five dredgers and two crab potters) fishing at the same time.

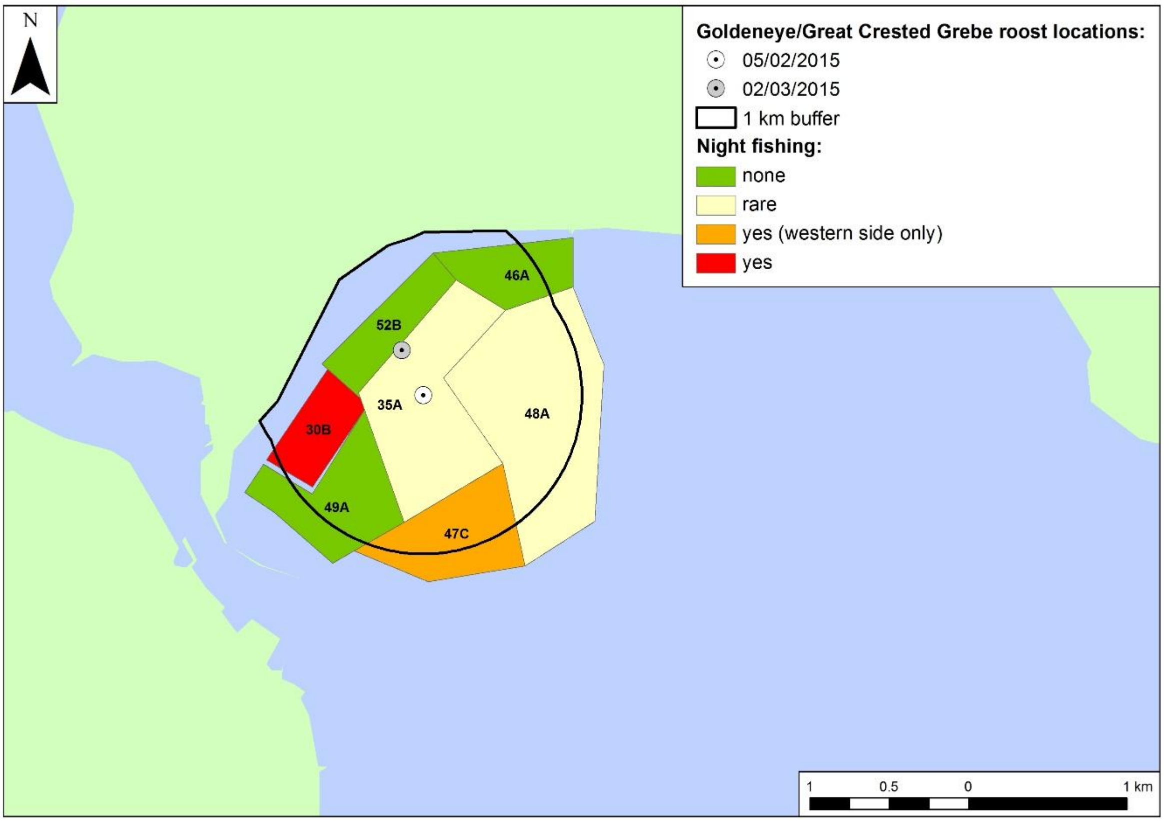

Figure 6.5 - Night-fishing activity in the vicinity of the Goldeneye/Great Crested Grebe roosting area.

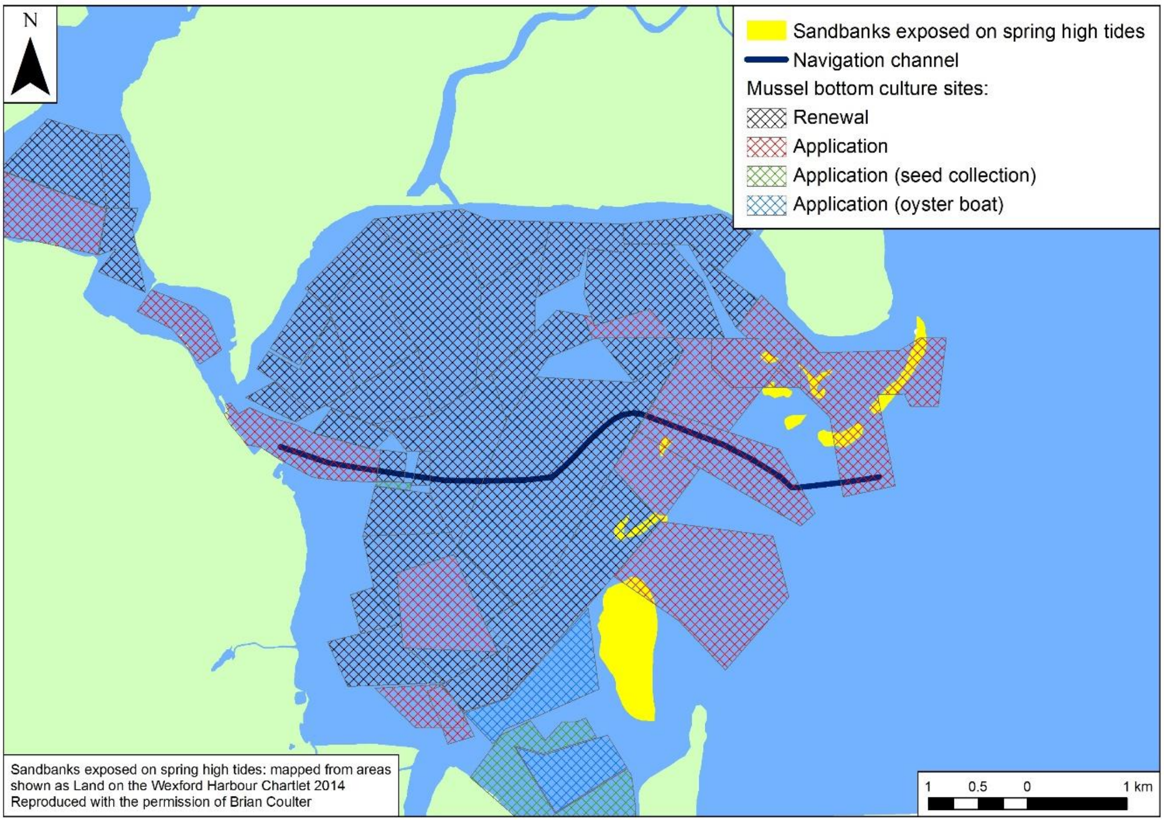

Figure 6.6 - Distribution of sandbanks exposed on spring high tides.

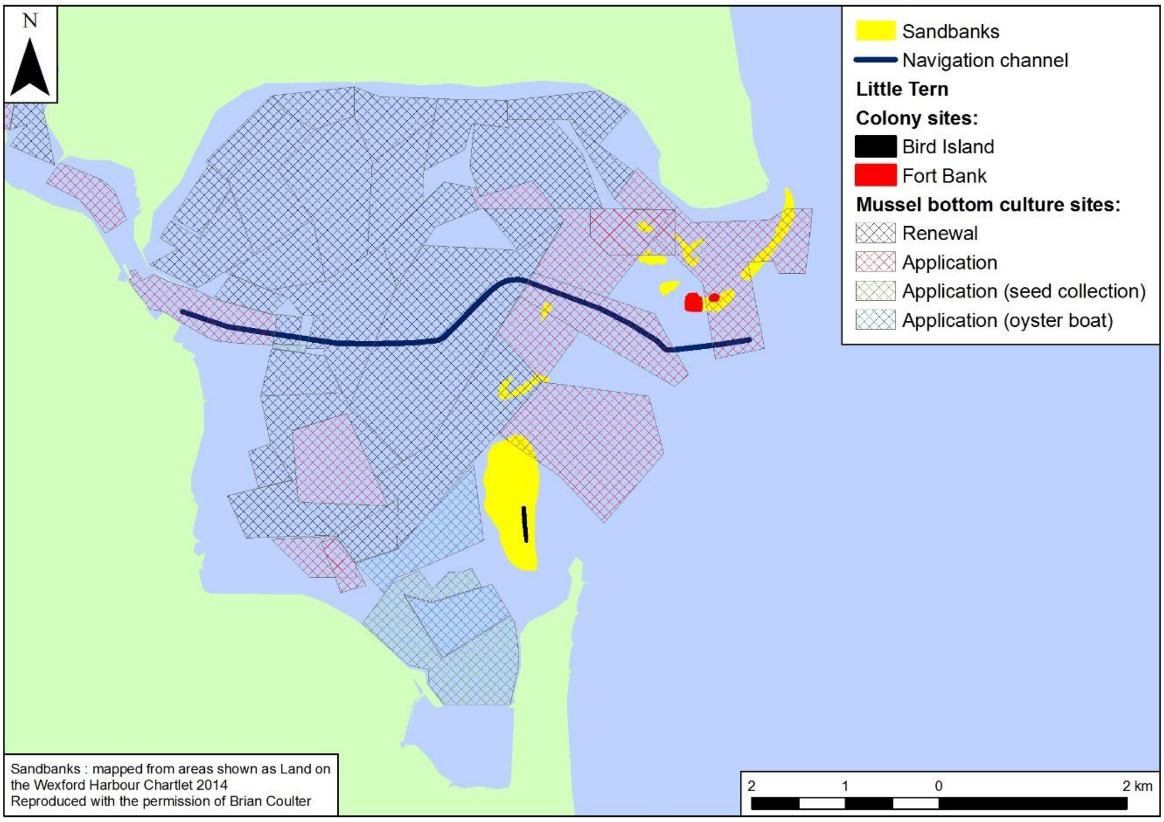

Figure 6.7 - Distribution of Little Tern colony locations in relation to the mussel bottom culture sites.

7. Intertidal oyster cultivation

Scope of activity

7.1 There are no sites currently licensed for intertidal oyster cultivation in Wexford Harbour. There are two sites with applications for intertidal oyster cultivation:

- T03/079A, which occupies an area of 22 ha on the western side of the harbour.
- T03/092A, which occupies an area of 11 ha on the western side of Bird Island.

7.2 Both sites will be cultivated by the same operator, by off-bottom cultivation using bags and trestles.

7.3 While intertidal oyster cultivation has never been licensed in Wexford Harbour, there has been unlicensed activity in site T03/079A. In 2014, the trestles occupied an area of around 1 ha. This activity has been occurring here since 2007, and the trestles have occupied a maximum area of 1 ha during this period.

Description of activity

7.4 The following description is based upon notes of an interview with the operator supplied by Brian O'Loan (BIM), and responses from the operator to specific queries, unless otherwise stated.

7.5 The applicant has applied for two sites: T03/79A and T03/92A. Site T03/79A will be the main husbandry site, while site T03/92A will be used to finish the oysters. The market season is likely to be October-January, and oysters will require finishing for several months before harvesting. Therefore, most activity on site T03/92A is likely to take place from late summer through to mid-winter.

7.6 Oysters will be cultivated in these sites by off-bottom cultivation using bags and trestles. The density of trestles in the plots will be relatively low, to avoid sediment build up due to the slack currents in these areas of the harbour. The oyster 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.

7.7 The trestles will be lined out in single rows with a separation of around 4 m between rows and with wider (10-20 m) access lanes between blocks of rows. The rows are usually orientated more or less in line or at a slight angle to the current direction.

7.8 Oyster spat is supplied by hatcheries and is placed in mesh bags. These mesh bags are 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 and protection from predators. The mesh bags facilitate handling.

7.9 The intertidal oyster sites will be accessed for husbandry activities by boat on fortnightly spring tides. Therefore, these sites would be accessed on eight days/month. Husbandry activity will not take place at night. Husbandry activity will involve turning and shaking bags, splitting bags (reducing number of oysters per bag and final bagging in 25 kg onion bags). Three people will be working on the plots over the low tide period during normal husbandry practices, with five during the harvesting season.

7.10 Husbandry activities involve turning some of the mesh bags every spring tide to improve the shape of oysters, avoid oysters growing into each other and the bag, to promote even growth throughout the bag, to reduce seaweed growth on the bag and to knock off the frill of growth prior to sale. Only a proportion of the trestles will hold oyster bags at any one time. Trestles will hold the most bags approaching the sales season and will hold the least bags after sales and before new seed arrives in.

7.11 Two boats will be used to access the sites, travelling at speeds of around 1.5-2 knots. Site T03/079A will be accessed at its northern end, while site T03/92A will be accessed at its western end. Most access will be by a flat bottomed cot 6.1 m (20 ft) long, 1. 8 m (6 ft) beam, with a couple of inches draft and an outboard engine (8 hp). A steel flat-bottomed boat 6.7 m (22 ft) long, with no wheelhouse, and with an outboard motor (20 hp) will be used occasionally.

7.12 This boat will take staff to and from the sites from the Hantoon Road/Harbour View Road slip. All grading, splitting of bags, and bagging into 25 kg onion bags for sale will be done on site on a raft (in site T03/92A). The raft is 6.1 m (20 ft) by 4.9 m (16 ft) and has 16-20 barrels secured underneath it. 25 kg bags of oysters ready for market will be stored on plastic pallets on site until a load of 2 tonnes is ready.

7.13 Bagged loads will be transported to Ferrybank and loaded onto pallets for transport to buyers. This boat will be used mainly in the late autumn winter months which will be the main harvesting period.

Potential impacts

Ecosystem effects

7.14 Aquaculture could, 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 (see paragraphs 6.77-6.79). However, given the small scale of intertidal oyster cultivation proposed for Wexford Harbour, in relation to the overall size of the harbour, the trophic pathways involving intertidal oyster cultivation are unlikely to form a major component of the overall food web system, and, therefore, ecosystem level effects on fish populations are unlikely to occur.

Habitat structure

7.15 Intertidal oyster cultivation causes a significant alteration to the intertidal habitat suitable for bird usage 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 that trestles may interfere with flocking behaviour causing species that typically occur in large, tightly packed flocks to avoid the trestles (Gittings and O'Donoghue, 2012). Trestles could also interfere with the visibility of potential predators causing increased vigilance and reduced foraging time, while they may also interfere with the ability of hunting raptors to detect and capture prey.

Food resources

Benthic fauna

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

7.17 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.

7.18 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 or 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.

7.19 In more recent work commissioned by the Marine Institute, Forde *et al*. (*in prep.)* looked at benthic invertebrates along access tracks, under trestles and in close controls at a number of sites nationally. 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, this research indicates that intertidal oyster cultivation is unlikely to have had major impacts on food resources for waterbirds that feed on benthic fauna (Forde *et al*., 2015).

Fish

7.20 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.

Disturbance

7.21 Intertidal oyster cultivation can require intensive husbandry activity and this may cause impacts to waterbirds using intertidal and/or shallow subtidal habitats through disturbance. Disturbance will not affect high tide roosts, or waterbirds that mainly, or only, use trestle areas when they are covered at high tide, because no husbandry activity takes place during the high tide period.

7.22 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 in relation to potential impacts on waterbirds at low tide.

Screening

7.23 Common Scoter and Red-throated Diver occur almost exclusively within the Raven Zone (means of 99% and 95%, and ranges of 93-100% and 73-100%, of the total counts, respectively). Therefore, these species have been screened out of the assessment of intertidal oyster culture.

7.24 Intertidal oyster cultivation in Wexford Harbour will not affect the habitat quality for fish-eating species that only utilise subtidal habitat. Therefore, Red-breasted Merganser, Great Crested Grebe and Cormorant can be screened out from further assessment in relation to habitat impacts. However, Red-breasted Merganser appears to be very sensitive to disturbance from marine traffic in Wexford Harbour, so detailed assessment of potential disturbance impacts is required for this species.

7.25 The intertidal oyster culture sites, and the access routes to/from these sites, are not located close to the North or South Slobs. Therefore, husbandry activity will not cause disturbance to birds in these areas. Given the small scale of the activity, husbandry activity will not pose a significant risk of disturbance to birds temporarily displaced from the North and South Slobs by hunting activity. Therefore, the following species, which occur mainly, or exclusively, on the North and South Slobs, can be screened out from further assessment: Whooper Swan, Bewick's Swan, Wigeon, Teal, Mallard, Pintail, Little Grebe and Coot. In addition, Greenland White-fronted Goose, which mainly occurs on the slobs, but roosts nocturnally on sandbanks within the harbour, can be screened out because husbandry activity will not take place at night (and the main roost site is also several kilometres from the intertidal oyster culture sites).

7.26 A number of species have neutral, or positive, associations with intertidal oyster cultivation and can, therefore, be screened out from further assessment: Grey Heron, Oystercatcher, Curlew and Redshank.

7.27 Therefore, the following species remain for detailed assessment: Light-bellied Brent Goose, Shelduck, Scaup, Goldeneye, Red-breasted Merganser, Golden Plover, Grey Plover, Lapwing, Knot, Sanderling, Dunlin, Black-tailed Godwit, Bar-tailed Godwit, Black-headed Gull, Lesser Black-backed Gull and Little Tern.

Table 7.1 - Species and potential impacts screened-in for detailed assessment of intertidal oyster cultivation.

Species	Ecosystem impacts	Habitat impacts	Disturbance impacts	Other impacts
Light-bellied Brent Goose	x	√	x	x
Shelduck	x	√	x	x
Scaup	x	√	√	x
Goldeneye	x	√	√	x
Red-breasted Merganser	x	x	√	x
Golden Plover	x	√	x	x
Grey Plover	x	√	x	x
Lapwing	x	√	x	x
Knot	x	√	x	x
Sanderling	x	√	x	x
Dunlin	x	√	x	x
Black-tailed Godwit	x	√	x	x
Bar-tailed Godwit	x	√	x	x
Black-headed Gull	x	√	x	x
Lesser Black-backed Gull	x	√	x	x
Little Tern	x	x	√	√

see text for details.

Species assessments: Scaup and Goldeneye

Distribution within Wexford Harbour and the Raven/Rosslare Bay

7.28 Historically, most Scaup occurred within the Harbour Zone. Very few Scaup have been recorded in recent years, and these have mainly been recorded from the North Slob. However, if Scaup numbers were to recover, significant numbers might again occur within the Harbour Zone (see paragraph 6.119). On the few complete counts of the Harbour Zone, when large numbers of Scaup have been recorded, their distribution has varied, although there may be a preference for the northern section of the harbour (Table 7.2).

7.29 Around 50% of the Goldeneye population occur within the Harbour Zone. Within the Harbour Zone, the highest numbers occur along the northern side of the harbour (subsite 0O490) (Table 6.13). Relatively high numbers of these species, compared to the available habitat, occur at Rosslare Backstrand (0O495) The Inner South Harbour (0O485/496) generally holds relatively low numbers compared to the available habitat.

Table 7.2 - Distribution of Scaup within the Harbour Zone on counts where significant numbers have been recorded.

Winter	Month	Raven Pt. - Ferrybank (0O490)	Rosslare Backstrand (0O495)	South Slob & adjacent harbour (0O496)	Total
1994/95	Jan	0	0	184	184
1995/96	Jan	420	0	10	430
	Feb	220	0	0	220
1996/97	Dec	240	0	0	240
	Jan	466	265	0	731
2002/03	Jan	0	0	82	82

Includes data from all I-WeBS counts with complete coverage of the Harbour Zone and on which more than 50 Scaup were recorded. Counts from 0O496 are assumed to refer to the section within the Harbour Zone.

Habitat impacts

7.30 In marine habitats Scaup mainly feed on molluscs and often feed predominantly on mussels. Goldeneye mainly feed on crustaceans and molluscs, and can also feed predominantly on mussels in some sites. However, in Wexford Harbour the relaid mussels are above the preferred size range for Goldeneye and will only be suitable for Scaup for the first few months following relay (see paragraphs 6.132-6.133). Therefore, these species are likely to feed on natural mussel settlement, and/or other benthic prey resources.

7.31 The potential impact of intertidal oyster culture on benthic prey resources for Scaup and Goldeneye is not known. The research discussed above (paragraphs 7.16-7.20) suggests that intertidal oyster culture in Ireland generally does not cause large changes to benthic communities and should not, therefore, have significant effects on the availability of food resources for Scaup and Goldeneye. However, it is possible that the trestles may impede access to the benthic habitat for diving birds. This would have a greater impact on Scaup, which mainly feed in the benthic zone, compared to Goldeneye, which feed in both the benthic and pelagic zones.

7.32 The intertidal oyster sites occupy a combined area of 33 ha. This amounts to around 1% of the total area of habitat that would be available at high tide within the Harbour Zone. While the data on Scaup distribution within the Harbour Zone is limited, both species are likely to feed over wide areas within the harbour. Therefore, it is not scientifically plausible that such a small scale habitat impact could significantly affect food resources for these species.

Disturbance impacts

7.33 No data is available on the response of Scaup to marine traffic in Wexford Harbour. Our observations suggest that Goldeneye are not highly sensitive to disturbance by marine traffic in Wexford Harbour, although the data is limited (see paragraph 6.142).

7.34 The potential disturbance impacts to Red-breasted Merganser (a species that is highly sensitive to disturbance in Wexford Harbour) from intertidal oyster cultivation have been assessed as not being significant (see paragraphs 7.37-7.41). Therefore, notwithstanding the lack of information for Scaup, and the limited data for Goldeneye, it is scientifically reasonable to conclude that the disturbance impacts from intertidal oyster cultivation will not be significant.

Species assessments: Red-breasted Merganser

Response to disturbance

7.35 Observations made during survey work for this assessment indicate that Red-breasted Mergansers in Wexford Harbour are very sensitive to disturbance, with 84% of observations within 500 m lateral distance of boat routes showing a disturbance response (see paragraphs 6.138-6.139 and Appendix C). The data included eight observations of disturbance responses to the cot that was being used to access the unlicensed intertidal oyster trestles. The disturbance response to this cot did not significantly differ from those to the other vessel types included in the dataset (although our analysis was constrained by limited data for the disturbance response to cots at large lateral distances).

7.36 On one of the occasions when mergansers were flushed by the cot as it approached the trestles, the birds settled on the water to the south of the trestles, within a few hundred metres, and remained there when the boat arrived and the workers began husbandry activities.

Energetic impacts

7.37 Applying a flat-ended 500 m buffer, the access routes to site T03/079A would affect 72 ha of habitat, while the access route to site T03/092A would affect 333 ha of habitat.

7.38 If the typical density of Red-breasted Mergansers within the Harbour Zone is assumed to be one bird per 38 ha, then a round-trip to site T03/079A would flush 3.8 birds, while a round-trip to site T03/092A would flush 17.5 birds. This means that the mean flush rate would be less than 0.05-0.25 flushes per bird per day. As husbandry work will take place on eight days per month, the mean flush rate across all days would be around 0.01-0.07 flushes per bird per day.[8]

7.39 This level of disturbance would not cause significant energetic impacts (see paragraphs 6.151-6.154).

Displacement impacts

7.40 The boats will only be used to travel to, and from, the sites and the duration of the journeys will be around 17 minutes (T03/079A), or 66 minutes (T03/092A). Therefore, the boat use will not cause sustained displacement of mergansers.

7.41 The observation described above of mergansers remaining present within a few hundred metres of workers while they were carrying out husbandry activities on the trestles, suggests that the mergansers are less sensitive to disturbance impacts from pedestrian activity, compared to their sensitivity to disturbance from boats. Similarly, mergansers were observed on several occasions close to shoreline areas where they did not show any disturbance response to pedestrian activity along the shoreline. Therefore, it is unlikely that husbandry work will cause significant displacement of mergansers.

[8] See paragraphs 6.154-6.155, and associated footnotes, for details of assumptions and caveats to this assessment.

Species assessments: Light-bellied Brent Goose, Shelduck, Golden Plover, Grey Plover, Lapwing, Knot, Sanderling, Dunlin, Black-tailed Godwit, Bar-tailed Godwit, Black-headed Gull and Lesser Black-backed Gull

Distribution within Wexford Harbour and the Raven/Rosslare Bay

7.42 The available data on the distribution of the species included in this section of the assessment is summarised in Table 7.3. Apart from Black-headed Gull, the BWS data indicates that the species occur in low numbers in the Inner South Harbour subsite (0O485). This pattern of occurrence is considered to be representative by the I-WeBS counter, although the subsite is counted from the south end so coverage of the further reaches of the subsite may be limited (Tony Murray, NPWS, pers. comm.). The Black-headed Gulls are mainly associated with the WWTP outfall. The presence of existing, unlicensed, intertidal oyster cultivation within the subsite could, in theory, have influenced the percentage occurrences to a small degree. However, the area of trestles involved is so small (around 1 ha), that any displacement impacts would have been very minor, and would not have significantly affected the occurrence of birds within the subsite.

7.43 Most species occur in higher numbers within the Rosslare Backstrand subsite (0O495). The species that occurred in the highest numbers are Golden Plover, Grey Plover and Sanderling, with significant numbers also of Bar-tailed Godwit (although the data for Sanderling are based on a single count). Grey Plover, Sanderling and Bar-tailed Godwit are often (Grey Plover), or usually (Sanderling) associated with sandy substrates. The high numbers of Golden Plover may be because the subsite offers extensive areas of undisturbed intertidal habitat. Therefore, it is likely that these species also use the area of intertidal habitat at the mouth of the harbour, to the north of the Rosslare Backstrand subsite, which was not covered by the BWS counts. If this is the case, then the figures in Table 7.3 will overestimate their percentage occurrence in the Rosslare Backstrand subsite.

7.44 Species that are typically associated with muddy substrates (Light-bellied Brent Goose, Shelduck, Dunlin and Black-tailed Godwit) occurred in higher numbers in the Hopeland subsite (0O498), suggesting that their occurrence within the Rosslare Backstrand subsite is likely to be mainly in the muddier southern section of the subsite (although Dunlin flocks were mapped on the intertidal area around Bird Island). Therefore, these species are less likely to make use of the area of intertidal habitat at the mouth of the harbour, to the north of the Rosslare Backstrand subsite, which was not covered by the BWS counts.

Table 7.3 - Distribution of intertidal and shallow subtidal species.

	Across zones		Within Harbour Zone			
Species	**Harbour Zone**	**n**	**0O485**	**0O495**	**0O498**	**n**
Light-bellied Brent Goose	60%*	16	9%	14%	52%	4
Shelduck	90%	17	0%	21%	71%	2
Golden Plover	53%*	19	0%	67%	31%	3
Grey Plover	95%	20	4%	61%	21%	4
Lapwing	42%*	15	0%	0%	82%	2
Sanderling	100%	12	0%	92%	8%	1
Dunlin	94%	20	0%	16%	70%	4
Black-tailed Godwit	38%*	22	1%	0%	55%	2
Bar-tailed Godwit	90%	22	1%	35%	23%	4
Black-headed Gull	42%	21	25%	19%	21%	4
Lesser Black-backed Gull	61%	9	5%	7%	4%	3

Mean percentage occurrence across zones calculated from all qualifying I-WeBS and BWS counts (see Table 5.7 for details).

Mean percentage occurrence within the Harbour Zone calculated from BWS low tide counts.

* may include significant numbers within the South Slob.

Impact on intertidal habitat

7.45 Site T03/079A, occupies an area of 22 ha on the western side of the harbour. Based on GSI bathymetry data the site becomes fully exposed on tides of 0.6-0.7 m, which are just below the mean low tide (0.75 m) (Table 7.4). However, the quality of the GSI bathymetry data was classified as being of limited reliability in this area.

7.46 Site T03/092A occupies an area of 11 ha straddling the eastern edge of the Inner South Harbour subsite (0O485/496) and the western edge of the Rosslare Backstrand subsite (0O495). Based on GSI bathymetry data, the portion of the site within the Rosslare Backstrand subsite is of relatively high elevation and becomes more or less fully exposed on tides of 0.8 m, which are just above the mean low tide (Table 7.5), while the portion of the site within the Inner South Harbour subsite is of lower elevation and only becomes substantially exposed on tides of 0.6 m (Table 7.4). The quality of the GSI bathymetry data was classified as being of high reliability in this area.

7.47 The intertidal habitat within the Rosslare Backstrand subsite shows a division between two substrate types, which is visible on aerial imagery: a muddy area in the southern section of the subsite, which is mapped by NPWS as the *estuarine muds dominated by polychaetes and crustaceans community complex* biotope; and a sandy area in the northern section of the subsite, which is mapped by NPWS as the *sand dominated by polychaetes community complex* biotope, and which extends to the north of the subsite boundary. Site T03/079B occurs within the sandy area, and the tidal exposure of the section of the subsite occupied by the *sand dominated by polychaetes community complex* biotope is shown in Table 7.6.

7.48 Based on the GSI bathymetry data and the frequency distribution of low tide heights, the intertidal oyster sites will occupy a mean of 4.5% of the intertidal area in the Inner South Harbour subsite (0O485/496), and 4.5% of the intertidal area, and 6.8% of the intertidal sand area, in the Rosslare Backstrand subsite (0O495).

Table 7.4 - Intertidal habitat in the Inner South Harbour subsite (0O485/496).

Elevation/m	% of tides exposed	Cumulative area exposed			
		subsite	T03/079A	T03/092A	% of subsite
0.3	< 1%	728 ha	22 ha	4.6 ha	3.7%
0.4	5%	701 ha	22 ha	4.6 ha	3.8%
0.5	23%	525 ha	22 ha	4.3 ha	5.0%
0.6	49%	451 ha	22 ha	3.8 ha	5.7%
0.7	75%	241 ha	15 ha	0.8 ha	6.6%
0.8	94%	78 ha	0 ha	0.8 ha	1.0%
0.9	99%	15 ha	0 ha	0.0 ha	0.1%
1.0	100%	1 ha	0 ha	0.0 ha	0.0%
1.1	100%	0.2 ha	0 ha	0.0 ha	0.0%
1.2	100%	0.1 ha	0 ha	0.0 ha	0.0%

Elevations refer to Chart Datum Wexford.

Table 7.5 - Intertidal habitat in the Rosslare Backstrand subsite (0O495).

Elevation/m	% of tides exposed	Cumulative area exposed		
		subsite	T03/092A	% of subsite
0.3	< 1%	215 ha	6.8 ha	3.2%
0.4	5%	213 ha	6.8 ha	3.2%
0.5	23%	200 ha	6.8 ha	3.4%
0.6	49%	184 ha	6.8 ha	3.7%
0.7	75%	127 ha	6.6 ha	5.2%
0.8	94%	117 ha	6.6 ha	5.6%
0.9	99%	84 ha	5.3 ha	6.3%
1.0	100%	41 ha	1.0 ha	2.5%
1.1	100%	26 ha	0.0 ha	0.0%
1.2	100%	17 ha	0.0 ha	0.0%

Elevations refer to Chart Datum Wexford

Table 7.6 - Intertidal sand habitat in the Rosslare Backstrand subsite (0O495).

Elevation/m	% of tides exposed	Cumulative area exposed		
		subsite	T03/092A	% of subsite
0.3	< 1%	120 ha	6.8 ha	5.7%
0.4	5%	119 ha	6.8 ha	5.7%
0.5	23%	114 ha	6.8 ha	6.0%
0.6	49%	110 ha	6.8 ha	6.2%
0.7	75%	91 ha	6.6 ha	7.2%
0.8	94%	84 ha	6.6 ha	7.8%
0.9	99%	62 ha	5.3 ha	8.4%
1.0	100%	33 ha	1.0 ha	3.1%
1.1	100%	22 ha	0.0 ha	0.0%
1.2	100%	16 ha	0.0 ha	0.0%

Includes areas mapped by NPWS as the *sand dominated by polychaetes community complex* biotope. Elevations refer to Chart Datum Wexford.

Impact assessment

7.49 The intertidal oyster sites occupy relatively small percentages (~ 5%) of the intertidal habitat in the two subsites in which they occur. For the proposed intertidal oyster cultivation to cause significant displacement impacts, very large proportions of the Wexford Harbour population would have to occur within these subsites, unless there is some reason for the birds within the subsite to be concentrated in the areas occupied by the intertidal oyster sites.

7.50 In the BWS low tide counts, the Inner South Harbour subsite (0O485/496) held very small numbers of all the species included in this section of the assessment, apart from Black-headed Gull. The latter are mainly associated with the WWTP outfall, which is located at the northern end of the subsite well away from the intertidal oyster sites. Therefore, even given the limited low tide count data, it can be reasonably concluded that site T03/079A will not cause significant displacement impacts to any intertidal or shallow subtidal associated SCI species.

7.51 The BWS low tide count data indicate that several of the intertidal or shallow subtidal associated SCI species that occur in the Rosslare Backstrand subsite are associated with the estuarine muds biotope. Site T03/079B does not overlap with the mapped extent of this biotope, and the aerial imagery indicates that the boundary of the mapped area is, if anything, too far north.

7.52 The species that may occur in significant numbers in the intertidal *sand dominated by polychaetes community complex* biotope within the Rosslare Backstrand subsite are Golden Plover, Grey Plover, Sanderling and Bar-tailed Godwit. Golden Plover, Grey Plover and Sanderling are likely to be completely excluded from areas occupied by oyster trestles, while Bar-tailed Godwit occurs in reduced densities within such areas (Gittings and O'Donoghue, 2012; and unpublished data). If these species are uniformly distributed through the sandy section of the subsite (as mapped by NPWS), then based on the percentage occurrences recorded in the BWS counts (Table 7.3), and the mean tidal exposure calculated above, the percentage displacement of these species would be 2.3% for Golden Plover, 3.9% for Grey Plover, 6.3% for Sanderling and 2.1% for Bar-tailed Godwit. Given the very limited low tide count data (particularly for Sanderling), these figures can only be considered as broadly indicative. However, they may significantly overestimate the likely displacement, due to two factors: the area mapped as the *sand dominated by polychaetes community complex* biotope probably significantly exaggerates the extent of the sandy area within the Rosslare Backstrand subsite; and these species are also likely to occur in the area of intertidal habitat at the mouth of the harbour, to the north of the Rosslare Backstrand subsite, which was not covered by the BWS counts.

7.53 Taking all the above factors into consideration, it is probable that the displacement impacts for all the intertidal and shallow subtidal SCI species will be substantially less than 5%. However, there is a significant uncertainty attached to this assessment for Golden Plover, Grey Plover, Knot, Sanderling and Bar-tailed Godwit, due to the very limited low tide count data.

Species assessments: Little Tern

Distribution within Wexford Harbour and the Raven/Rosslare Bay

7.54 In recent years, the Wexford Harbour Little Tern colony has moved between Fort Bank and Bird Island, with Fort Bank occupied in 2014 and Bird Island occupied in 2015 (see paragraphs 5.27-5.30 and Figure 5.7).

Disturbance impacts

Response to disturbance

7.55 The response of Little Terns to disturbance is discussed in paragraphs 6.201-6.206.

Assessment

7.56 Site T03/092A is, at its closest point, around 400 m from the Bird Island colony site.

7.57 Intertidal oyster cultivation will involve pedestrian activity in the intertidal zone. It is likely that the Little Terns are more sensitive to disturbance from pedestrians than they are from boats. The pedestrian activity will occur in an area of intertidal habitat that is contiguous with Bird Island. Therefore, comparisons with their response to existing pedestrian activity around Rosslare Back Strand are not relevant as the latter is separated from Bird Island by a deep subtidal channel. However, even given these considerations, it seems unlikely that pedestrian activity at a distance of 400 m from the colony could cause significant disturbance. In particular, the husbandry activity will be confined to within the area of trestles, and the husbandry workers will not directly approach the trestles, while the access to the trestles will be by boat from the western end of the site (the end of the site that is the farthest away from the Bird Island colony site). The only likely risk factor would be if the persons working in the site brought dogs with them (as has been observed to be the case with aquaculture husbandry activity in other sites), as the dogs could then run off and disturb the colony.

7.58 Therefore, providing no dogs are brought out, it is unlikely that husbandry work on site T03/092A will cause significant disturbance to the Bird Island colony site. However, there is some uncertainty about this assessment, given the lack of site-specific data on the response of Little Tern to disturbance in Wexford Harbour, and the perceived high sensitivity of Little Tern breeding colonies to disturbance in remote locations. This uncertainty can be addressed by an adaptive management strategy (see paragraph 6.215).

Other impacts: predation

7.59 Predation risk is generally considered to be a significant factor in the success, or otherwise, of Little Tern breeding colonies. In a UK review, predation was cited as the most common cause of nest failure (Ratcliffe, 2003). While the most commonly reported predators were Red Foxes and raptors, corvids were reported as causing 18% of the predation failures and gulls as causing 9%. Corvids and gulls can potentially be attracted to oyster trestles in the intertidal zone. Therefore, there is a potential risk that oyster trestles in site T03/092A could attract corvids and gulls and cause an increased predation risk from these birds to the Bird Island tern colony.

7.60 Our study of the effects of intertidal oyster culture on the spatial distribution of waterbirds (Gittings and O'Donoghue, 2012) found that Black-headed Gull, Common Gull and Herring Gull showed a variable response, while Great Black-backed Gull showed a negative response. Therefore, this study did not provide evidence of a strong attractive effect of oyster trestles towards gulls. However, this study looked at overall distribution patterns. It is quite plausible that individual gulls could be attracted by oyster trestles. In particular, Herring Gulls were regularly recorded perching on the trestles. A few individual gulls could have a significant predation effect on a Little Tern colony.

7.61 Our study also recorded significant numbers of Hooded Crows (as well as occasional Ravens) using oyster trestles (although we did not analyse the results in detail).

7.62 Therefore, there is a significant likelihood that oyster cultivation in site T03/092A will increase the activity of gulls and corvids in this area. It is not possible to predict to what extent, if any, this would cause an increased predation risk to the Bird Island tern colony (in the event that it was reoccupied).

Conclusions

Potentially significant impacts

7.63 We did not identify any potential impacts where the available evidence indicates a high likelihood of significant impacts occurring.

Other Potential Impacts

7.64 The following are potential impacts where the available evidence is not sufficient to rule out significant impacts beyond reasonable scientific doubt. However, this does not mean that all these impacts are considered to be very likely to occur.

Golden Plover, Grey Plover, Knot, Sanderling and Bar-tailed Godwit

7.65 The calculated displacement impacts for these species approach, or exceed, the 5% threshold. However, taking all the relevant factors into consideration, on the balance of probabilities, it is likely that the displacement impacts for these species will be substantially less than 5%. Nevertheless, there is a significant uncertainty attached to this assessment due to the very limited low tide count data, and significant displacement impacts cannot be ruled out beyond reasonable scientific doubt. Further data on the low tide distribution of these species across the whole of Wexford Harbour (not just the I-WeBS/BWS subsites) would be required to complete the assessment for these species.

Little Tern

7.66 We consider that the distance of site T03/092A from the Bird Island colony site is probably sufficient to prevent disturbance to the colony (providing no dogs are brought out). However, there is some uncertainty about this assessment, given the lack of site-specific data on the response of Little Tern to disturbance in Wexford Harbour, and the perceived high sensitivity of Little Tern breeding colonies to disturbance in remote locations. This uncertainty can be addressed by an adaptive management strategy (see paragraph 6.215).

7.67 There is a significant likelihood that oyster cultivation in site T03/092A will increase the activity of gulls and corvids in this area. It is not possible to predict to what extent, if any, this would cause an increased predation risk to the Bird Island tern colony.

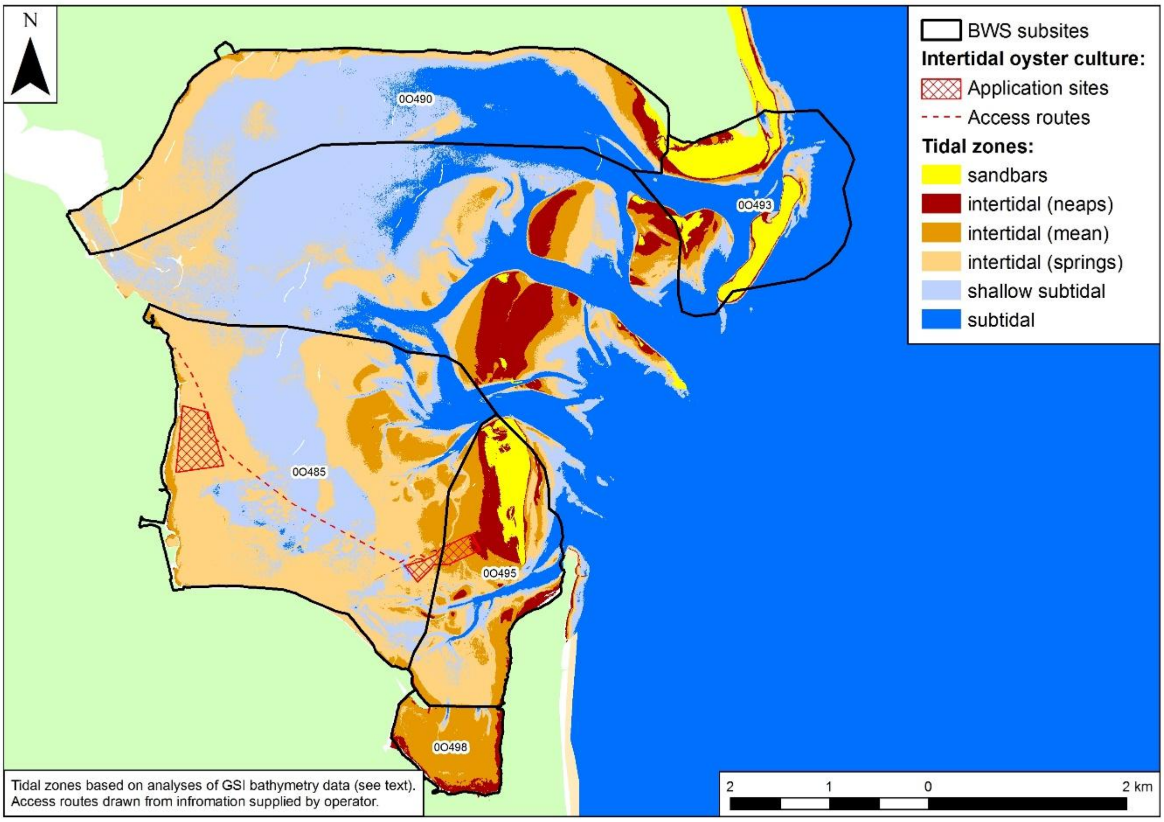

Figure 7.1 - Intertidal oyster cultivation sites and tidal zones in Wexford Harbour.

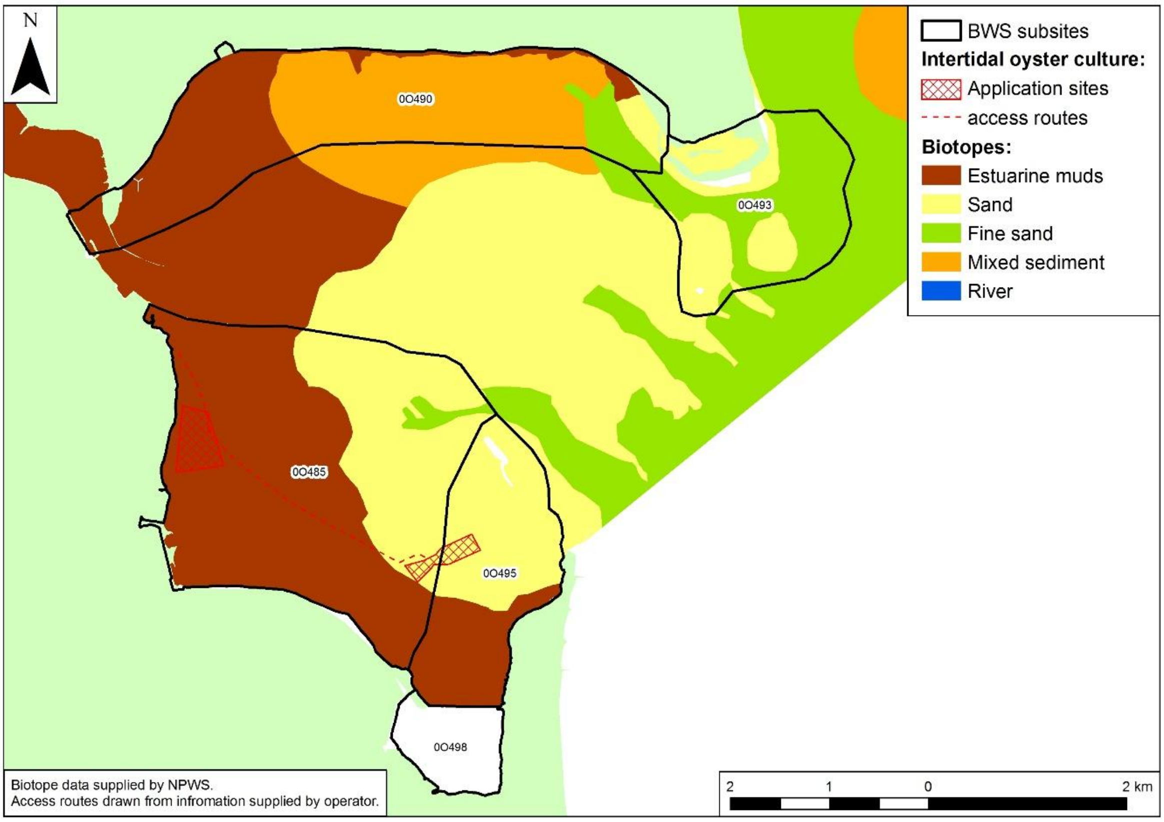

Figure 7.2 - Intertidal oyster cultivation sites and biotopes in Wexford Harbour.

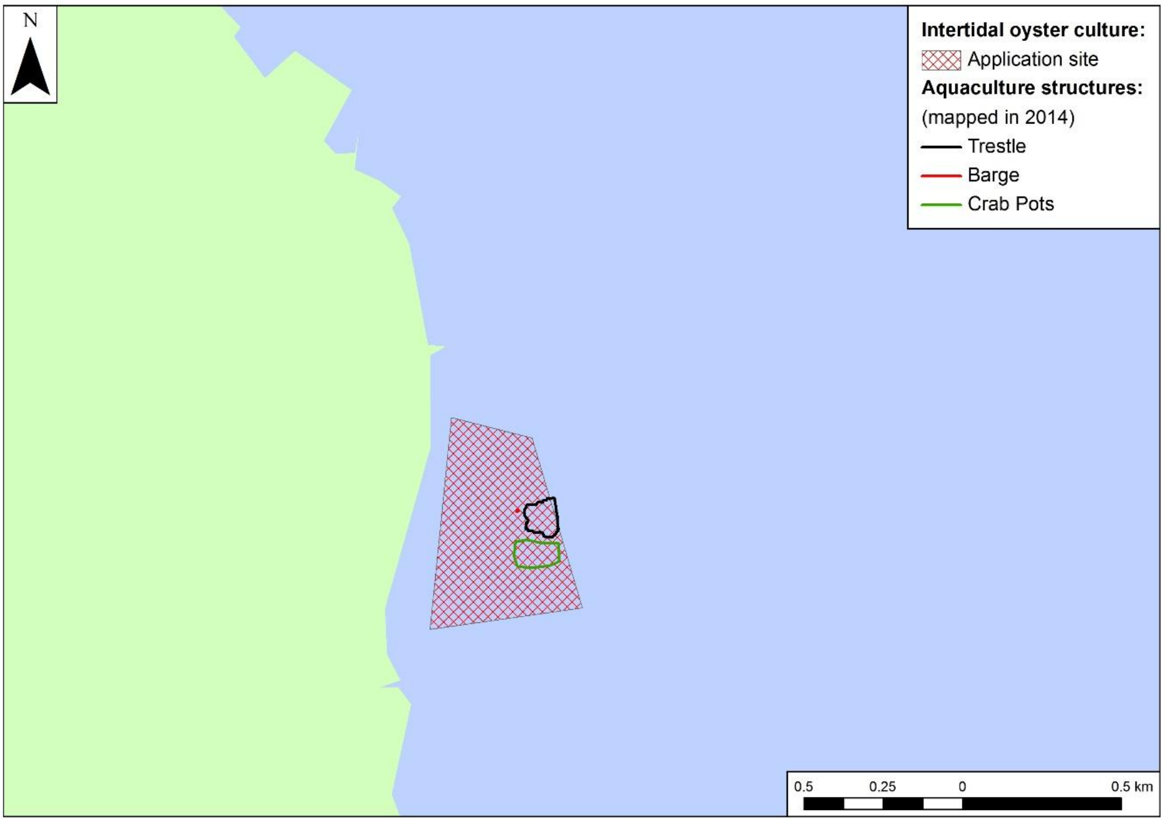

Figure 7.3 - Aquaculture structures associated with intertidal oyster cultivation in Wexford Harbour.

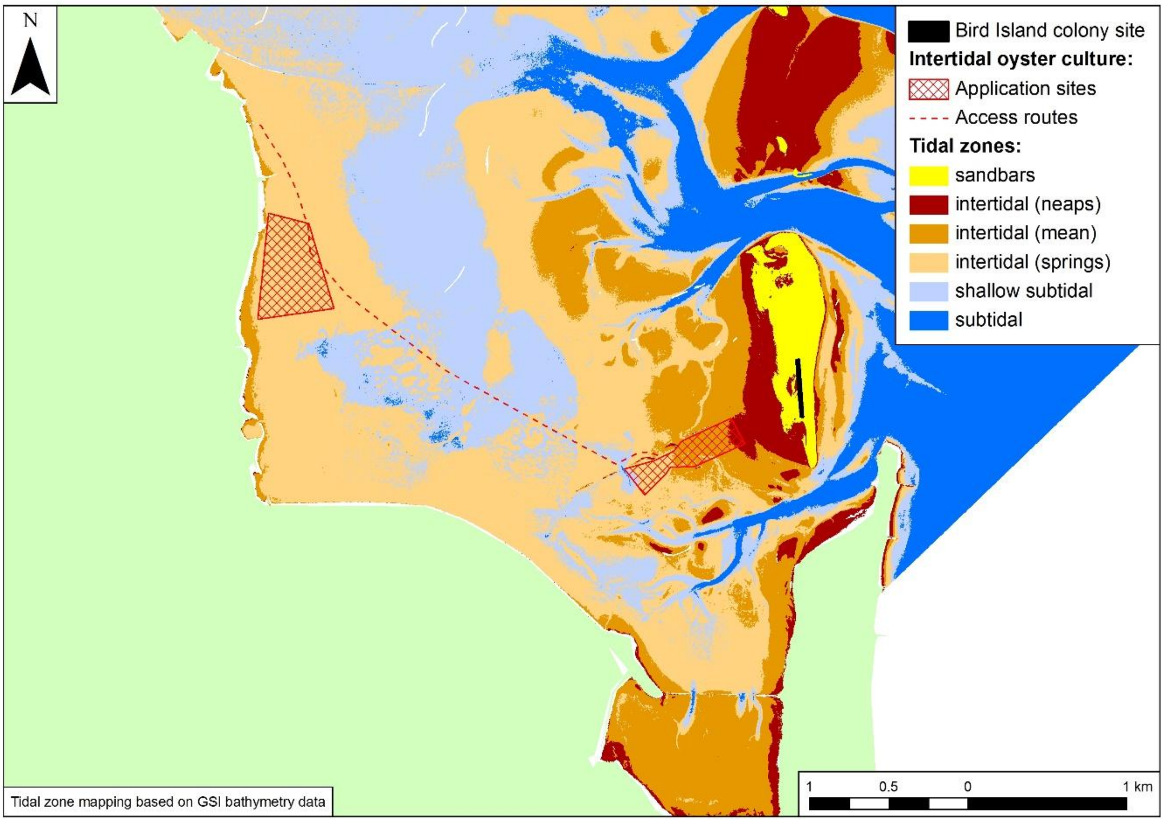

Figure 7.4 - Little Tern Bird Island colony site in relation to the intertidal oyster sites and access routes.

8. Suspended mussel cultivation

Scope of activity

8.1 There are no sites currently licensed for suspended mussel cultivation in Wexford Harbour and the Raven.

8.2 There are 10 sites (covering a total area of 128 ha) with applications for suspended mussel cultivation in the Raven SPA (Figure 8.1). There are also another six sites (covering a total area of 68 ha) in Rosslare Bay.

8.3 The individual sites range in size from 7-15 ha, with a mean size of 12 ha.

8.4 While the Rosslare Bay sites are outside the Wexford Harbour & Slobs and the Raven SPAs, they are considered in this assessment as they occur in an area that is likely to be used by some SCI populations from these SPAs.

Description of activity

8.5 The following description is based on the aquaculture profile (O'Loan, 2015), additional information supplied by Brian O'Loan (BIM), and responses from the operators to specific questions, unless otherwise stated.

8.6 Two operators have made applications. Operator A has applied for five sites, with three in the Raven SPA and two in Rosslare Bay. Operator B has applied for 11 sites, with seven in the Raven SPA and four in Rosslare Bay.

8.7 Suspended mussel cultivation in the Raven SPA and Rosslare Bay will involve mussel seed settlement on ropes suspended from longlines (Operator A) or longlines/rafts (Operator B). The longlines will be aligned across the tidal flow and will be spaced a minimum of 10 m apart and will occupy a total area of 1 ha in each site (Operator A). Operator B will use around 20% of the surface area of each site. Therefore, the total production area will be 29.6 ha (Table 8.1).

8.8 Operator A's projected production is 75 tonnes of seed per site, or 375 tonnes for the five sites combined. Operator B's projected production is 7-8 tonnes/ha, which would amount to 861-984 tonnes for the 11 sites combined. The size of the mussel seed when harvested will be 25-30 mm (Operator A), or 5-20 mm (Operator B).

8.9 The mussel seed settlement will be collected between April and September, with the seed harvest being brought in late September. All structures with the exception of the mooring blocks and navigational marks will be taken in after harvest and redeployed in late March.

8.10 The only activity by Operator A between October and March will be basic maintenance to the permanent navigation buoys. This will require a visit once a month, or after very bad weather. Operator B has not indicated any activity between October and March.

8.11 There will be no site cleaning, no fallowing, no predator control, no stock movement other than to harvest and/or relay to other sites. Stock maintenance will involve checking droppers and lines.

8.12 The sites will be accessed by boat from Wexford Harbour through the main navigation channel. Operator A will visit sites on five days per week. Operator B will make one round trip per week. Both operators will visit all their sites on the same day.

8.13 The boat used by Operator A to access the sites will be the Aisling J WD299. This is a half-decker boat, 8.09 m long, 2.69 gross tonnes and 34 hp engine.

8.14 The boat used by Operator B to access the sites will be a line mussel harvester, 17.2 m in length with a beam of 6.8 m. The boat will travel at a speed of 8-15 knots.

Table 8.1 - Production areas in the suspended mussel sites.

Area	Operator	Number of sites	Site area	Production area
Raven SPA	Operator 1	3	43 ha	3 ha
	Operator 2	7	85 ha	17 ha
	Sub-totals	*10*	*128 ha*	*20 ha*
Rosslare Bay	Operator 1	2	30 ha	2 ha
	Operator 2	4	38 ha	7.6 ha
	Sub-totals	*6*	*68 ha*	*9.6 ha*
Totals		**16**	**196 ha**	**29.6 ha**

Operator 1 production area is 1 ha per site. Operator 2 production area is 20% of site.

Potential impacts

Ecosystem effects

8.15 Aquaculture could, 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 (see paragraphs 6.77-6.79). However, given the small scale of suspended mussel cultivation proposed for the Raven and Rosslare Bay, in relation to the overall size of the area, the trophic pathways involving suspended mussel cultivation are unlikely to form a major component of the overall food web system, and, therefore, ecosystem level effects on fish populations are unlikely to occur.

8.16 The suspended mussel culture proposed will allow natural settlement of seed mussels on the structures over the summer, with these then being harvested in the autumn. Therefore, mussel production will be removed from the system at an early stage and this will remove food resources for birds that feed on mussels. However, it is highly unlikely that the suspended mussel culture will reduce the level of recruitment to benthic mussel seed beds: larvae will settle on any available surface and this is the limiting factor and not larval availability (Francis O'Beirn, Marine Institute, pers. comm.). Therefore, the mussel production that will be removed when the seed mussels are harvested from the suspended mussel culture sites is additional production that would not have been available in the absence of suspended mussel culture.

Habitat alteration

8.17 Subtidal mussel culture using longlines or rafts causes a physical alteration to the structure of the subtidal habitat through the placement of physical structures (anchors, longlines and rafts) in the subtidal habitat.

8.18 Subtidal mussel culture using longlines or rafts may cause impacts to benthic invertebrates through sedimentation and eutrophication, and this could potentially affect food resources for waterbird species.

8.19 Suspended mussel culture may increase the abundance of fish, due to the structures attracting fish, and/or the prey resources provided by the epifauna associated with the structures (McKindsey *et al*., 2011).

Disturbance

8.20 Subtidal mussel culture using longlines or rafts could cause impacts to waterbirds through disturbance associated with husbandry activities.

8.21 The potential disturbance impact can be divided into two components: -

- The energetic impact of the response to disturbance, which occurs mainly when boats and travelling to/from sites.
- The temporary displacement of birds from the vicinity of the sites for the duration of the husbandry activity.

8.22 Most husbandry activity will take place between April and September. Therefore, the potential for significant disturbance impacts is limited to this period.

Screening

8.23 All the suspended mussel sites are located in moderately deep, or deep subtidal habitat in the Outer Zone. Access to/from the sites will be from Wexford Town, via the main navigation channel. This would involve a maximum of six boat movements per day along an established navigation route. This level of boat activity would, by itself, not give rise to significant disturbance impacts within the Harbour Zone (apart from, possibly, Red-breasted Merganser, a species that is highly sensitive to disturbance by marine traffic in Wexford Harbour). Outside the Harbour Zone, the boats will not travel close to shoreline areas. Therefore, all the following species, which do not regularly occur in moderately deep, or deep subtidal habitat in the Outer Zone, can be screened out from further assessment: Whooper Swan, Bewick's Swan, Greenland White-fronted Goose, Light-bellied Brent Goose, Shelduck, Wigeon, Teal, Mallard, Pintail, Scaup, Goldeneye, Little Grebe, Grey Heron, Coot, Oystercatcher, Golden Plover, Grey Plover, Lapwing, Knot, Sanderling, Dunlin, Black-tailed Godwit, Bar-tailed Godwit, Curlew and Redshank.

8.24 The following SCI species may regularly occur in moderately deep, or deep subtidal habitat in the Outer Zone: Common Scoter, Red-breasted Merganser, Red-throated Diver, Great Crested Grebe, Cormorant, Black-headed Gull, Lesser Black-backed Gull, Little Tern, Sandwich Tern, Roseate Tern, Common Tern and Arctic Tern. Therefore, these species may overlap with the suspended mussel sites.

8.25 Roycroft *et al*. (2004; 2007) studied the interactions of waterbirds and seabirds (mainly divers, cormorants, gulls and auks) with suspended mussel culture using longlines in deep subtidal habitat in Bantry Bay. This study found no evidence of adverse impacts from suspended mussel culture on waterbirds and seabirds.

8.26 The mussel sites in Roycroft *et al*.'s study varied in size from 7-43 ha, compared to 7-15 ha in the Raven and Rosslare Bay sites. While no detail is provided of the level of husbandry activity in the mussel sites in Roycroft *et al*.'s study, it is reasonable to assume, from the size of the sites, that it would be of similar, or greater intensity, compared to the husbandry activity that will take place in the Raven and Rosslare Bay sites. Roycroft *et al*.'s study included two of the SCI species that feed in subtidal habitat the Outer Zone (Red-throated Diver and Cormorant), as well as grouped data for gulls (including Black-headed and Lesser Black-backed Gull), and provides strong evidence that suspended mussel culture using longlines does not affect three of these species (Cormorant, Black-headed Gull and Lesser Black-backed Gull). Moreover, the range of species covered by their study provides evidence that fish-eating species in general are not affected by suspended mussel culture, and suspended mussel culture may actually increase prey resources for these species (see above).

8.27 However, Roycroft *et al*. (2004)'s data did suggest that Red-throated Divers may "*possibly avoid areas of mussel culture*", although the numbers recorded were very low. They suggested that this might be due to disturbance, as well as obstructions to diving caused by the longline structures. However, the latter would presumably have similar effects on the closely related Great Northern Diver (which did not avoid suspended mussel culture sites in Roycroft *et al*.'s study). There is some evidence from other studies (see paragraphs 8.58-8.60) that the Red-throated Diver is relatively more sensitive to disturbance, compared to the Great Northern Diver.

8.28 Based on the above review of Roycroft *et al*. (2004; 2007), and the fact that suspended mussel culture is likely to increase the abundance of fish (McKindsey *et al*., 2011), it can be concluded that subtidal mussel culture using longlines is unlikely to cause impacts to food resources, or their accessibility, for fish-eating birds in the Raven and Rosslare Bay, and that Cormorant, Black-headed Gull, Lesser Black-backed Gull are unlikely to be significantly affected by disturbance. While Great Crested Grebe was not included in Roycroft *et al*.'s study, this species shows a high degree of tolerance of marine traffic in Wexford Harbour (see paragraph 6.143) and is, therefore, unlikely to be significantly affected by disturbance from activity associated with suspended mussel culture. Therefore, Great Crested Grebe, Cormorant, Black-headed Gull and Lesser Black-backed Gull can be screened out from further assessment. Little Tern, Sandwich Tern, Roseate Tern, Common Tern and Arctic Tern can also be screened out from further assessment, as foraging terns are not very sensitive to human disturbance.

8.29 The evidence discussed above shows that there is a possibility that Red-throated Diver could be significantly affected by disturbance, while Red-breasted Merganser are known to be highly sensitive to disturbance from marine traffic in Wexford Harbour (see paragraphs 6.138-6.139). Therefore, detailed assessment of potential disturbance impacts is required for these species. However, as these are predominantly fish-eating species, detailed assessment of potential ecosystem and habitat impacts is not required for the reasons discussed above.

8.30 Common Scoter feed mainly on bivalves. Suspended mussel culture could have positive impacts on the availability of mussels as prey resources for the scoters but could potentially also have negative effects on food resources for Common Scoter if associated sedimentation and/or eutrophication affects benthic bivalve prey resources. Common Scoter are also considered to be highly sensitive to disturbance from marine traffic. Therefore, detailed assessment of potential habitat and disturbance impacts is required for this species.

8.31 The species, and potential impacts, screened in for detailed assessment are listed in Table 8.2.

Table 8.2 - Species and potential impacts screened-in for detailed assessment of suspended mussel culture.

Species	Ecosystem impacts	Habitat impacts	Disturbance impacts
Common Scoter	x	√	√
Red-breasted Merganser	x	x	√
Red-throated Diver	x	x	√

see text for details.

Species assessments: Red-breasted Merganser

Distribution within Wexford Harbour and the Raven/Rosslare Bay

8.32 In I-WeBS/BWS counts of Wexford Harbour and the Raven, Red-breasted Merganser only occurred in small numbers within the Raven (mean of 5%, and ranges of 0-21%, of the total count).

8.33 Rosslare Bay was not covered by the I-WeBS/BWS counts. Only a single Red-breasted Merganser was recorded in Rosslare Bay in the 1997/98 NEWS survey in 1997/98 (which covered the entire bay), while none were recorded in the 2006/07 NEWS survey (which covered the northern section of the bay). However, Dempsey and O'Clery (2007) state that "*large numbers of … Red-breasted Merganser are present throughout winter*" in Rosslare Bay, although it is possible that the reference to "*large numbers*" may not be specific to Red-breasted Merganser, as this text refers to a number of species. Red-breasted Merganser generally feeds in waters of less than 5 m depth. This depth zone is around 1-1.5 km wide in Rosslare Bay, narrowing to around 500 m wide in the Raven. Therefore, higher numbers of Red-breasted Merganser in Rosslare Bay, compared to the Raven, would be expected.

8.34 The mean count across all counts within the Raven subsite is 6.0 birds, but the seasonal pattern of occurrence indicates that numbers in September are usually low. Due to the relatively narrow width of the suitable depth zone within the Raven, the counts are likely to be reasonably accurate. The seasonal pattern of the counts in both the Harbour and Outer Zones (Table 8.3) corresponds to the seasonal pattern shown by BirdTrack reporting rates across Britain and Ireland, although the seasonal pattern of monthly indices in Crowe (2005) shows relatively high numbers in September. While mean numbers for the Raven subsite in March are relatively high, these reflect high counts in early March, with low counts recorded in late March. This again corresponds to the seasonal pattern shown by BirdTrack reporting rates across Britain and Ireland, with a sharp decline in reporting rates beginning in mid-March. Therefore, significant numbers are unlikely to occur in the Raven and Rosslare Bay between April and August.

Table 8.3 - Seasonal pattern of occurrence of Red-breasted Merganser in the Harbour Zone and the Outer Zone.

Month	Harbour Zone			Outer Zone		
	Mean count	Max count	n	Mean count	Max count	n
Sep	3.5	5	2	1.6	4	8
Oct	9.6	40	8	2.8	11	10
Nov	24.1	102	30	7.6	36	14
Dec	23.1	87	19	3.8	13	9
Jan	27.6	180	19	8.3	31	15
Feb	22.6	122	12	6.9	15	8
Mar	15.5	41	4	8.0	24	7

Harbour Zone counts will underestimate the true population within the Harbour Zone, due to incomplete coverage. Outer Zone counts comprise counts for the Raven subsite. Only includes complete counts for each zone.

Disturbance impacts

Disturbance response

8.35 Observations made during survey work for this assessment indicate that Red-breasted Mergansers in Wexford Harbour are very sensitive to disturbance, with 84% of observations within 500 m lateral distance of boat routes showing a disturbance response (see paragraphs 6.138-6.139 and Appendix C). The data included 16 observations of disturbance responses to small inshore potting vessels, similar to the types of boat that will be used to access the suspended mussel sites. The disturbance response to these vessels did not significantly differ from those to the other vessel types included in the dataset. However, these responses were recorded within the harbour and it is possible that the disturbance response may be different outside the harbour.

Assessment of energetic impacts

8.36 Boats travelling along the navigation channel to/from the suspended mussel sites would be expected to flush an average of 3.2 Red-breasted Mergansers on each round-trip in September (Table 8.4). This amounts to around 28% of the estimated average September population, and 4% of the estimated mid-winter population, of the Harbour Zone.

8.37 Boats travelling to/between/from the suspended mussel sites in the Outer Zone would be expected to flush an average of 1.4-1.6 Red-breasted Mergansers on each trip in September (Table 8.5). This amounts to around 34-39% of the estimated average September population, and 7-8% of the estimated mid-winter (November-March) population, of the Outer Zone. When weighted by the frequency of the visits, the average daily flush rate would represent 30% of the population. If birds are assumed to be randomly mixed (i.e., each individual has an equal probability of being in any particular area on any given day), then, on average, each bird will be flushed once every 3.3 days. This level of disturbance is not likely to cause significant energetic impacts (see paragraphs 6.151-6.155). It should also be noted that the above calculations probably overestimate the actual impact as the effects of displacement of birds due to husbandry activity are not taken into account (i.e., when the boats are leaving a suspended mussel site there will be reduced numbers of mergansers within the potential disturbance zones as birds will already have been displaced during the husbandry activity on that site).

Table 8.4 - Calculations of the number of Red-breasted Mergansers flushed within the Harbour Zone by a boat trip to a suspended mussel site.

Lateral distance from boat	Area	Number of birds encountered	Flush rate	Number of birds flushed
0-250 m	650 ha	2.4	70%	1.7
250-500 m	638 ha	2.4	36%	0.9
500-1000 m	1234 ha	4.6	14%	0.6

Calculations based on observed encounter rates (one bird/38 ha) and flush rates (see Appendix C). The observed encounter rate was corrected for the relative occurrence of Red-breasted Merganser in the Harbour Zone in September compared to mid-winter (November-February), giving an encounter rate in September of one bird/266 ha. The observed > 500 m lateral distance band has been conservatively assumed to have an upper limit of 1000 m for the purposes of these calculations.

Table 8.5 - Calculations of the number of Red-breasted Mergansers flushed within the Outer Zone by a boat trip to the suspended mussel sites.

Operator	Lateral distance from boat	Area	Number of birds encountered	Flush rate	Number of birds flushed
1	0-250 m	522 ha	0.9	70%	0.7
	250-500 m	561 ha	1.0	36%	0.4
	500-1000 m	1074 ha	1.9	14%	0.3
2	0-250 m	721 ha	1.3	70%	0.9
	250-500 m	617 ha	1.1	36%	0.4
	500-1000 m	1331 ha	2.4	14%	0.3

Number of birds encountered calculated from mean density recorded in September counts from the Raven subsite (0.18 birds/km^2) and assumes that the mean density in the Raven subsite represents the mean density across the entire Outer Zone. Areas were calculated from intertidal habitat and subtidal habitat of less than 5 m depth.

Assessment of displacement impacts

8.38 Assuming a 750 m displacement distance (see paragraph 6.160), seven of the 16 sites would potentially cause disturbance to Red-breasted Merganser habitat (i.e., intertidal habitat and subtidal habitat < 5 m depth). The areas potentially disturbed range from 27-173 ha (1.1-6.9% of the total area of suitable habitat within the Outer Zone). Across all 16 sites, the mean area potentially disturbed is 21 ha (0.9% of the total area of suitable habitat within the Outer Zone). When weighted by the frequency of the visits, the areas potentially disturbed would be 0.8% of the available habitat. It should be noted that the actual displacement distance is likely to be less than 750 m, as this is a conservative estimate, and, also, birds may show lower displacement from stationary activity, compared to moving boats.

8.39 Therefore, taking all the above factors into account, we do not consider the potential displacement impact to be significant.

Species assessments: Common Scoter

Distribution within Wexford Harbour and the Raven/Rosslare Bay

8.40 In I-WeBS and BWS counts, Common Scoter occurred almost exclusively within the Raven (mean of 99%, and range of 93-100%, of the total count).

8.41 Rosslare Bay was not covered by the I-WeBS/BWS counts. Common Scoter was not recorded in the sections of Rosslare Bay were covered in the NEWS survey in 1997/98 (the entire bay) and in 2006/07 (the northern section). However, Rosslare Bay is known to support significant numbers of Common Scoter. For example Dempsey and O'Clery (2007) state that "*large numbers of … Common Scoter are present throughout winter*" in Rosslare Bay.

8.42 During the aerial transects carried out for the scoter survey in March 2014, three Common Scoter registrations were recorded in Rosslare Bay, and one in the Raven, with an additional two a further 500 m offshore from the eastern boundary of the Raven subsite. In December 2014, 122 registrations were recorded in the Raven with a further ten registrations in Rosslare Bay (Figure 8.2). The broader distribution of Common Scoter recorded in these surveys shows that Common Scoter in the western Irish Sea occur almost exclusively in waters of less than 20 m depth, and there appears to be a preference for waters of less than 10 m depth (Table 8.6).

8.43 The mean count across all counts within the Raven subsite is 1964 birds. The seasonal pattern of occurrence indicates that numbers build-up quickly in autumn, with numbers in September similar to the mid-winter peak (Table 8.7). Numbers are likely to build-up prior to September: for example at Castlemaine Harbour, large numbers can occur from late June. Similarly, some birds are likely to remain after March, although the seasonal pattern of the count data indicate that the numbers are likely to be very small. These seasonal patterns correspond to the seasonal pattern shown by BirdTrack reporting rates across Britain and Ireland.

Table 8.6 - Distribution of Common Scoter registrations by depth zone in aerial surveys of the western Irish Sea.

Survey date	Depth zone	Area covered	Number of registrations
March 2014	0-10 m	58 ha	24
	10-20 m	116 ha	17
	> 20 m	115 ha	4
December 2014	0-10 m		88
	10-20 m		85
	> 20 m		3

Table 8.7 - Seasonal pattern of occurrence of Common Scoter in the Raven

Month	Mean count	Max count	n
Sep	2591	7350	8
Oct	3471	8261	10
Nov	2140	4414	14
Dec	2116	5760	9
Jan	1492	5760	15
Feb	1003	4508	8
Mar	664	1179	7

Source: I-WeBS/BWS counts of the Raven subsite.

Habitat impacts

8.44 Suspended mussel culture has been shown to improve the availability of mussels as prey resources for sea ducks (including the closely related Surf Scoter) by increasing the density of mussels, with the farmed mussels having weaker byssal attachments (making the mussels easier to capture) and reduced shell mass (making the mussels easier to crush in the birds gizzards) compared to natural settlement of mussels in intertidal areas (Kirk *et al*., 2007). In a related study, a strong positive relationship was found between the density of the sea ducks and of the aquaculture operations (Žydelis *et al*., 2009). Predation by sea duck (including scoters) can be a serious problem for suspended mussel culture operations (Varennes *et al*., 2013). This suggests that the suspended mussel sites in the Raven and Rosslare Bay may provide a food resource that will be exploited by the Common Scoter population and, therefore, have a positive effect on the population.

8.45 Conversely, suspended mussel culture can also cause changes to the benthic fauna underneath the site, with a shift from filter feeders (such as bivalves) to deposit-feeders (McKindsey *et al*., 2011). Therefore, it is possible that the suspended mussel sites in the Raven and Rosslare Bay may have negative effects on benthic food resources for Common Scoter in the suspended mussel sites, although these effects may be limited by the exposed nature of the sites. Moreover, any such effects are likely to be very localised. The operational area within the suspended mussel sites amounts to around 0.4% of the total area of subtidal habitat within the Outer Zone. Therefore, it is not scientifically plausible that any negative effects on benthic food resources for Common Scoter within the suspended mussel sites would affect the overall availability of benthic food resources within the Outer Zone.

Disturbance impacts

Disturbance response

8.46 We do not have any site-specific data on the response of Common Scoter to marine traffic in the Wexford Harbour area. However, this species is generally considered to be highly sensitive to such disturbance. Furness *et al*. (2013) classified its sensitivity to disturbance from ship and helicopter traffic as 5 on a scale of 1 to 5, where 5 represents "*strong escape behaviour, at a large response distance*". Schwemmer *et al*. (2011) reported a median flush distance of 804 m during experimental disturbance work in the North Sea, with a maximum flush distance of 3.5 km, and only 0.5% of Common Scoter flocks did not flush as the boat approached. They also found a significant positive correlation between flock size and the distance at which birds flushed. Similarly, Kaiser *et al*. (2006) reported that larger flocks flushed at distances of 1-2 km, while smaller flocks flushed at distances of less than 1 km. Both studies used medium-sized vessels (lengths of 25-40 m) and Kaiser *et al*. (2006) state that "*flush distance is likely to relate to the size (height) of vessel structure above the water-line*". However, we did not find this to be the case in our observations of disturbance to Red-breasted Merganser within Wexford Harbour.

8.47 While the above research indicates that Common Scoter are highly sensitive to disturbance from marine traffic, and can flush at long distances from boats, the reported flush distances cannot be directly used to assess potential disturbance impacts. Schwemmer *et al*. (2011) note that "*only the flush distances of flocks of birds located within 300 m of either side of the ship's track line were measured, as we assumed that flocks too far outside the track line of the vessel would not show comparable flush reactions*". Kaiser *et al*. (2006) do not specify the lateral distance over which they recorded disturbance responses, but it is reasonable to assume that it would have been of a similar order to that used by Schwemmer *et al*. Therefore, for the purposes of our assessment, we have conservatively assumed a 100% flush response within 500 m lateral distance from the boat route, and a 50% flush response between 500 and 1000 m from the boat route.

Assessment of energetic impacts

8.48 Our calculations indicate that, on average, the boat trips to the suspended mussel sites may flush 2665 (Operator 1) or 2983 (Operator 2) Common Scoters, representing 52-58% of the total population[9]. When weighted by the frequency of the visits, the average daily flush rate would represent 45% of the population. If birds are assumed to be randomly mixed (i.e., each individual has an equal probability of being in any particular area on any given day), then, on average, each bird will be flushed once every 2.2 days. By analogy to Red-breasted Merganser, this level of disturbance is not likely to cause significant energetic impacts (see paragraphs 6.151-6.155). It should also be noted that the above calculations probably overestimate the actual impact as the effects of displacement of birds due to husbandry activity are not taken into account (i.e., when the boats are leaving a suspended mussel site there will be reduced numbers of scoter within the potential disturbance zones as birds will already have been displaced during the husbandry activity on that site).

[9] These calculations are, in fact, calculations of the relative area disturbed. The total population number is calculated from the encounter rate. Therefore, the total population number is simply a mathematical function of the encounter rate and the calculated flush rate per bird will be the same whatever encounter rate is used. However, bird numbers are used in these calculations to make the results more intuitive.

Table 8.8 - Calculations of the number of Common Scoter flushed within the Outer Zone by a boat trip to a suspended mussel site.

Operator	Lateral distance from boat	Area	Number of birds encountered	Flush rate	Number of birds flushed
1	0-500 m	2662 ha	1784	100%	1784
	500-1000 m	2631 ha	1763	50%	881
2	0-500 m	2985 ha	2000	100%	2000
	500-1000 m	2934 ha	1966	50%	983

Number of birds encountered calculated from mean density recorded in September counts from the Raven subsite (0.67 birds/ha) and assumes mean density in the Raven subsite represents the mean density across the entire Outer Zone.

Assessment of displacement impacts

8.49 We have no specific information on the likely disturbance response (if any) of Common Scoter to husbandry activity at the suspended mussel sites. However, it is likely that the scoters would be less sensitive to such activity than they would be to marine traffic, as there is no directional stimulus (i.e., the activity is stationary, unlike a boat moving towards the birds).

8.50 Assuming a 500 m displacement distance around an operational site (i.e., the productive area), the area potentially disturbed would be 97 ha (Operator 1) or 107 ha (Operator 2), representing 1.3-1.4% of the total area of the Outer Zone. When weighted by the frequency of the visits, the areas potentially disturbed would be 1.1% of the available habitat. Based on the mean count for the Raven subsite in September (and assuming that this represents the mean density across the entire Outer Zone), the mean number of birds displaced per day would be 57. These potential disturbance impacts would occur across up to three months (July -September) out of the nine months (July-March) when significant numbers of Common Scoter are likely to be present.

8.51 It should also be noted that the Outer Zone is an artificially defined site for the purposes of this assessment, while the outer boundaries of the Raven SPA are arbitrary. Suitable Common Scoter habitat occurs up to 5 km offshore from the outer boundaries of these areas. Therefore, the above percentage displacement figures are somewhat arbitrary.

8.52 Therefore, taking all the above factors into account, we do not consider the potential displacement impact to be significant.

Species assessments: Red-throated Diver

Distribution within Wexford Harbour and the Raven/Rosslare Bay

8.53 In I-WeBS/BWS counts of Wexford Harbour and the Raven, Red-throated Diver occurred almost exclusively within the Raven Zone (mean of 95%, and range of 73-100%, of the total count, respectively).

8.54 Rosslare Bay was not covered by the I-WeBS/BWS counts. Red-throated Diver was not recorded in the sections of Rosslare Bay that were covered in the NEWS survey in 1997/98 (the entire bay) and in 2006/07 (the northern section). However, Rosslare Bay is known to support significant numbers of Red-throated Divers. For example Dempsey and O'Clery (2007) state that "*large numbers of … Red-throated Divers are present throughout winter*" in Rosslare Bay, while a count of 50 Red-throated Divers was reported from Rosslare Bay on 7th March 2015 (www.irishbirding.com).

8.55 During the aerial transects carried out for the scoter survey in March 2014, three Red-throated Diver registrations were recorded in Rosslare Bay, but none were recorded in the Raven. In December 2014, 36 Red-throated Diver registrations were recorded in Rosslare Bay and 32 were recorded in the Raven (Figure 8.3). The broader distribution of Red-throated Divers recorded in these surveys shows that Red-throated Diver in the western Irish Sea occur almost exclusively in waters of less than 20 m depth, and there appears to be a preference for waters of less than 10 m depth (Table 8.9).

8.56 The mean count across all counts within the Raven subsite is 33 birds. The seasonal pattern of occurrence indicates that numbers are relatively constant from September-December, and then decrease across the late winter period (Table 8.10). The seasonal pattern of the counts corresponds to the seasonal pattern shown by BirdTrack reporting rates across Britain and Ireland. Significant numbers are unlikely to occur between April and August.

8.57 Divers are notoriously difficult to accurately count as birds can spend lengthy periods of time underwater and can occur at long distances offshore, and accurate counts require weather conditions that are not of frequent occurrence during a typical Irish winter. In the Raven, the suitable habitat zone extends over 2 km offshore. Therefore, it is likely that the mean counts underestimate the true numbers that occur. It is possible that the maximum counts are a better reflection (i.e., they represent the few counts that happened to coincide with ideal counting conditions). However, Red-throated Divers are also very mobile in winter and it would not be surprising to have days when numbers within the Raven were relatively low.

Table 8.9 - Distribution of Red-throated Diver registrations by depth zone in aerial surveys of the western Irish Sea.

Survey date	Depth zone	Area covered	Number of registrations
March 2014	0-10 m	58 ha	35
	10-20 m	116 ha	7
	> 20 m	115 ha	2
December 2014	0-10 m		89
	10-20 m		80
	> 20 m		19

Table 8.10 - Seasonal pattern of occurrence of Red-throated Diver in the Raven.

Month	Mean count	Max count	n
Sep	35	114	8
Oct	41	105	10
Nov	46	153	14
Dec	46	184	9
Jan	22	65	15
Feb	19	55	8
Mar	16	37	7

Source: I-WeBS/BWS counts of the Raven subsite.

Disturbance impacts

Disturbance response

8.58 We do not have any site-specific data on the response of Red-throated Divers to marine traffic in the Wexford Harbour area. However, this species is generally considered to be highly sensitive to such disturbance. Furness *et al*. (2013) classified its sensitivity to disturbance from ship and helicopter traffic as 5 on a scale of 1 to 5, where 5 represents "*strong escape behaviour, at a large response distance*". Topping and Petersen (2011) state that Red-throated Divers often flush at distances of about 1 km from an approaching ship, while Schwemmer *et al*. (2011) detail research that they carried out in the German North Sea in which they determined that Red-throated Divers and Black-throated Divers avoid active shipping lanes.

8.59 In a survey of diver response to disturbance in Inner Galway Bay (Gittings, 2015) two of the three Red-throated Divers recorded within 500 m of the boat were flushed, while an additional four Red-throated Divers recorded in flight only could possibly have flushed at distances of greater than 500 m. In contrast, none of the 64 Great Northern Divers recorded within 500 m flushed, and only one Great Northern Diver was recorded in flight[10].

8.60 Therefore, in the absence of site-specific data, it has to be assumed that Red-throated Divers could potentially be flushed by boats at substantial distances.

Assessment of energetic impacts

8.61 Sufficient data is not available on the disturbance response of Red-throated Divers to quantify the potential energetic impacts of disturbance by boat trips to the suspended mussel sites. However, it seems unlikely that Red-throated Divers are significantly more sensitive that Common Scoters. Therefore, the potential impact is unlikely to be significantly greater than that assessed for Common Scoter: that, on average, each bird will be flushed once every 2.2 days (see paragraph 8.48)[11]. This impact will occur in one of the four months (September-December) with peak numbers of Red-throated Divers present. By analogy to Red-breasted Merganser, this level of disturbance is not likely to cause significant energetic impacts (see paragraphs 6.151-6.154).

Assessment of displacement impacts

8.62 Sufficient data is not available on the disturbance response of Red-throated Divers to quantify the potential displacement impacts of disturbance by husbandry activity on the suspended mussel sites. However, it seems unlikely that Red-throated Divers are significantly more sensitive that Common Scoters. Therefore, the potential impact is unlikely to be significantly greater than that assessed for Common Scoter: that, on average, the areas potentially disturbed would be 1.1% of the available habitat (see paragraph 8.50). This impact will occur in one of the four months (September-December) with peak numbers of Red-throated Divers present. Taking all the relevant factors into account (see paragraphs 8.49-8.51); we do not consider the potential displacement impact to be significant.

Conclusions

8.63 Our assessment has not identified any potentially significant impacts from the proposed suspended mussel culture in the Raven and Rosslare Bay. However, the reliability of this assessment for Common Scoter and Red-throated Diver is only moderate due to the high potential sensitivity of these species to disturbance impacts, and the limited quantitative data available on the nature of their disturbance responses. Site-specific data on the disturbance responses of Common Scoter and Red-throated Diver in the Raven and Rosslare Bay would improve the reliability of this assessment.

[10] Two unidentified divers were also recorded in flight.
[11] Note the calculations for Common Scoter are calculations of the relative area disturbed, although bird numbers are used in these calculations to make the results more intuitive (see footnote 9 on page 107).

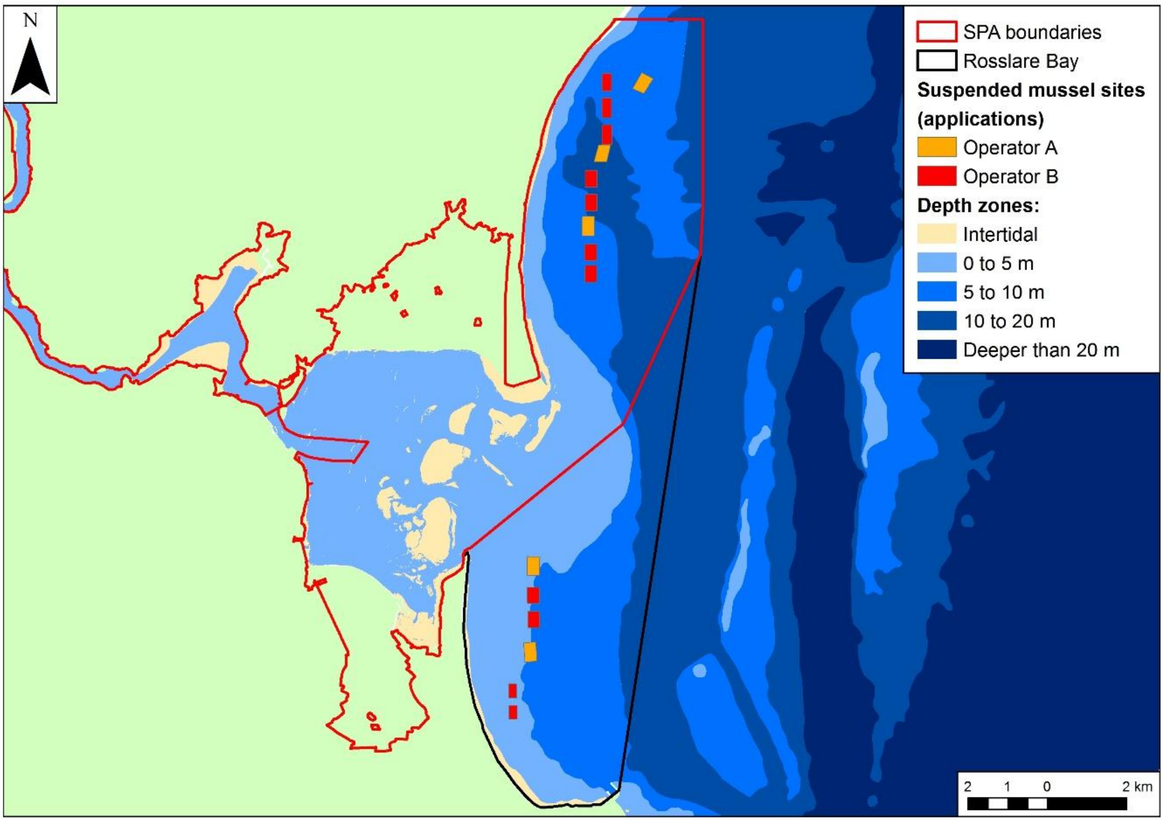

Figure 8.1 - Suspended mussel sites in the Raven SPA and Rosslare Bay.

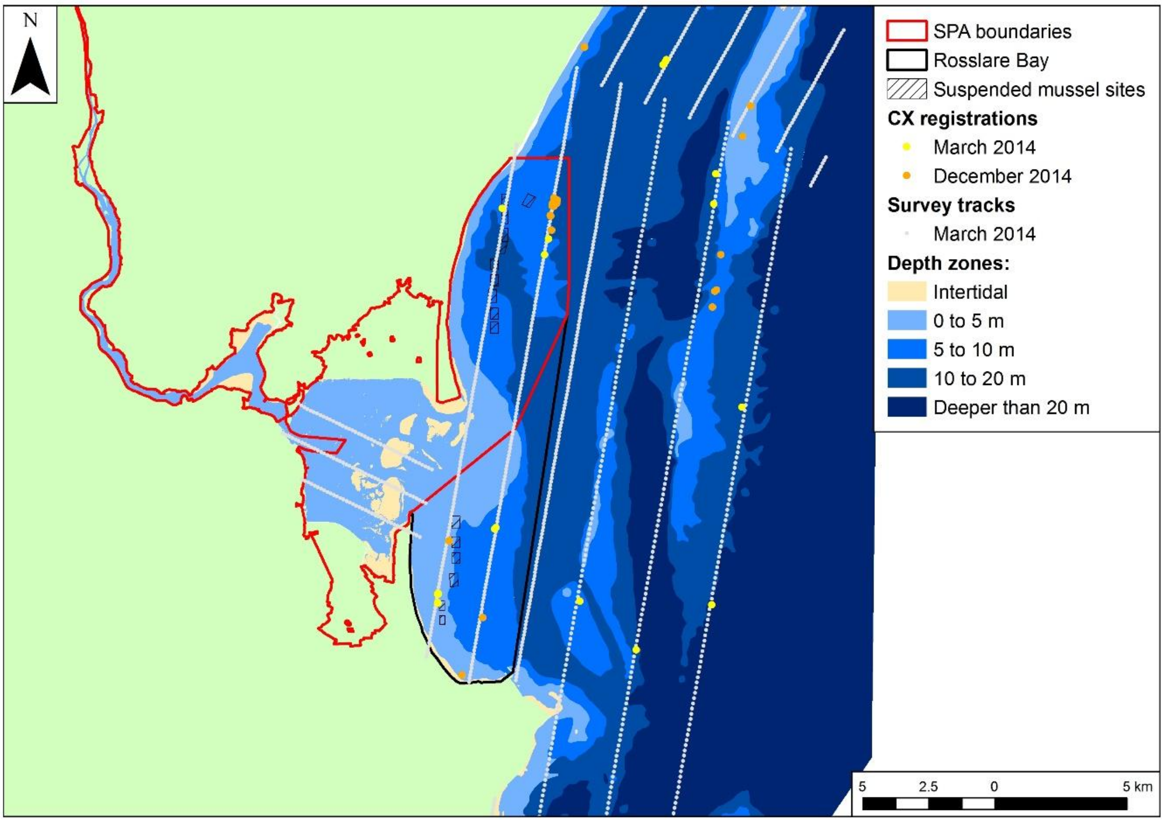

Figure 8.2 - Common Scoter registrations recorded during the Marine Institute aerial surveys.

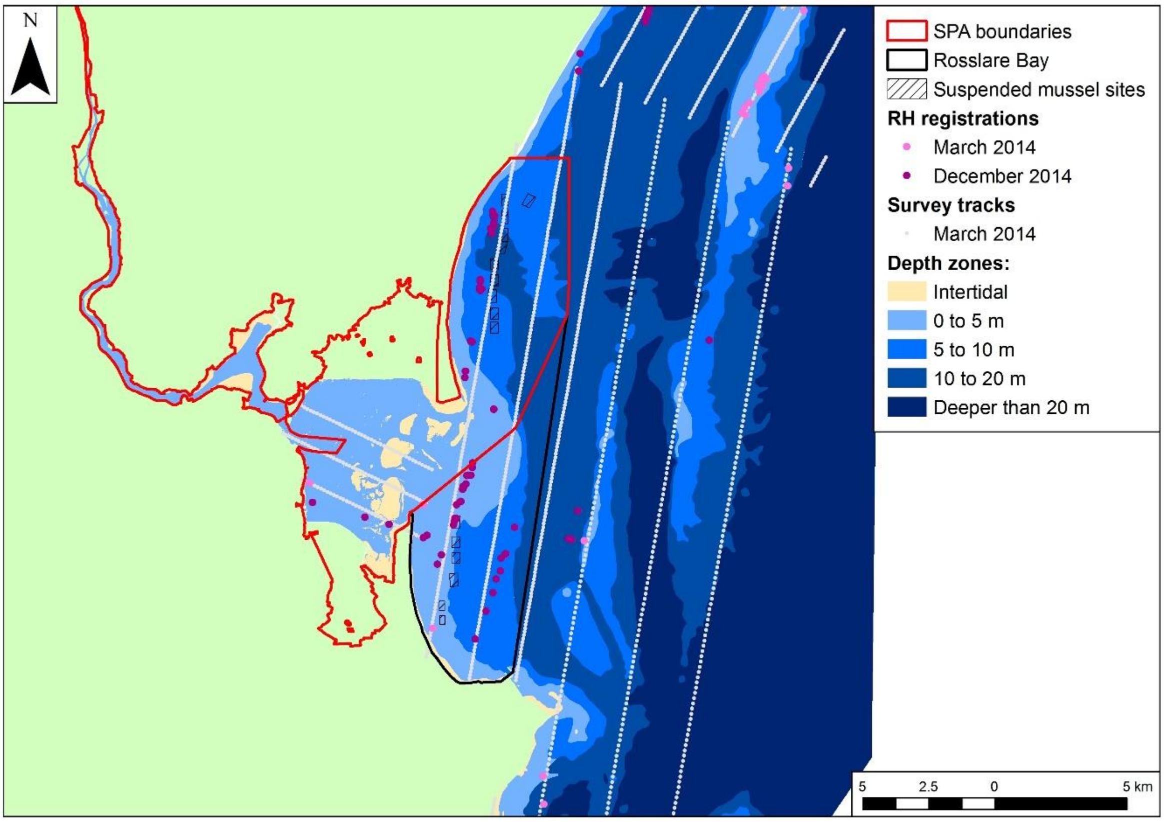

Figure 8.3 - Red-throated Diver registrations recorded during the Marine Institute aerial surveys.

9. Conclusions

Potentially significant impacts

9.1 The following are potential impacts where the available evidence indicates a high likelihood of significant impacts occurring.

Bottom mussel culture impact on Red-breasted Merganser

9.2 Disturbance from bottom mussel-related boat activity may cause significant displacement impacts to Red-breasted Merganser. The mean area potentially disturbed could amount to around 19-27% of the total area of available habitat. High levels of impact could occur on around 80% of days in the October-December period, for periods of up to 55-66% of daylight hours (however, note the assumptions set out in paragraphs 6.63-6.76 regarding predicted levels of boat activity). The population-level consequences of the displacement impact will depend upon whether the displaced birds can find suitable alternative habitat to feed in while they are displaced, or, if this is not the case, whether the undisturbed portion of the day provides sufficient feeding time for the birds to meet their daily energetic requirements. There is no site-specific data available that can be used to address these questions, and we are not aware of any comparable studies in the literature that can be used.

Bottom mussel culture impact on Little Tern

9.3 There is potential for significant disturbance impacts to the Little Tern breeding colony. However, these can be avoided through an appropriate adaptive management strategy (see paragraph 6.215).

Other potential impacts

9.4 The following are potential impacts where the available evidence is not sufficient to rule out significant impacts beyond reasonable scientific doubt. However, this does not mean that all these impacts are considered to be very likely to occur.

Bottom mussel culture impact on Greenland White-fronted Goose

9.5 NPWS have raised concerns about the potential for dredger activity close to the North Slob to cause disturbance to Greenland White-fronted Geese feeding on the North Slob. As noted, review of potential disturbance impacts from dredger activity to Greenland White-fronted Goose (Appendix D). The closest vessel activity by the Branding and Laura Anne to the North Slob will be around 400 m from the sea wall, or around 350 m while the Branding is travelling to/from its site. It is not known whether Greenland White-fronted Geese are susceptible to disturbance from dredgers at these distances from the sea wall. Given the current low frequency of dredger activity in sites 46A, 49B and 52A, any disturbance of Greenland White-fronted Geese by dredger activity in these sites is likely to be a rare event and on a comparable scale to disturbance by licensed wildfowling (which occurs on around 5% of days during the October- March period). However, the patterns of site usage, and the locations of dredger access routes, may change in the future as a result of changes in sedimentation patterns in the harbour, and (in the case of site usage) increases in seed supply. It should be noted also that there is an additional site close to the sea-wall (site 57F). This site is licensed to an operator who is currently not active, and has not been active since around 2008. Further information on the distance from the sea wall at which dredging activity causes disturbance to geese on the North Slob would be required to fully assess this potential impact.

Bottom mussel culture impacts on Scaup, Goldeneye, Red-breasted Merganser and Great Crested Grebe

9.6 There is potential for night-time dredging to cause disturbance to nocturnal roosts of these species. Further information about the location and seasonal patterns of usage of these nocturnal roosts is required, as well as information about the sensitivity of nocturnally roosting birds to disturbance from marine traffic, is required to fully assess this potential impact.

Bottom mussel culture impact on intertidal mussel beds

9.7 In the long term, it is possible that the seed collection method could prevent the regeneration of existing intertidal mussel beds and reduce the quality of the habitat for Oystercatcher, Knot, Curlew and Redshank. Information on the existing extent of intertidal mussel beds, their usage by these wader species, and the impact of seed collection on the mussel bed dynamics would be required to fully assess this potential impact.

Bottom mussel culture impact on high tide roosts

9.8 Mussel-related boat activity could cause disturbance to high tide wader and tern roosts on sandbanks in the mouth of Wexford Harbour. Further information on the distribution and usage of wader and tern roost sites under various tidal conditions, and the sensitivity of sandbank roosting waders and terns to disturbance from dredging activity, in Wexford Harbour would be required to fully assess this potential impact.

Intertidal oyster culture impact on Golden Plover, Grey Plover, Knot, Sanderling and Bar-tailed Godwit

9.9 Taking all the relevant factors into consideration, it is probable that the displacement impacts for these species will be substantially less than 5%. However, there is a significant uncertainty attached to this assessment due to the very limited low tide count data. Further data on the low tide distribution of these species across the whole of Wexford Harbour (not just the I-WeBS/BWS subsites) would be required to complete the assessment for these species.

Intertidal oyster culture impact on Little Tern

9.10 We consider that the distance of site T03/092A from the Bird Island colony site is probably sufficient to prevent disturbance to the colony (providing no dogs are brought out). However, there is some uncertainty about this assessment, given the lack of site-specific data on the response of Little Tern to disturbance in Wexford Harbour, and the perceived high sensitivity of Little Tern breeding colonies to disturbance in remote locations. This uncertainty can be addressed by an adaptive management strategy (see paragraph 6.215).

9.11 There is a significant likelihood that oyster cultivation in site T03/092A will increase the activity of gulls and corvids in this area. It is not possible to predict to what extent, if any, this would cause an increased predation risk to the Bird Island tern colony (in the event that it was reoccupied).

Management Responses / Measures

9.12 The following management measures, research and information compilation is required to complete this assessment: -

- Record comprehensive information on all bottom mussel-related boat activity. At a minimum, this should include daily logs of all vessel activity, including information on the time, duration and location of the activity. This information would be required over a period of years to allow characterisation of typical patterns of activity, and the level of variation around these patterns. Information on mussel relay activity (including the location and sizes of the plots, the dates of the relay and the tonnages relaid) would also be required to relate vessel activity to the scale of production, and, thereby, allow prediction of impacts from any expansion of the activity. As noted this information would further inform the assessment of impacts on Greenland White-fronted geese, Red-breasted Merganser and other diving species.

- Research into the impact of the bottom mussel culture seed collection method on the long-term dynamics of intertidal mussel beds is required to fully assess the impact of this method on habitat quality for Oystercatcher, Knot, Curlew and Redshank in Wexford Harbour.

- In parallel to the recording of patterns of vessel activity, further Red-breasted Merganser disturbance studies are required to determine if there is any seasonal, spatial, or other, variation in the nature of the response, and to refine the prediction of the scale of the displacement impact. Placement of observers on the dredgers would allow more accurate estimation of distances. These studies could also record the disturbance responses of the other potentially sensitive species (Scaup, Goldeneye and Great Crested Grebe).

- Research into the ecology of Red-breasted Merganser in Wexford Harbour. This research is required to allow assessment of the population-level consequences of the displacement of mergansers by boat activity. The scope of the research should include mapping the spatial distribution of mergansers throughout the Harbour Zone, determining their activity budget and how this varies seasonally and with the intensity of vessel activity, and recording their diet.

- Should night-time dredging be permitted, surveys of night-time roosting behaviour by Scaup, Goldeneye, Red-breasted Merganser and Great Crested Grebe would be required.

- Surveys of high-tide wader and tern roosts. This research is required to allow assessment of the potential disturbance impact from bottom mussel-related boat activity. The scope of the research should include recording the distribution of the roosts, and their sensitivity to disturbance by boat activity, and how these vary seasonally, and with the neap-spring tidal cycle.

- Surveys of the low tide distribution of Golden Plover, Grey Plover, Knot, Sanderling and Bar-tailed Godwit. This research would be required to allow assessment of the potential impact of displacement by intertidal oyster cultivation in site T03/092A.

- Little Tern research. This research would form part of an adaptive management strategy for the Little Tern population (see paragraph 9.14).

9.13 It should be noted that a lot of the above bird survey requirements will be logistically challenging (e.g., surveying sandbank areas in the middle of the harbour). Therefore, if the research is to be carried out, adequate lead-in time should be allowed to trial methodologies, etc.

Mitigation recommendations

9.14 An adaptive management strategy to protect the Little Tern breeding colony, and the post-breeding flocks of juveniles in the Hopeland area, should be prepared. This would specify: the buffer zones required to protect the colonies/flocks from disturbance (e.g., 340 m around the Fort Bank colony; see paragraph 6.209); additional measures (such as prohibiting dogs from accompanying workers in the seed collection site); and monitoring requirements. The strategy would have to allow for the possibility of the terns moving their colony locations: e.g., an assessment could be carried out in April of the suitability of the existing colony sites and, if the existing colony sites were considered to now be unsuitable (due to winter storm damage) buffer zones could be put in place around additional potential sites until it became clear which site(s) are going to be occupied that year. The monitoring carried out as part of this strategy would help to improve knowledge about the sensitivity of Little Terns in Wexford Harbour to disturbance, and may allow relaxation of some of the prescriptions (e.g., reduce the size of the buffer zones required).

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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
Bewick's Swan	*Cygnus columbianus*	BS
Black-headed Gull	*Chroicocephalus ridibundus*	BH
Black-tailed Godwit	*Limosa*	BW
Common Scoter	*Melanitta nigra*	CX
Common Tern	*Sterna hirundo*	CN
Coot	*Fulica atra*	CO
Cormorant	*Phalacrocorax carbo*	CA
Curlew	*Numenius arquata*	CU
Dunlin	*Calidris alpina*	DN
Gadwall	*Anas strepera*	GA
Golden Plover	*Pluvialis apricaria*	GP
Goldeneye	*Bucephala clangula*	GN
Goosander	*Mergus merganser*	GD
Great Black-backed Gull	*Larus marinus*	GB
Great Crested Grebe	*Podiceps cristatus*	GG
Great Northern Diver	*Gavia immer*	ND
Greenland White-fronted Goose	*Anser albifrons flavirostris*	NW
Grey Heron	*Ardea cinerea*	H.
Grey Plover	*Pluvialis squatarola*	GV
Hen Harrier	*Circus cyaneus*	HH
Herring Gull	*Larus argentatus*	HG
Hooded Crow	*Corvus cornix*	HC
Knot	*Calidris canutus*	KN
Lesser Black-backed Gull	*Larus fuscus*	LB
Light-bellied Brent Goose	*Branta bernicla hrota*	PB
Little Grebe	*Tachybaptus ruficollis*	LG
Little Tern	*Sternula albifrons*	AF
Mallard	*Anas platyrhynchos*	MA
Oystercatcher	*Haematopus ostralegus*	OC
Pintail	*Anas acuta*	PT
Raven	*Corvus corax*	RN

Common name	Scientific names	BTO code
Red-breasted Merganser	*Mergus serrator*	RM
Redshank	*Tringa totanus*	RK
Red-throated Diver	*Gavia stellata*	RH
Ring-billed Gull	*Larus delawarensis*	IN
Ringed Plover	*Charadrius hiaticula*	RP
Roseate Tern	*Sterna dougallii*	RS
Sanderling	*Calidris alba*	SS
Sandwich Tern	*Sterna sandvicensis*	TE
Scaup	*Aythya marila*	SP
Shag	*Phalacrocorax aristotelis*	SA
Shelduck	*Tadorna*	SU
Shoveler	*Anas clypeata*	SV
Surf Scoter	*Melanitta perspicillata*	FS
Teal	*Anas crecca*	T.
Tufted Duck	*Aythya fuligula*	TU
Whooper Swan	*Cygnus cygnus*	WS
Wigeon	*Anas penelope*	WN

Appendix B

Literature review - Impacts of bottom mussel culture on benthic fauna

B.1 Review

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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Appendix C

Red-breasted Merganser disturbance study

C.1 Introduction

C.1.1 During our reconnaissance visit to Wexford Harbour on 4th and 5th February 2015 we noted that Red-breasted Merganser appeared to show a very strong disturbance response to marine traffic. On this visit, we recorded some observations of the response of mergansers to a cot and to small inshore potting vessels. We subsequently made two additional visits, on 20th February and 2nd March 2015, with the specific aim of recording the response of mergansers to dredgers.

C.2 Methods

Survey durations and activity observed

C.2.1 Observations were made on 4th, 5th and 20th February and 2nd March 2015. The duration of the observation periods on each of those days, and the vessel activity observed, is shown in Table C.1. The positions of the activities observed are shown in Figure C.1.

Table C.1 - Duration of observation periods and vessel activity observed.

Date	Time	Vantage point	Vessel activity
04/02/2015	15:45	Harbour View	Watched cot returning from oyster trestles to quays
05/02/2015	15:30-16:30	Harbour View	Watched cot returning from oyster trestles to Hantoon Road/Harbour View Road slip and a small inshore potting vessel returning along navigation channel
20/02/2015	07:00-09:00	Harbour View	Watched Branding and Hibernia, and three small inshore potting vessels departing along navigation channel
20/02/2015	09:45-10:50	Observation Tower	Watched Hibernia starfish mopping
20/02/2015	11:30-13:00	Observation Tower	Watched Branding starfish mopping and retuning across northern side of harbour
02/03/2015	06:45-08:30	Harbour View	Watched one small inshore potting vessel departing along navigation channel
02/03/2015	09:45	Harbour View	Watched Laura Anne departing
02/03/2015	10:30	Ferrybank	Watched Laura Anne returning
02/03/2015	11:00-12:30	Observation Tower	Watched Hibernia starfish mopping
02/03/2015	13:00-14:00	Harbour View	Watched Edenvale and Laura Anne departing
02/03/2015	14:30-18:00	Ardcavan/Ferrybank	Watched Edenvale, Hibernia and Laura Anne mussel dredging. Edenvale returned at 16:40.

Survey methods

C.2.2 Four vantage points were used: Harbour View Road, Ferrybank (by Wexford Swimming Pool and Leisure Centre), Ardacavan Beach, and the observation tower in the Wexford Wildfowl Reserve (Figure C.1).

C.2.3 Observations of boats travelling to/from the quays in Wexford and the Hantoon Road/Harbour View Road slip were mainly made from the Harbour View Road vantage point, with a small number made from the Ferrybank vantage point.

C.2.4 Observations of dredgers actively mussel dredging or starfish mopping were made from the other three vantage points, depending upon their position.

C.2.5 For each boat observed, details of the boat size were obtained from the *Irish Fleet Register 16-02-2015* (www.agriculture.gov.ie/media/migration/fisheries/seafisheries/seafisheriesadministration/), or from information provided by the operators. For the dredgers, the boat speeds were provided by the operators. For other boats, speeds were calculated, in some cases, by timing the boats passage across a known length (the navigation channel, or the distance from the oyster trestles to the Hantoon Road/Harbour View Road slip).

C.2.6 For each boat observed travelling, the response of all mergansers within a distance of at least 500 m perpendicular to the boat's route was recorded. Often, the response of mergansers at greater distances were recorded. Some observations were also made of the response of Goldeneye and Great Crested Grebe.

C.2.7 For each dredger observed actively mussel dredging or starfish mopping, the response of all mergansers within a distance of around 1 km from the area being fished was recorded, as far as possible. However, when dredgers were working at long distances from the vantage points, birds within this zone on the far sides of the dredgers could have been missed.

C.2.8 The parameters recorded for each observation are listed in Table C.2. For observations of boats travelling in, and around, the navigation channel, the positions of the birds and the boats relative to the navigation markers mapped on the *Wexford Harbour Chartlet 2014* were used to help estimate distances. For observations of dredgers fishing, the position of the plot being fished (as supplied by the operators) was used to help estimate distances.

C.2.9 Lateral distances were not estimated for responses to boats dredging or starfish mopping, as the boats were not following defined routes in these cases.

C.2.10 The distance categories used in Table C.2 reflect the range of different levels of precision in the distance estimates, and the apparent significance of 500 m as a threshold for disturbance effects. Where the birds were close to the navigation channel, distances could be estimated to the nearest 100 m. However, in other cases, it was more difficult to estimate distances. When birds flushed, it was difficult to estimate the closest distance as the latter required the single observer to keep track of two widely separate targets (the boat and the birds that flushed). However, the lateral distance could usually be estimated more accurately, by watching the boat pass the location of the birds.

C.2.11 On some occasions when a flush response was recorded, the birds were followed and the following additional parameters were recorded: time spent flying, distance travelled, and whether any additional birds were flushed.

Table C.2 - Parameters recorded for each observation.

Parameter	Categories	Notes
Activity (before response to boat)	Feeding	Birds actively feeding
	Not feeding	Birds not actively feeding or displaying but not sleeping
	Displaying	Birds displaying
	Sleeping	Birds with their heads down sleeping
Response to boat	No response	Continued normal behaviour as the boat passed
	Alert response	Stopped previous behaviour, sat up in water and stretched neck, often looking around at the boat
	Swam away	Purposefully swimming away from the path of the boat, usually following an alert response
	Flushed	Flew away from the path of the boat, often following alert and swam away responses
Due to boat	Yes	Birds observed for a period before the response, so the change in behaviour could be directly attributed to the boat
	Probable	Birds only observed at the time of the response, so the behaviour cannot be directly attributed to the boat, but is likely to be due to the boat
	No	This category would be used
Lateral distance	> 500 m	The perpendicular distance from the path of the boat.
	250-500 m	
	< 250 m	
Closest distance*	> 500 m	The closest distance between the boat and the bird before the bird showed any disturbance response. For birds showing no response, the closest distance = the lateral distance
	250-500 m	
	< 250 m	

* For nine observations, the closest distance was estimated in the field as c. 500 m; these observations have been allocated to the 250-500 m distance band.

Data analysis

C.2.12 Red-breasted Mergansers typically occur in small groups and, usually, the disturbance response was the same for all members of the group. For most of the analyses, we have used the number of observations (where each observation represents the interaction of one group with one boat), rather than the total number of birds. In two cases, the response within the group was variable: in these cases we have used each response as a separate observation. It should be noted also that, in some cases, separate observations may refer to the same birds interacting with different boats.

C.3 Results

Red-breasted Merganser

Distribution and behaviour

C.3.1 We made 13 sets of observations of boats travelling along defined routes and we have used these observations to calculate the mean encounter rate during our study. We defined 500 m flat-ended buffers around these routes, excluding areas of land from the buffers. We then used the area enclosed by these buffers to calculate the encounter rate as ha/bird. We only included birds recorded within the 0-250 m and 250-500 m lateral zones. The overall encounter rate was one bird every 38 ha (Table C.3).

Table C.3 - Encounter rate of Red-breasted Mergansers.

Date	Time	Boat	Route	Area/ha	Number recorded	Encounter rate (ha/bird)
04/02/2015	15:45	cot	trestles-quay	280	8	35
05/02/2015	15:40	WD264P	nav channel (long)	382	14	27
	16:20	cot	trestles-slip	72	2	36
20/02/2015	07:15	WD248	nav channel (long)	382	2	191
	07:30	WD264P	nav channel (long)	382	8	48
	07:45	Hibernia	nav channel (short)	166	14	12
	08:07	WD269	nav channel (long)	382	4	96
	14:15	cot	trestles-slip	72	11	7
	14:50	WD264P	nav channel (long)	382	2	191
	16:25	WD248	nav channel (long)	382	11	35
	17:35	cot	trestles-slip	72	7	10
02/03/2015	08:15	WD264P	nav channel (long)	382	3	127
	14:00	Edenvale	nav channel (short)	166	5	33
Totals				3502	91	38

Routes: nav channel (short) = from end of north training wall to markers Wx21 and Wx22; nav channel (long) = from end of north training wall to markers Wx13 and Wx12; trestles-quay = from trestles to end of south training wall and then along navigation channel to end of north training wall; trestles-slip = from trestles to Hantoon Road/Harbour View Road slip

C.3.2 The median group size was three birds (range 1-12 birds, n = 41).

C.3.3 Across all observations where the pre-disturbance behaviour was recorded, 55% of birds were feeding (Table C.4). The percentage of birds feeding was lower in the morning, compared to the middle of the day and the evening, but the difference was not significant ($\chi^2 = 3.7785$, $p > 0.1$).

Table C.4 - Pre-disturbance behaviour of Red-breasted Mergansers.

Time period	Number of birds				% feeding
	Feeding	Not feeding	Displaying	Sleeping	
07:00-10:00	18	13	7	4	43%
11:00-15:30	26	16	0	0	62%
15:30-17:30	23	15	0	0	61%
Total	67	44	7	4	55%

Disturbance response

C.3.4 A total of 45 observations of Red-breasted Mergansers interacting with marine traffic were recorded (Table C.5). The disturbance response was clearly related to the lateral distance from the boat route (Table C.6). Birds that flushed, always flushed at more than 250 m from the boat, and often flushed at very long distances. The maximum flush distance recorded was around 1.5 km.

C.3.5 Observations of interactions with the cot travelling to/from the oyster trestles showed the highest incidence of active disturbance responses. However, when the distribution of observations in relation to lateral distances from the vessels are taken into account, and taking account of the small sample sizes, there are no clear differences in the nature of the disturbance responses between the three vessel types (Table C.7). The size of the group of mergansers, and their pre-disturbance behaviour, did not obviously influence the disturbance response, although the sample sizes are small (Table C.8).

Table C.5 - Red-breasted Merganser disturbance responses recorded.

Lateral distance	Closest distance	No response	Alert	Swam away	Flushed	Totals
< 250 m	< 250 m	2	0	3	0	5
	250-500 m	0	0	0	6	6
	> 500 m	0	0	1	8	9
250-500 m	250-500 m	3	0	4	3	10
	> 500 m	0	0	0	1	1
> 500 m	> 500 m	5	1	0	1	7
Not classified	< 250 m	0	0	0	0	0
	250-500 m	3	0	0	1	4
	> 500 m	0	1	0	2	3
Totals	all	13	2	8	22	45

Table C.6 - Summary of incidence of disturbance response type by lateral distance.

Lateral distance	% of observations with		n
	any disturbance response	flush response	
< 250 m	90%	70%	20
250-500 m	73%	36%	11
> 500 m	29%	14%	7
All	71%	49%	45

Table C.7 - Summary of disturbance responses by boat type.

Boat type	Lateral distance	no response	alert	swam away	flushed
cot	< 250 m	0	0	0	6
	250-500 m	0	0	1	1
small inshore potting vessel	< 250 m	1	0	4	3
	250-500 m	2	0	2	3
	> 500 m	3	1	0	1
dredger	< 250 m	1	0	0	5
	250-500 m	1	0	1	0
	> 500 m	2	0	0	0
	not classified	3	1	0	3

Table C.8 - Summary of disturbance responses by group size.

Group size	Lateral distance	no response	swam away	alert	flushed
1 bird	< 250 m	1	1	0	2
	250-500 m	1	1	0	0
	> 500 m	1	0	0	0
2 birds	< 250 m	1	0	0	2
	250-500 m	1	2	0	3
	> 500 m	1	0	1	0
3-4 birds	< 250 m	0	1	0	4
	250-500 m	1	0	0	0
	> 500 m	2	0	0	1
	not classified	2	0	1	2
5-12 birds	< 250 m	0	2	0	6
	250-500 m	0	1	0	1
	> 500 m	1	0	0	0
	not classified	1	0	0	1

Table C.9 - Summary of incidence of disturbance response type by pre-disturbance behaviour.

Lateral distance	Behaviour	no response	swam away	alert	flushed
< 250 m	feeding	1	2	0	5
	other	0	2	0	3
250-500 m	feeding	0	1	0	0
	other	3	2	0	3
> 500 m	feeding	4	0	1	0
	other	1	0	0	0

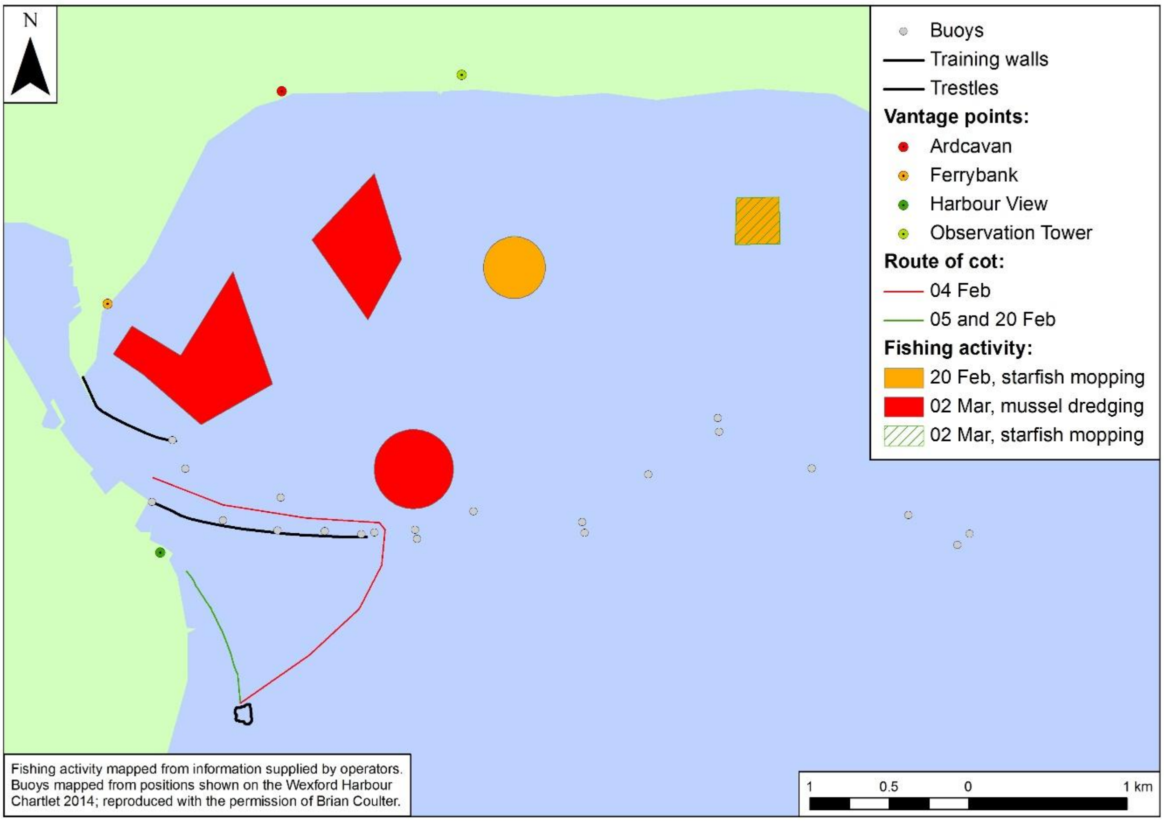

Figure C.1 - Red-breasted Merganser disturbance study vantage points used, and activity observed.

Appendix D

Review of potential disturbance impacts from dredger activity to Greenland White-fronted Goose

D.1 Introduction

D.1.1 This appendix reviews the potential impact of dredger activity close to the North Slob on the Greenland White-fronted Geese using the North Slob.

D.2 Sensitive zone

D.2.1 According to NPWS, Greenland White-fronted Geese are considered to be potentially affected by disturbance from vessel activity when they (the geese) are within 200-300 m of the sea-wall. The geese are not considered to be potentially affected by disturbance from vessel activity in the area to the west of the observation tower, even in areas within 300 m. of the sea-wall. Therefore, a sensitive zone of 300 m width from the sea-wall, east of the observation tower, was defined for the purposes of this assessment (Figure D.1).

D.3 Geese activity

D.3.1 Field by field counts of Greenland White-fronted Geese for 39 dates across the winters of 2011/12, 2012/13 and 2013/14, were supplied by NPWS. These were analysed to assess the usage of the fields within the sensitive zone. The fields within, or partially within, the sensitive zone are field numbers 11, 12, 13, 52, 53, 55, 56, 112 and 114 (Figure D.1). A small part of field 14 also extends into the sensitive zone, but this field was not defined as being within the sensitive zone for the purposes of this analysis.

D.3.2 Geese occurred within these fields on 37 of the 38 counts included in the analysis (one count was excluded as only 6 geese were present across the entire North Slob). The mean percentage of the total count using the fields within the sensitive zone was 7.6% (95% C.I. = 5.9-9.2%, n = 37).

D.4 Vessel activity

Review of vessel tracking data

D.4.1 There are three dredgers that fish sites close to the North Slob: the Branding, Hibernia and Laura Anne. Vessel activity/tracking data for the Branding, Hibernia and Laura Anne has been supplied by BIM for 117 dates across the winters of 2011/12, 2012/13 and 2013/14. These dates were selected to coincide with the dates of NPWS management counts, and the days before and after each management count. Note that the tracking data was not available for all dates, but the operators supplied information on their activity for the missing dates. There are a few dates with information still missing for individual operators.

D.4.2 The distribution of the dates with vessel activity in the sites close to the northern shore is shown in Table D.1.

D.4.3 The sites fished by the Branding and the Laura Anne are, at their closest points, around 400 m from the sea-wall (Figure D.1). It is not known whether Greenland White-fronted Geese are susceptible to disturbance from dredgers at these distances from the sea wall.

D.4.4 Only the Hibernia uses sites close into the sea-wall (distances of 100-200 m at their closest points), and activity was rare in these sites (< 5% of the days included in the dataset). However, on many of the days with vessel activity in site 55F&C, the vessel tracking shows the Branding passing within around 200 m of the sea-wall on its route to/from the site[12].

[12] Because of the nature of the data supplied (screen-grabs without any indication of scaling), it is difficult to quantify precisely the number of days on which the Branding passed within specified distances of the sea-wall.

Table D.1 - Distribution of the dates with vessel activity in the sites close to the northern shore.

	Sites	Day before	Count day	Day after
Branding	55F&C	11	14	16
Hibernia	46A, 49B and 52A	1	4	0
Laura Anne	48A	1	1	0

Data available for a total of 39 dates in each category (with a few missing days for each vessel).

Further information

D.4.5 Arising from the above review, further information was requested from the operators about their activities. The following is a summary of the information provided by the operators, with some supplementary information from BIM.

D.4.6 The vessel tracking data is considered to represent fairly typical activity patterns for the Hibernia in sites 46A, 49B and 52A in recent years. However the activity could be slightly higher or lower depending on mussel seed availability, and may have been higher in the past when there was higher levels of seed supply. The trend over the last few years is to relay seed on the sites on the north side of the harbour in August or September. This seed is then mostly moved around April to sites away from the north side from where the mussels would be fished for harvest the following winter. The initial relaying of this seed is always completed before October and the moving activity is normally in April. Monthly surveying of this seed would be the only need to visit these mussel beds, apart from on rare and sporadic occasions where starfish infestation may require the vessel activity. Some mussel stock was still maturing on site 49B in September 2015 and, at that time, the operator anticipated that seven or eight visits to the site over the winter would be required to harvest this stock. However, this is considered to not be typical of the usage patterns of these sites in recent years.

D.4.7 The typical low water access route for the Branding to/from site 55F&C is shown in Figure D.1, based on information supplied by BIM. The Branding approaches TP1 from the SW (on access) and turns at TP1 and heads east to TP2, from where it heads SE away from the sea-wall and loops into site 55F&C. The access route shown in Figure D.1 allows for 10 m north of the turning points. The distance from TP1 to the sea-wall is 367 m, the distance from the sea-wall at the closest point to sea-wall between TP1 and TP2 is 352 m, and the distance from the turn at TP2 to the sea-wall is 405 m. The Branding cannot go further south than the line between TP1 and TP2 due to sand banks. It should be noted also that prior to seven years ago the main route for all boats in and out of Wexford Harbour was a line north of TP1 and TP2. Now the main route is through the middle of the harbour so boat activity has been reduced considerably in proximity to the north slob sea-wall in the last seven years or so.

D.5 Analysis of topographic data

D.5.1 Topographic data for the North Slob was obtained from the OPW. This comprised LIDAR data, in the form of a point file giving elevation data to a precision of 0.01 m at grid intervals of approximately 1-5 m. The elevations within the sensitive zone on the North Slob are mainly within the range -1.5 to 0.0 m OD Malin, with the fields at the eastern end being slightly lower-lying than those adjacent to the observation tower (Figure D.1). These fields are around 3-5 m below the level of the sea-wall (2.5-3.5 m OD Malin). The sea-wall is around 2.0-3.0 m above the mean high tide level (0.5 m OD Malin). There are also small areas of higher ground, with arable fields, within the sensitive zone (Figure D.1).

D.5.2 The LIDAR data was used to analyse the maximum distance from the sea-wall at which the mast of a dredger will be visible over the sea-wall within the sensitive zone. This distance will vary according to the elevation of the field, the height of the sea-wall, the distance of the goose from the sea-wall and the tidal state. Preliminary calculations for the fields adjacent to the observation tower indicate that the distance (at mean high tide) ranges from around 100-150 m for geese at 50 m from the sea-wall, through 450-600 m for geese at 200 m from the sea-wall, to 700-900 m for geese at 300 m from the sea-wall (Table D.2).

D.5.3 Note also, that: -

- There are some arable fields on high ground adjacent to the shoreline within the sensitive zone. There will be no distance limit to the visibility of dredger masts in these fields.
- NPWS also consider noise from dredgers to cause disturbance to the geese. The degree of noise attenuation provided by the sea-wall is not known.

Table D.2 - Distance over which boats are visible to geese feeding on low-lying fields within the sensitive zone.

Distance of goose from sea-wall/m	Max. distance (m) of boat from sea-wall where it is visible to a goose feeding at elevations of		
	-0.25 m	-0.75 m	-1.25 m
50	154	132	115
100	307	263	231
150	461	395	346
200	615	527	461
250	768	659	576
300	922	790	692

Calculations are for mean high tide (0.47 m), and use a sea-wall height of 3.25 m (judged as being representative by eye), a mast height of 12 m above the water surface (the mast height on the Hibernia), and assume that the height of the goose's eyes above the field is 0.5 m (interpolated from bird measurements in literature sources). All levels are OD Malin.

D.6 Conclusions

D.6.1 The closest vessel activity by the Branding and Laura Anne to the North Slob will be around 400 m from the sea wall, or around 350 m while the Branding is travelling to/from its site. It is not known whether Greenland White-fronted Geese are susceptible to disturbance from dredgers at these distances from the sea wall.

D.6.2 Given the current low frequency of dredger activity in sites 46A, 49B and 52A, any disturbance of Greenland White-fronted Geese by dredger activity in these sites is likely to be a rare event and on a comparable scale to disturbance by licensed wildfowling (which occurs on around 5% of days during the October- March period).

D.6.3 However, the patterns of site usage, and the locations of dredger access routes, may change in the future as a result of changes in sedimentation patterns in the harbour, and (in the case of site usage) increases in seed supply.

D.6.4 It should be noted also that there is an additional site close to the sea-wall (site 57F). This site is licensed to an operator who is currently not active, and has not been active since around 2008.

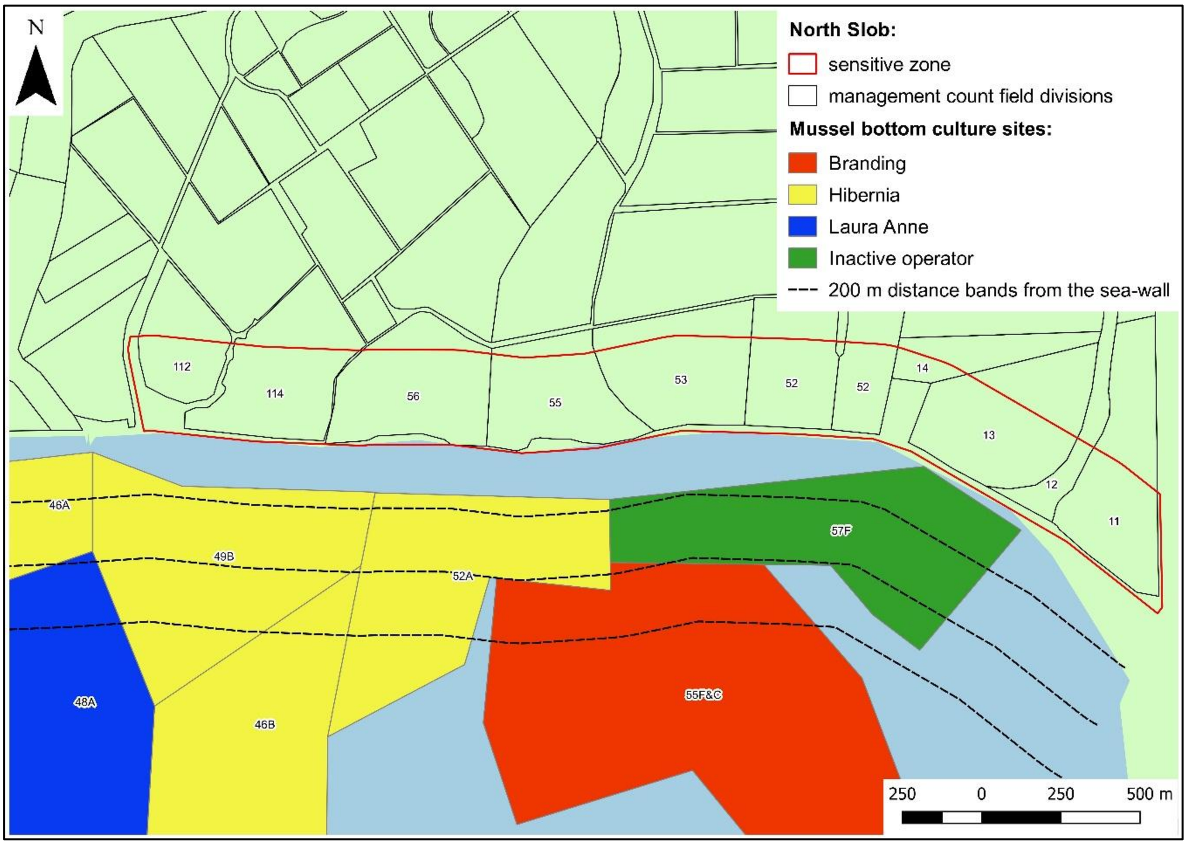

Figure D.1 - Aquaculture sites close to the sensitive zone for goose disturbance on the North Slobs.

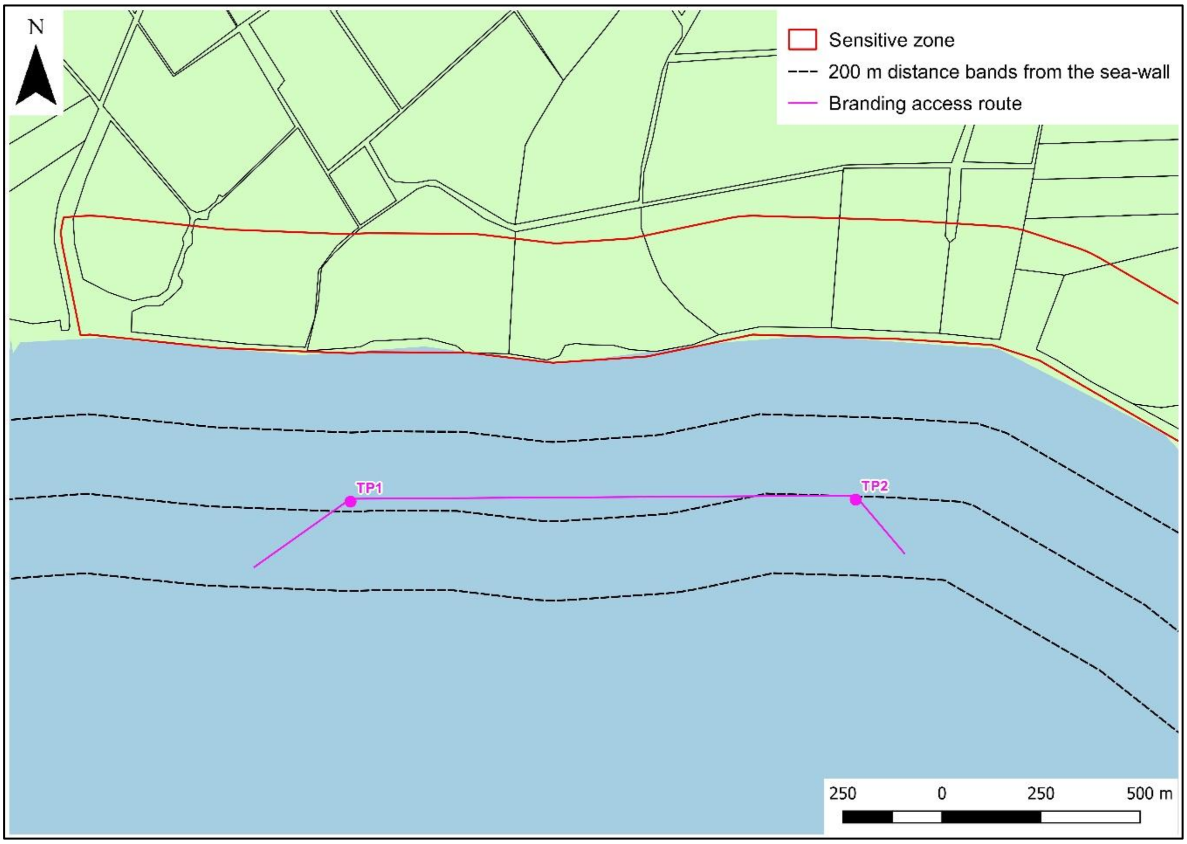

Figure D.1 - Main access route used by the Branding.

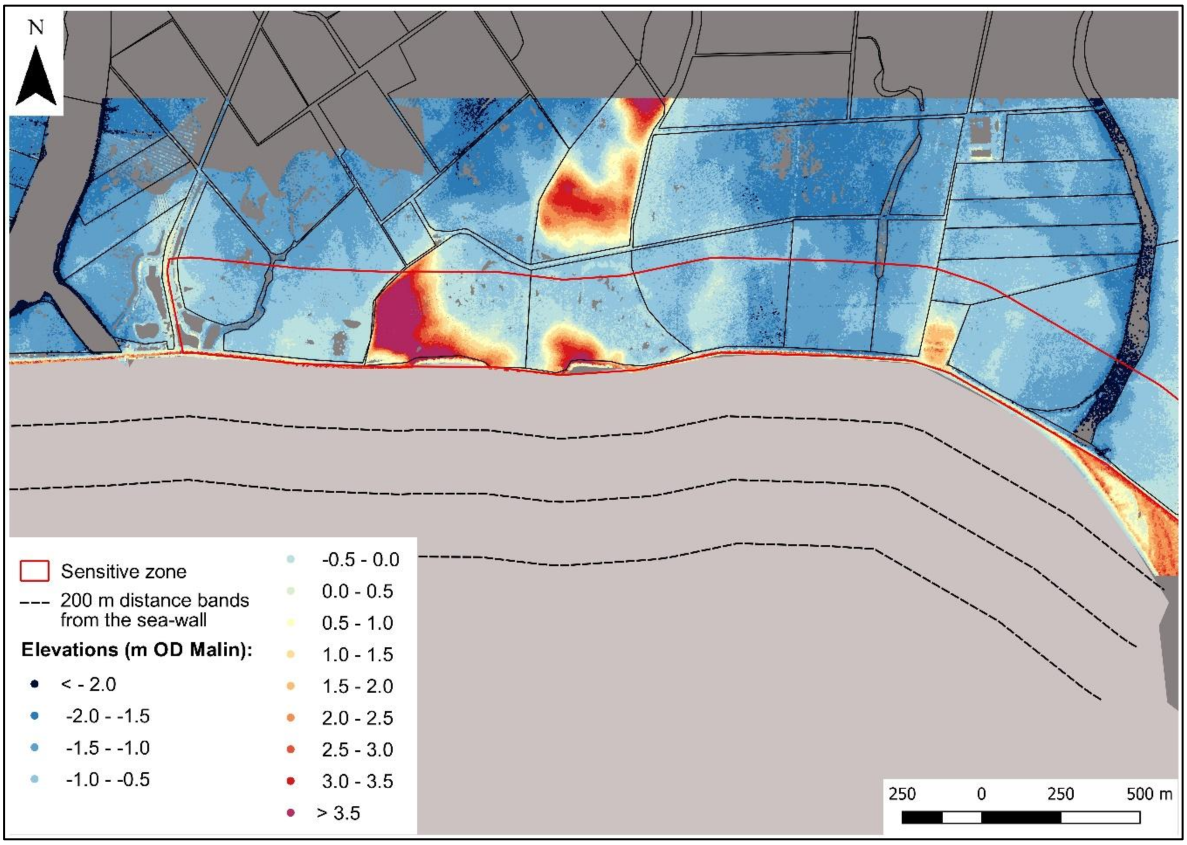

Figure D.1 - Elevations on the North Slobs.