Galway Harbour Company

Galway Harbour Extension

APPENDICES TO RESPONSE

TO REQUEST FOR FURTHER INFORMATION

OCTOBER 2014

DOCUMENT AMENDMENT RECORD

Client: **Galway Harbour Company**

Project: **Galway Harbour Extension**

Title: **Appendices to Response to Request for Further Information**

PROJECT NUMBER: 7476				DOCUMENT REF: 7476 Appendices to Response to RFI			
A	Appendices to Response to RFI	BR	6/10/14	LEW	8/10/14	JPK	14/10/14
Revision	**Description & Rationale**	**Originated**	**Date**	**Checked**	**Date**	**Authorised**	**Date**
TOBIN Consulting Engineers							

Galway Harbour Company

Galway Harbour Extension

Appendices to Response to Request for Further Information

TABLE OF CONTENTS

0 GUIDANCE ON DOCUMENTATION SUBMITTED IN RESPONE TO AN BORD PLEANÁLA REQUEST FOR FURTHER INFORMATION [RFI] OF 27TH MAY 2014-10-14

The response to the Request for Further Information [RFI] is presented in separate ring binders / volumes as follows:-

0.1 RESPONSE TO REQUEST FOR FURTHER INFORMATION.

The layout follows the sequence of issues raised in the RFI.

- Alternatives.
- Noise – Vibration.
- Marine Hydrology Issues
- Ecology Issues.

  Dr. Michelene Sheehy-Skeffington has carried out an assessment of the salt marshes and stony banks adjacent to Lough Atalia and Renmore Lough having regard to the winter storms of early 2014.

- Marine Mammals

  Kelp Marine Research, Hoorn, The Netherlands, a research organisation in cetacean behaviour and ecology were engaged to assist in:-

  (i) A desk top analysis to address harbour seal habitat, and
  (ii) A risk assessment of marine mammals in the area of the proposed development.

- Birds

  Dr. Tom Gittings, Whitegate, Cork and ecological consultant was engaged to assist in a desk study to assess the sensitivity of bird species to potential impacts from the proposed development.

0.2 APPENDICES TO RFI

This volume includes the following Appendices:

RFI 1 - **Consideration of Development in Context of Article 6[4] of the Habitats Directive as Transposed into Irish Law.**

RFI 2 - **Mammals**

RFI 2.1 - Seal Raw Data
RFI 2.2 - Kelp Report
+ Risk Assessment for all Marine Mammals
+ Aquatic Habitat Use of the Harbour Seal

RFI 3 - **Birds**

RFI 3.1 - Birds Raw Data
RFI 3.2 - Species Profiles by Dr. Chris Peppiatt
RFI 3.3 - Bird Species Assessments by Dr. Tom Gittings

0.3 NIS ADDENDUM / ERRATA

Generally, the information presented in the NIS Addendum is new information which should be considered as ADDITIONAL to that included in the NIS as submitted with the planning application originally. ERRATA will be noted specifically, in addition to scenarios where it is considered that the information considered in the NIS Addendum should supersede information presented in the main NIS document. Where possible, reference material which was previously presented in the EIS and has now been incorporated into the NIS Addendum is presented as Appendices, as this information is not necessarily new information. Similarly, where new information has been prepared by external consultants, relevant portions have been incorporated into the body text of the NIS Addendum, with their original report presented in an Appendix for reference. Where possible, the NIS addendum follows the same sequence and numbering system as the original NIS, with notes provided to show where no additional information has been added under a heading or sub-heading.

0.4 APPENDICES TO NIS ADDENDUM / ERRATA

Chapter 1 - No Appendices

Chapter 2

- Appendix 2.1 - Lough Atalia and Renmore Lagoon Habitats
- Appendix 2.2 - Benthic Fauna
- Appendix 2.3 - Salmon Smolt Tracking and Fish Predation Surveys
- Appendix 2.4 - Otter
- Appendix 2.5 - Seal Raw Data
- Appendix 2.6 - Kelp Report
  - \+ Risk Assessment for all Marine Mammals [Excluding Otter]
  - \+ Aquatic Habitat Use of the Harbour Seal
- Appendix 2.7 - Raw Bird Data
- Appendix 2.8 - Bird Species Profiles by Dr. Chris Peppiatt
- Appendix 2.9 - Lough Corrib SPA SCI's

Chapter 3

- Appendix 3.1 - Potential Impacts and Mitigation
- Appendix 3.2 - Chapter 8 from original EIS
- Appendix 3.3 - Marine Hydrology Issues
  - 3.3.1 - Sediment Transport / Morphology Modelling
  - 3.3.2 - Potential for Transport of Sand for River Corrib
  - 3.3.3 - Modelling of Wind Waves
  - 3.3.4 - Wind Waves and Current Effects
  - 3.3.5 - Wind Waves and Coastal Areas
  - 3.3.6 - Effects of Sea Bed Roughness
  - 3.3.7 - Wind Waves and Friction
  - 3.3.8 - Outfall Dispersion Study
  - 3.3.9 - Mapping of Maximum Wave Heights
  - 3.3.10 - Mapping of Areas of Potential Flood Risk
- Appendix 3.4 - Bird Species Assessments [Dr. Tom Gittings]
- Appendix 3.5 - Oil Spill Contingency Plan
- Appendix 3.6 - The Port of Galway Marine Emergency Plan [Galfire]
- Appendix 3.7 - Environmental Management Framework

0.5 EIS ADDENDUM / ERRATA AND APPENDICES

This volume includes the following:

- Addendum to Non-Technical Summary
  [Amendments to Sect. 7.3 – Impacts]

- Addendum to Chapter 3 – Background & Alternatives

- Addendum to Chapter 7 – Flora & Fauna

- Addendum to Chapter 8 – Water
  [Marine Hydrology Issues]

- Appendices to EIS Addendum / Errata

  - **EIS[A] 1 - No Appendix**

  - **EIS[A] 2 - Mammals**
    + EIS[A] 2.1 - Seal Raw Data
    + EIS[A] 2.2 - Kelp Report
      * Risk Assessment for all Marine Mammals [except Otter]
      * Aquatic Habitat Use of Harbour Seal

  - **EIS[A] 3 - Birds**
    + EIS[A] 3.1 - Birds Raw Data
    + EIS[A] 3.2 - Species Profiles by Dr,. Chris Peppiatt
    + EIS[A] 3.3 - Bird Species Assessments by Dr. Tom Gittings

Galway Harbour Company

Galway Harbour Extension

Appendix RFI 1

Consideration of Development in Context of Article 6[4] of the Habitats Directive as Transposed into Irish Law

Galway Harbour Extension
Consideration of development in context of Article 6(4) of the Habitats Directive as transposed into Irish Law.
14th October 2014

TABLE OF CONTENTS

List of Tables

List of Figures

1. BACKGROUND

The proposed development at Galway Harbour Company (GHC) encroaches on Natura 2000 sites (i.e. SAC & SPA), established under the Habitats Directive[1] ('the Directive'). The Natura Impact Statement (NIS) prepared as part of this planning application has concluded that adverse impact on the Natura 2000 sites cannot be ruled out beyond reasonable scientific doubt, primarily as a consequence of the project footprint. It is to be noted however, that the nearby **Priority Habitat of Lough Atalia is not affected** by this proposed project[2].

In accordance with the European Commission Document *Managing Natura 2000 Sites*[3]*,* in the absence of feasible alternatives, or in the presence of solutions having even more negative environmental effects on Natura 2000 sites, the next step is to determine whether there are Imperative Reasons of Overriding Public Interest (IROPI), including those of a social or economic nature, which require the realisation of the proposed plan or project.

There is thus a two-step process involved:

(i) assess whether **feasible alternatives** exist, and

(ii) if they do not, determine whether there are **Imperative Reasons of Overriding Public Interest (IROPI)** which require the realisation of the proposed plan or project.

The question of **feasible alternatives** has been dealt with in Chapter 3 of the EIS and the addendum thereto, and it was concluded that there was not a feasible alternative that met the objectives of the project. These findings are recounted in **Chapter 2 of this document**.

Turning to Step (ii), Commission guidance is that it should be demonstrated that the balance of interest between the conservation objectives of the site affected by the project and the imperative reasons why the project should proceed, should weigh in favour of the latter. *Managing Natura 2000 Sites* provides that this should be determined on the basis of the following considerations:

a) The public interest must be **overriding**; it is therefore clear that not every kind of public interest of a social or economic nature is sufficient, in particular when seen against the particular weight of interest protected by the Directive.

[1] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:01992L0043-20070101&from=EN

[2] We understand it is predicted that there may be minor changes in salinity but this will not affect the ecological functioning of the habitat.

[3] Commission Document, *Managing Natura 2000 Sites - The Provisions of Article 6 of the 'Habitats' Directive 92/43/EEC*. http://ec.europa.eu/environment/nature/natura2000/management/docs/art6/provision_of_art6_en.pdf

b) In this context, it also seems reasonable that the public interest can only be overriding if it is a **long-term interest**; short term economic interest or other interests which would only yield short-term benefits for society would not appear to be sufficient to outweigh the long-term conservation interests protected by the Directive.

The Commission document goes on to state:

> *"It is reasonable to consider that the 'imperative reasons of overriding public interest including those of a social and economic nature' referred to situations where plans or projects envisaged prove to be indispensable:*
> - *Within the framework of actions or policies aiming to protect fundamental values for Citizens' lives (health, safety, environment);*
> - *Within the framework of fundamental policies for the State and society;*
> - *Within the framework of carrying out activities of an economic or social nature, fulfilling specific objectives of public service."* (p.44)

In identifying IROPI, the different elements of the term have been considered;

Imperative: It must be essential, weighed in the context of the other elements below, that the plan or project proceed.

Over-Riding: The interest served by the plan or project outweighs the harm (or risk of harm) to the integrity of the site as identified in the appropriate assessment.

Of Public Interest: A public benefit must be delivered rather than a solely private interest. Public interest can occur at national, regional or local level.

This Document therefore will assess the Galway Harbour Extension (GHE) project in accordance with the following criteria, which are deemed relevant in terms of satisfying the IROPI test above. Thus after consideration of alternatives in Chapter 2, the rest of the document is as follows:

Chapter 3 - Necessity
Chapter 4 - Long term
Chapter 5 - Of Public Interest
Chapter 6 - Of a Social & Economic Nature
Chapter 7 - Scale of Importance.

The findings are then summarised in Chapter 8.

2. ASSESSMENT OF ALTERNATIVES

2.1 APPROACH

Having concluded that an adverse impact on the Natura 2000 sites cannot be ruled out beyond reasonable scientific doubt, it is necessary to assess alternative solutions with a view to establishing whether there is an alternative that would involve less damage to Natura 2000 sites. This comprises two steps –

1. Identification of potential alternatives, and
2. Assessment of whether a feasible alternative exists.

2.2 IDENTIFICATION OF POTENTIAL ALTERNATIVES

2.2.1 Objectives of the Project

Article 6(4) sets out *inter alia* an **alternative solutions test** to determine whether there are any other feasible ways to deliver the overall objectives of the plan or project which will be less damaging to the integrity of the European site(s) affected. For the proposed development to "pass" the test the competent authority must be able to demonstrate objectively the absence of feasible alternative solutions. Alternative solutions are limited to those which would deliver the overall objectives of the original proposal.

The primary objective of the Galway Harbour Extension (GHE) is to provide new port facilities, building on existing port infrastructure, that will upgrade and replace existing inadequate facilities. Ports are essential elements of economic infrastructure, and key to continued socio-economic competitiveness and prosperity of their respective catchments and the wider economy. This is demonstrated in the socio-economic Cost Benefit Analysis of the current project, which confirmed the wider economic benefits of the development of the port. Thus the project contributes to the achievement of balanced regional development and supports the strategic role of Galway as the Gateway City serving the West region. In addition the project contributes to the delivery of the National Ports Policy, which envisages a strategic regional role for Galway port. The commercial viability of the project was also demonstrated in the Business Case.

The existing port serves a number of different functions and sectors. The predominant activity is freight, specifically bulk freight. It also serves as a fishing port, international cruise tourism destination and a marina, as well as servicing offshore exploration and research and offshore renewable energy generation. Notably, the port is a base for the Marine Institute's *RV Celtic Explorer* research vessel, as well as being an important research base for Galway University (NUIG) and Galway Mayo Institute of Technology (GMIT). The Marine Institute's website notes that:

> "Ireland's unique strategic position on the edge of the Atlantic means that the Celtic Explorer is able to facilitate both national and international research and exploration. **The vessel is based in Galway, which is ideally located as the gateway to the Atlantic and geographically close to the main working areas**."[4] (our emphasis)

The proposed harbour extension is required so that Galway Harbour Company can continue to fulfil these roles as the principle maritime gateway to the West region.

Galway City is the primary population centre within the region, the designated Gateway City and strategic regional transport hub for both road and rail transport. Galway Harbour has significant established port-related infrastructure including dedicated storage and distribution facilities for a range of bulk commodities, in particular oil and bitumen.

Notably, following the pre-application consultation process for potential strategic infrastructure projects with An Bord Pleanála (ABP), the Board determined that GHE constitutes strategic infrastructure and is of strategic importance (ABP Ref: 61 PC0012).

The primary requirement for the extension arises from the severe operational and infrastructural constraints within the existing harbour. **The objective for the extension therefore is to provide a facility which will serve existing and future long term transport and economic needs of the region** over a minimum 30-year period, and will include the following:

- Sufficient quay length to accommodate freight, cruise and offshore servicing and operational requirements;
- Sufficient draft for all-tide access to each berth based on proposed use;
- Sufficient capacity to accommodate 20,000 tonne freight capacity vessels;
- Sufficient land to support the necessary land-based facilities for a sustainable port;
- Addressing existing SEVESO issues through the construction of petroleum and bitumen terminals and transfer pipelines to the existing tank farms, to replace current unloading operations within the existing harbour/city centre area[5].

Broader objectives can be articulated as:

- To facilitate the economic growth of the region;
- To enable the Galway and West Region to enhance its reputation as a major maritime tourism and leisure location;

[4] https://www.marine.ie/home/services/researchvessels/explorer/

[5] The SEVESO Directives relate to procedures for handling dangerous substances (in this case loading and offloading petroleum and bitumen) within prescribed zones in order to minimise danger to residents in the case of an accident. They are relevant in the current case because the loading and offloading occurs at present within the Inner Harbour, which is close to the city centre and residential areas.

- To enable Galway to become a major destination for the international cruise business, and to cater for marine tourism;
- To safeguard, sustain and facilitate employment associated with the movement of goods through the port;
- To facilitate urban regeneration through reintegration of the Inner Harbour with the city centre.

2.2.2 Alternative Solutions

A key test of alternative solutions is thus by reference to whether they meet the project objectives above. Alternatives can be considered across a number of dimensions, such as:

a) Locations;
b) Scale or size;
c) Means of meeting objectives (e.g. demand management);
d) Methods of construction;
e) Operational methods;
f) Decommissioning methods at the end of the projects life;
g) Scheduling & timescale proposals (e.g. seasonal working).

In the current context, alternatives effectively fall under a) to c). Alternatives d) to g), while potentially applicable in other circumstances are not relevant in the current context, as it is not impacts arising from construction/operational /decommissioning methods, or seasonal working which result in the situation where adverse impact on the Natura 2000 sites cannot be ruled out beyond reasonable scientific doubt.

In view of this, the potential alternatives that have been considered are:

1. 'Demand Management' i.e. take steps to reduce demand for port facilities in GHC's hinterland;
2. 'Do Nothing', i.e. continue to operate GHC as is;
3. 'Do Minimum', i.e. improvements to the existing Inner Harbour;
4. 'Do Something', i.e. alternative scales/designs at the proposed project location, in effect an intermediate or incremental project;
5. 'Do Elsewhere'; i.e. cater for GHC's traffic elsewhere. This incorporates a range of options, including –
   - 5a. consideration of other locations in the inner Galway Bay (i.e. Tawin and Mutton Island);
   - 5b. Consideration of other locations elsewhere in Galway Bay, i.e. Ros a' Mhíl;
   - 5c. Consideration of other ports beyond Galway Bay, i.e.
     - 5ci Ports of National Significance as per NPP – Tier I (Dublin, Cork – specifically Ringaskiddy[6] and Shannon-Foynes – specifically Foynes[7]);

[6] Cork port includes other terminals, including Tivoli and the City Docks. Tivoli is largely a container terminal, and has significant operational limitations. It is clear that Cork's long term strategy is to concentrate on development at Ringaskiddy. See for instance details of the ABP Oral Hearing at the

5cii Ports of National Significance as per NPP – Tier II (Waterford, Rosslare);
5ciii Other commercial ports on the island of Ireland;

5d Consideration of other ports abroad, i.e. ports outside the island of Ireland;

5e. Consideration of other transport modes – road, rail, air.

Some of these options can be eliminated on initial analysis, namely (1) demand management, (5ciii) non-national ports on the island of Ireland, (5d) ports outside island of Ireland, and (5e) other modes, the rationale being as follows:

Table 2.1: Options eliminated on Initial Analysis

Option		Rationale for Elimination
1	Demand management	Demand management is not relevant as the project is designed to cater for economically arising international trade serving the region.
5ciii	Non-national ports on island of Ireland	These were eliminated for a range of reasons, including one or more of the following: • Excessive distance from Galway; • Inability to cater for the traffic in question (e.g. doesn't cater for bulk traffic, lacks landside storage and other facilities); • Severe operational limitations (e.g. tidal, depth, quay length, etc.); • Not in accordance with National Ports Policy, which indicates that ports of regional significance should cater for their own region.
5d	Ports outside island of Ireland	Cannot meet the objectives as commodities in question must be transported onto/off the island of Ireland.
5e	Other modes	• Road and rail on their own cannot meet the objectives as commodities in question must be transported onto/off the island of Ireland. • Air transport is commercially non-viable because of the nature of the commodities in question, which have a high bulk/value ratio[8].

time of writing (http://www.irishtimes.com/news/environment/cork-needs-port-upgrade-for-cargo-sector-planning-hearing-told-1.1924566).

[7] Limerick Dock is also part of Shannon-Foynes, as are the large dedicated terminals at Moneypoint, Aughinish, Tarbert and Shannon Airport Jetty. However, these are not open for general trade. We understand that in 2013 Foynes catered for approximately 85% of the total cargo handled by the two general ports, Foynes and Limerick Docks. Limerick Dock is also subject to significant operational constraints, including tidal restrictions both in the channel and at the dock. Shannon-Foynes Port Company Visions 2041 Masterplan further indicates that "over time the petroleum based facility is not expected to remain operational in Limerick Docks" (p.14). On this basis Limerick Dock was not considered as an option in our analysis. (see Shannon-Foynes Port Company Visions 2041 Masterplan , p.10)

[8] Because of its cost, air freight is confined to relatively small volumes of freight that are high value to volume and/or highly time sensitive. The freight handled at Galway is neither. Total freight handles by Irish airports in 2013 was 128,000 tonnes (compared to 46.7 million tonnes through

Three options then relate to actions potentially to be taken (or lack thereof) at the existing port, namely:

2. 'Do Nothing', i.e. continue to operate GHC as is;
3. 'Do Minimum', i.e. improvements to the existing Inner Harbour;
4. 'Do Something', i.e. alternative scales/designs at proposed location, in effect an intermediate or incremental project at GHC;

These are each discussed below.

2. 'Do Nothing' Option

The 'do-nothing' scenario is, by definition, based on the existing port configuration being retained, with no improvement to facilities or capacity. This would fail to address the very significant tidal and vessel capacity constraints that currently affect the port, as well as the Seveso issues, and Galway would continue to be disadvantaged in this regard. The limitations on cruise and marina tourism would also remain.

- This threatens Galway's longer term viability as a commercial port, as it would be limited in its ability to cater for new business, and over time existing customers might be forced to switch to other ports that can handle larger vessels and are not subject to tidal restrictions. In effect, this would lead to the decline of the harbour with associated negative socio-economic implications for the region, notably in respect of employment (current employment in the port, its suppliers and customers amounts to some 800 FTE employees; the proposed project would underpin this as well as generating further employment in the wider economy).

As a result, either economic activity in the region would decline, or commodities would have to be imported or exported via other ports in Ireland, imposing extra costs on the region.

In summary, the 'do nothing' scenario would result in:

- Continued tidal constraints;
- Continued handling/berthage constraints;
- No freight rail link;
- Continued SEVESO issues;
- Decline of the port, with question mark over its commercial viability in the long run, leading to:
    - Socio-economic cost/loss to the city and region region, and
    - Unrealised maritime tourism potential.

Since 'Do Nothing' fails to address the objectives of the project, it is therefore concluded that it is not a feasible option.

---

seaports), the vast bulk of it through Dublin airport.
http://www.cso.ie/en/releasesandpublications/er/as/aviationstatistics2013/#.VA19hMVdUWQ

3. 'Do Minimum' Option

This involves undertaking the feasible improvements that can be delivered within the existing Inner Harbour.

Tobin Consulting Engineers indicate that further enhancement of vessel capacity within the existing gated dock footprint, which has walls with listed building status, would require:-

i) Expansion of gate width, gate depth and dock footprint,
ii) Removal of rock bed within footprint without wall disturbance, and
iii) Deepening and widening of channel.

This would allow Harbour access to be enhanced marginally with regard to vessel size, albeit at very significant cost. It would still be limited by vessel turning capacity and quay length which would allow an improvement only generally from 5,000 tonne to 10,000 tonne vessels.

However, this option could not address the constraints inherent in continuing to operate at the Inner Harbour, in particular the tidal and handling/berthage constraints, and the SEVESO issues. It would also have negative impacts on adjacent existing and proposed urban developments.

The 'do minimum' option therefore would not be substantially different from 'do-nothing', in terms of delivering on the objectives of the project. It is, therefore, concluded that this is not a feasible option.

4. 'Do Something' Option

This Option moves beyond the Inner Harbour to the location of the proposed project. It effectively amounts to alternative scales/designs at the proposed investment location.

In addressing this Option, it is useful to consider the evolution and rationale for the current design, through a total of eight designs over a seven-year period. The final design, completed in July 2011, satisfies the business case, client and customer requirements, while minimising so far as reasonably possible the environmental impacts, and a decision was made to proceed with the planning application on that basis (see EIS Chapter 3 for more details).

With regard to an intermediate/incremental delivery of the project, this is seen as inferior to proceeding with the full project in line with the specified schedule, for two reasons:

(i) Delivering incremental investments will not provide for the long term requirements of the port, as identified in the Business Case and CBA, and will be costlier and generate more disruption than delivering the full project in line with the specified schedule; and
(ii) Importantly, delivering the project on an incremental basis will result in more disruption to the Natura sites.

We therefore conclude that this is not a feasible option.

The remaining options take the analysis beyond the existing harbour location to possible other locations. It is thus necessary to develop a set of criteria which these potential other locations should be assessed against, taking into account long term requirements. These are:

- Available land: Taking into account established landside capacity together with projected long term requirements over a 30 year timeframe, a land requirement of **40ha minimum** to accommodate both open and covered storage as deemed necessary.
- Draft capacity: The project objectives require a port capable of handling vessels with at least **20,000 tonne capacity and 8 metre draft afloat in all tides**, which is deemed to be the commercially viable vessel size, and draft capacity was determined on this basis.
- Commodities: In line with its role servicing the West region, the port must be capable of handling a range of commodities, but specifically **dry and liquid bulk cargos.**
- Quay length: Sufficient quay length to accommodate dry bulk, liquid bulk and cruise vessels is required in order to meet the project objectives – required **length 660 metres**.
- Access to region: The new port must have access to the national transport network in order to fulfil its role as a regional port. Both **road and rail networks** of adequate capacity were deemed to be a requirement in this regard. This is also linked to the proximity requirement below. It must be noted also that most rail connections are Dublin-centric, which reduces their usefulness to Galway-based customers unless accessing Dublin port.
- Proximity Principle[9]. Any other location would need to be within such distance as would not deter customers or render use of same uncompetitive;
- **Hazardous Materials (i.e. bitumen and petroleum) Storage** facilities.
- SEVESO Directive: The new port must be capable of handling commodities such as petroleum and bitumen in a manner which **complies with the SEVESO Directive**, particularly with regard to proximity to residential or built up areas, major employment centres etc.
- Natura Directive: that such development at the other possible location could be shown not to **generate a greater impact on Natura 2000 sites** than the proposed project.
- National Ports Policy: does not contravene NPP requirement that **regional ports cater for their regional traffic, while national ports can cater** for both regional and national traffic.

[9] Fulfilling the project objectives therefore in terms of serving a regional customer base/hinterland requires the port to be within an acceptable travel time/distance of its hinterland. A travel time/distance of maximum 1½ hours or 150KM was deemed to be the very upper limit in terms of satisfying the proximity principle. In this regard while an alternative port may be within 150km of Galway City, it may be a much greater distance from a significant part of Galway Port's region. For example, Galway Port's catchment/region extends northwards from the city by up to 100km. Furthermore, depending on the road network a travel distance of 150km may involve an average travel time of up to 2 hours or greater.

The next stage is to consider options in Galway Bay, beyond the existing port area, namely:

5a. other locations in the Inner Galway Bay, i.e. Tawin and Mutton Island;
5b. other locations elsewhere in Galway Bay, i.e. Ros a' Mhíl.

5a. Inner Galway Bay

Tawin and Mutton Island were assessed in terms of their potential suitability as alternative sites to the proposed location. Neither location has any harbour infrastructure at present and would effectively constitute the development of a new port on a greenfield site together with all of the associated facilities.

In the case of Mutton Island a number of schemes were considered. These can broadly be subdivided into two categories:

- The first involves the development of a new harbour in conjunction with existing landside facilities at GHEP, while
- the second involves a total replacement of these facilities and therefore effectively involves the development of a new harbour in its entirety together with replacement of all landside facilities.

EIS Chapter 3 provides a description of both the Tawin and Mutton Island options, and compares them with the proposed project. Note that both locations have the same Natura designation as the proposed development site. The analysis concluded with respect to the two locations:

Tawin -

- Has deep water and adjacent land available
- Would require very significant upgrade works on roads with significant existing residential development or a new road access system
- Is remote from rail & in a rural area
- Would not suit existing customer infrastructure
- Would generate significant visual impact, very exposed landscape
- Is of little tourist, amenity or community benefit
- Has viability issues arising from complete lack of services & infrastructure
- Is in a most exposed location to westerly and south westerly winds and seas,
- Would require greater sea wall defences
- Is located on a site which forms part of the Natura 2000 network (i.e. cSAC, SPA) upon which it would have significant impacts, with less strategic benefits arising to the region due to the remote location.

Mutton Island:

- Has adjacent deep water, no land available, is adjacent to existing port and city
- Would require very significant road upgrade works which would have considerable environmental and amenity impacts

- Is remote from rail in an urban setting
- Would not suit existing customer infrastructure
- Has a significant visual impact, with very exposed Island landscape
- Is of reduced tourist amenity and community gain
- Is exposed to south-westerly winds and seas
- Has viability issues arising from lack of services & inadequate infrastructure
- Is located on a site which forms part of the Natura 2000 network (i.e. cSAC, SPA).

For these reasons neither Tawin nor Mutton island were considered feasible alternatives to the proposed project.

5b. Elsewhere in Galway Bay

The only other potential candidate in Galway Bay is Ros a' Mhíl, a designated fishery harbour which provides berths and safe anchorage for smaller vessels, particularly fishing vessels and ferries. It is a major hub for transport between the mainland and the Aran Islands, with an all-year-round base for passenger services.

An investment programme will provide a dedicated fishing berth of some 200m. This development also includes dredging in the inner harbour area and the freeing up of the existing ferry berth to provide a cargo berth for servicing the Aran Islands.

However, the existing harbour is not suitable as a commercial port for vessels of over 2,000 tonnes to anchor and of 1,000 tonnes to dock. Even following the improvements, the 200m quay is insufficient to handle a number of vessels at the same time, as is required. Similarly, the proposed turning circle would be inadequate for larger vessels. There are also navigational restrictions on approach that would be a danger for larger vessels.

Relocation of Galway Harbour to Ros a' Mhíl would impose greater cost on customers and the importers of petroleum and bitumen products would have to construct tankage in Ros a' Mhíl and then transport the product by road to customers and for processing. Significant investment would be required to provide tank farms to cater for the region's liquid fuel storage requirements, a role that Galway currently fulfils.

On the basis of current petroleum and bitumen throughput in Galway Harbour, this would generate approximately 36,000 truck movements per annum (100 per day) travelling the 37km between Ros a' Mhíl and Galway on minor regional roads (R336, R372)[10]. Other cargoes would add further to the road traffic volumes, and future growth in tonnages would see truck movements increase in tandem.

[10] In 2013 some 430,000 tonnes of petroleum and bitumen were handled at Galway. Average tare assumed to be 24 tonnes, with return journey empty.

Not only would these additional movements add to distribution costs, which would have to be absorbed or passed on to customers, they would put considerable strain on the road network, generate major traffic hazards and give rise to potential accidents. The environmental impact of this extra traffic would also be at variance with EU policy on CO_2 emissions as well as EU policy on Maritime Transport which has as an objective the removal of freight from the road network.

Upgrading of these roads would risk generating potential impacts on adjacent Natura 2000 sites. Ros a' Mhíl furthermore has no rail connection.

In addition, Ros a' Mhíl is not considered an optimum location to take advantage of increased maritime tourism. It lacks the recognition factor and attraction of Galway city for cruise traffic. Cruise tourists interested in visiting Galway city and beyond would have to travel along the same poor quality road. This compares with the ability to walk directly into the city centre from the proposed and current Galway harbour, which is a major advantage for a cruise location. The lack of services for both the ships and visitors at Ros a' Mhíl is a major drawback.

In summary, the "relocate to Ros a' Mhíl" scenario would result in:

- Port handling constraints,
- Port access constraints,
- Increased journey costs/times,
- Requirement for new landside storage facilities,
- Poor road links (with environmentally problematic upgrade options) and no potential rail link,
- Unrealised maritime tourism potential.

For these reasons, it was concluded that locations elsewhere in Galway Bay were not feasible.

5c. Consideration of Ports of National Significance as per NPP

Consideration was also given to the ports of national significance on the island of Ireland, i.e.

5ci Tier I national ports, (Dublin, Cork, Shannon-Foynes);
5cii Tier II national ports, (Waterford, Rosslare);

In considering these, we revert back to the qualification criteria listed above and assess each port by reference to same, as per the table overleaf. Note the question of damage to Natura 2000 sites is addressed separately in section 2.3.

Table 2.2: TESTING OF OTHER PORTS OUTSIDE GALWAY BAY BY REFERENCE TO QUALIFICATION CRITERIA

Qualification Criteria/Port	Tier I National			Tier II National	
	Dublin	**Shannon-Foynes (Foynes)**	**Cork (Ringaskiddy)**	**Waterford**	**Rosslare**
Minimum **40ha land**	45.25ha (including 41ha for hazardous materials)	53.5ha	40.4ha	In excess of requirements	10ha
Capacity **20,000 tonne capacity and 8 metre draft** float in all tides	9-11m	10.5m	5.6-13.5m	8-10m	7.2-10m
Quay length **660 metres**	1,974m	657m	2,237m	970m (includes 120m private quay)	962m
Capable of **handling dry and liquid bulk** cargos	Yes	Yes	Yes	Yes	No
Access to **national road and operational rail** networks/services*	Yes (M50 & rail)	Road yes (N69) Rail connection present but not operational since 2000 and in need of upgrading.	Road yes (N28) Rail No	Yes (N25 & rail)	Yes (N25 & rail)
Proximity: **maximum 1½ hours or 150km** from customer/region (distance from Galway city)	No (219km)	Yes (130km)	No (201km)	No (233km)	No (294km)
Hazardous material storage	Yes	Yes	Yes	No	No
Complies with Seveso Directive	Yes	Yes	Yes	n/a	n/a
Complies with NPP	Yes	Yes	Yes	Yes	Yes

Note: most of the data in the table is drawn from the IMDO report *Irish Ports Offshore Renewable Energy Services* (IPORES)
*Most rail connections connect with Dublin, and which reduces their usefulness to Galway-based customers unless accessing Dublin port.
http://oar.marine.ie/bitstream/10793/838/1/IMDOIPORESReport.pdf, except where more up to date information is available.

In summary:

- Dublin meets all criteria with the exception of proximity.
- Foynes meets all the criteria with the exception of having an operational rail connection.
- Cork meets all criteria with the exception of proximity and rail services.
- Waterford does not meet the proximity and hazardous material storage criteria.
- Rosslare, critically, does not handle bulk cargoes, and it lacks the land requirement; as with Waterford, it does not meeting the proximity and hazardous material storage criteria.

Figure 2.1: COMMERCIAL PORTS ON ISLAND OF IRELAND

Source: MKOS, based on Irish Marine Development Office (IMDO) Report *A Review of Irish Ports Offshore Capability in Relation to Requirements for the Marine Renewable Energy Industry*. Sligo added.

The Port of Foynes comes closest to meeting all the criteria. Dublin fails on the proximity criterion; Cork, in addition to failing the proximity criterion, also lacks a rail connection. Waterford and in particular Rosslare exhibit more significant limitations.

While Foynes meets the proximity criterion, it does not do so by a great margin, and for businesses based in the northern section of Galway's hinterland the distance to Foynes will be considerably longer, and may be outside our proximity criterion. As can be seen from the above there is a significant distance to Foynes port from Galway (130km). Customers using Galway have indicated that attempting to use ports other than Galway would impose significant increased land transport costs.

2.3 Assessment of Feasible Alternatives

The above analysis of the feasibility of other ports concluded that any possible other ports were in essence confined to the ports of Foynes, Dublin and Cork, with Foynes coming closest to meeting the criteria. The question arises then **whether any of these represent feasible alternatives,** from the perspective of (i) policy,

(ii) business and socio-economic viability,
(iii) damage to Natura 2000 sites, and
(iv) land-transport-related environmental impact.

Our findings can be summarised as follows:

2.3.1 Objectives and Roles for GHC in National and Regional Policy

- The proposed development at GHC is needed for local and regional socio-economic development, and is in accordance with proper planning and sustainable development (as reflected in national policy regarding ports) and indeed it is clear that their realisation requires the project to proceed, specifically in terms of:
  - The servicing of Galway's substantial hinterland.
  - The accommodation of larger vessels in deeper waters.
  - GHC's role as a strategic hub for petroleum logistics and storage.
  - Refocusing of the Inner Harbour towards leisure and tourism, and reconnection with the city.
  - Servicing the offshore renewable energy, oil and gas sectors.

- The *National Spatial Strategy*[11] (NSS) designates **Galway as a national Gateway**, and the only Gateway in the West NUTS III region. Gateways are designated drivers of economic activity, and centres of key economic infrastructure, such as ports. Galway is also the "**major urban centre" in IDA Ireland's West region**[12]**.**

[11] http://nss.ie/pdfs/Completea.pdf
[12] Which comprises Galway and Mayo (http://www.idaireland.com/locations/regions-of-ireland/west/). The NUTS III West region also includes Roscommon.

- At a broader level, the project is in accordance with and contributes to meeting the policy requirements of national spatial, industrial development and employment policy, as articulated in the NSS, IDA Ireland's *Horizon 2020 Strategy*, and the *Action Plan for Jobs.*

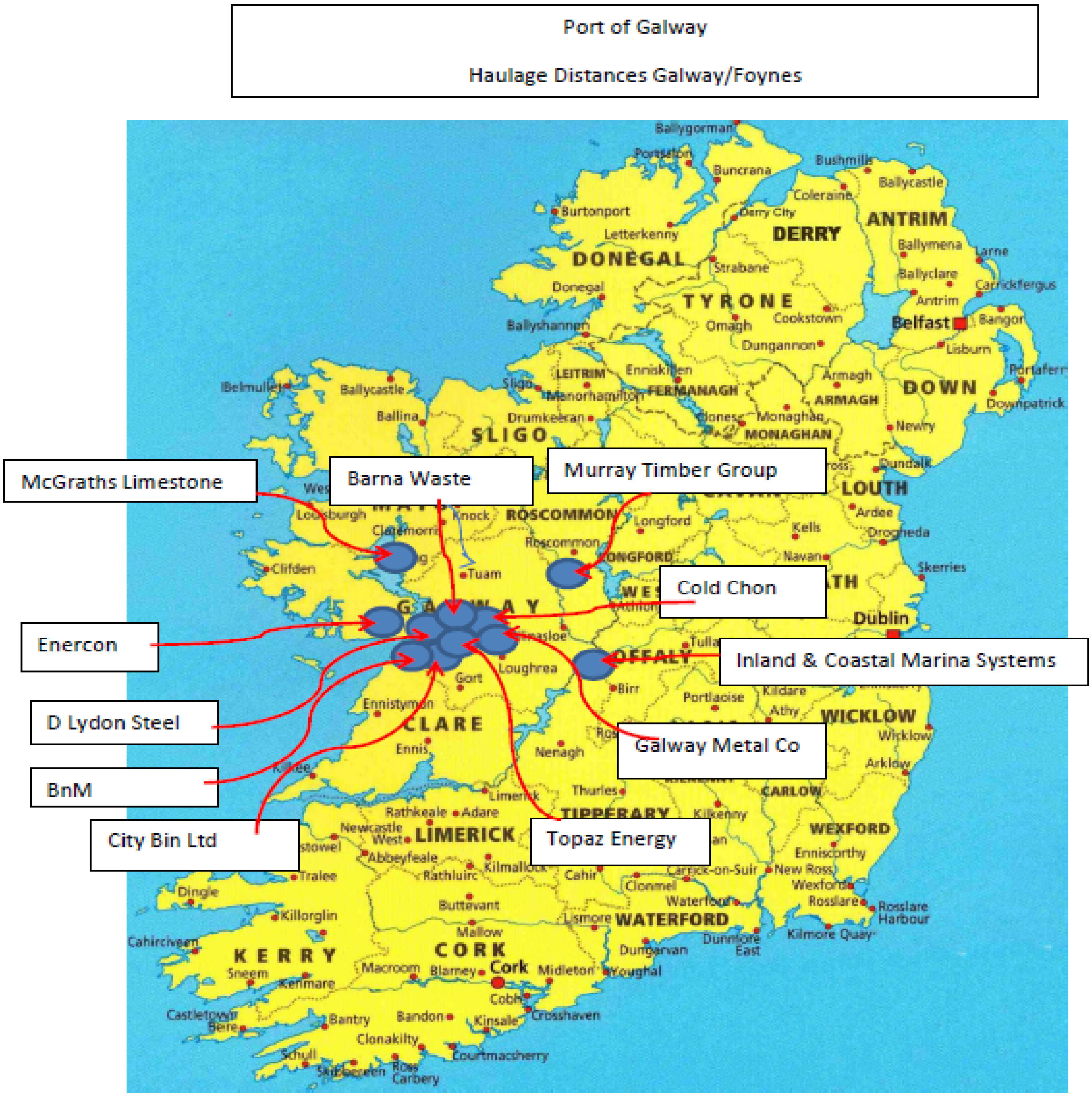
Attempting to utilise Foynes, Dublin or Cork in place of Galway would not be capable of delivering sustainable development and proper planning, and in particular would not be capable of meeting these objectives as reflected in national and regional policy.

2.3.2 The Business & Socioeconomic Case for GHE

- DKM and Raymond Burke Consulting (RBC) have produced a business case and Cost Benefit Analysis (CBA) for GHE, which confirms not only its commercial viability, but more importantly the very substantial wider socio-economic benefits of the project.
- Indeed, the wider economic benefits of the project dwarf the commercial benefits to GHC itself (which at the same time is important in demonstrating that the development is sustainable and will be self-financing in respect of its operational costs, as has been demonstrated). Most of the wider economic benefits estimated in the CBA accrue to the ports' customers and to the local and regional tourism sector.
- All of this business is "natural" to GHC, in its role as a regional port, being situated in its catchment, and the nearest port to the businesses in question (see map overleaf).
- The future continuation of a commercial port in Galway is vital to those businesses within the region using the port now and in the future. Loss of the port facility or the failure to develop same as proposed would put a question mark over a number of its lines of business, given the extra distance that would have to be travelled to a different port, the nearest of which is Foynes, 130km distance from Galway itself. A number of the port's existing bulk customers have indicated that attempting to utilise Foynes for its exports would not be commercially feasible. Data from these customers confirm the extra cost of shipping via Foynes or Dublin compared to Galway. This is particularly relevant given the high volume-to-value ratio of the bulk cargoes handled at Galway, which means that transport costs represent a relatively high proportion of total costs. It is worth noting that the proposed development, by removing existing constraints on Galway, will further strengthen the cost advantage of using Galway for businesses in the region.
- Some of these customers have made significant investments in Galway and the port, and plan to invest further and expand their operations significantly if the project proceeds. This investment in Galway would be lost if the business were forced to relocate to port facilities elsewhere. Indeed, some of the additional business would be lost to Ireland as a whole. With respect to the bitumen business in Galway, for instance, transfer to Foynes would require the construction of a new tank farm at Foynes with associated costs. By contrast, the tank farm at Galway has planning permission for extension.

The bitumen facilities operator on Galway has indicated that relocation to other ports would not be compatible with its business plan.

Figure 2.2: GHC's Main Customers, Locations and Haulage Distances



#	Customer	Location	Galway (km)	Foynes (km)	Commodity
1	McGraths Quarries	Cong	42	170	Limestone (Export)
2	Murray	Ballygar	62	179	Timber (Import)
3	Cold Chon	Oranmore	10	120	Bitumen (Import)
4	D Lydon	Bushypark	5	133	Steel (Import)
5	BnM	Port Estate	0.5	129	Coal (Import)
6	Inland & Coastal Marina	Banagher	94	127	Marina Pontoons (Export)
7	Topaz	Port Estate	0.5	129	Petroleum (Import)
8	Galway Metal Company	Oranmore	10	120	Scrap Steel (Export)
9	Barna Waste	Carrowbrowne	11	131	RDF (Export)
10	City Bin	Oranmore	10	120	RDF (Export)
11	Enercon	Barna	10	130	Wind Turbines (Import)

Source: GHC

- Other business using GHC would be less viable if it had to use another more distant port, because of higher land transport costs. One key Galway customer, for instance who carried out feasibility studies to determine if their product could be exported via Sligo, Killybegs, Limerick and Foynes found that it was uneconomic to export the product out of any port other than Galway.
- In reality, a failure to extend Galway does not guarantee that **any** business will be transferred to other ports. Customers choose ports based on a range of evidence-based criteria that can be benchmarked such as door-to-door transport costs, berth length and availability, water depths, stevedoring services available, tidal windows, road access, etc.
- This is illustrated by the continued usage of GHC by its current customers, despite the availability of other ports, and the clear constraints in using Galway.
- The bulk of the tourism impacts – related to the cruise business – would be lost to Ireland if the project did not proceed, as these cruise ships are being attracted specifically to Galway Bay, the city and the surrounding region including Connemara and the Cliffs of Moher. Irish cruise destinations for the most part complement rather than compete with each other.
- Significant employment will be generated/maintained by the project. We estimate that during the construction phase, almost 600 work years of employment will be generated, while in the tourism industry some 73 additional permanent Full Time Equivalent (FTE) jobs will be generated; the project will also underpin current employment in the port, its suppliers and customers (who along with the port itself currently employ some 800 FTE employees).
- The generation of these significant employment impacts, in the West region in particular, is important and contributes to meeting the Government's policy focus on employment generation.

It is clear therefore that, for the Port's customers, using Shannon-Foynes, Dublin or Cork instead of Galway cannot deliver the same socio-economic and commercial benefits that would accrue to proceeding with the GHC development. Furthermore, it would also result in a significant increase in land-based transport of goods to and from the other port compared to the use of Galway port, as set out in more detail below.

2.3.3 Impact on Natura 2000 Sites

Shannon-Foynes

- **Shannon-Foynes** is located within two Natura 2000 sites; the River Shannon and River Fergus Estuaries SPA (Site Code 0004077) and Lower River Shannon SAC (Site Code 0002165), which takes in both the freshwater and estuarine components of the River Shannon and its tributaries. Coastal Lagoons are identified as an Annex I priority habitat for which the Lower River Shannon SAC is designated, in addition to fourteen other Annex I habitats.
- The SAC is designated for seven Annex II species including the Bottlenose Dolphin, for which the Shannon estuary is home to a significant population

and for which only two SACs are designated in Ireland. The River Shannon and River Fergus Estuaries SPA is designated for 21 species of special conservation importance and is considered of great ornithological significance, being of international importance on account of the numbers of wintering birds it supports. It supports internationally important numbers of three species: Dunlin, Black-tailed Godwit and Redshank, and also supports 16 species that have populations of national importance.

- In conclusion, the following ecological issues have been arrived at based on the NIR :
  1. The bottle nosed dolphin (which is a qualifying interest species for the Lower Shannon cSAC) is a highly mobile and gregarious species could be impacted by the increased shipping through greater disturbance (including noise) and physical damage (collision).
  2. The proposed expansion of port facilities will require the destruction of qualifying interest habitats such as intertidal muds and sands and shallow bays and inlets.
  3. Operational maintenance of the ports in the Shannon Estuary requires regular dredging within the cSAC which gives rise to permanent increases on levels of suspended sediments in the water column.

  The proposed expansion of facilities in the Shannon Estuary is therefore considered to have greater ecological impacts than the planned Galway Harbour Extension project. Due to the lack of information in the SFPC Vision 2041 NIR but nevertheless based on the precautionary principle, the level of impact of the proposed expansion of shipping in the Shannon Estuary must be considered as being significant.

Dublin

- The approaches to the **Dublin Docks** pass through or close to 3 cSACs (North Dublin Bay, South Dublin Bay and Rockabill to Dalkey Island). The qualifying interests for the Rockabill to Dalkey Islands are harbour porpoise and common seal.
- With regard to SPAs, 10 (North Bull, Rockabill, Rogerstown Estuary, South Dublin Bay and River Tolka Estuary, Malahide Estuary, Lambay Island, Howth Head, Ireland's Eye, Skerries Island and Dalkey Islands) are located within or close to the approach channel to the Dublin Docks.
- This high number of Natura sites makes Dublin Bay considerably more environmentally sensitive area than Galway Bay. It should be noted that all of the Natura sites in Dublin Bay are marine in character.

Cork

- The approaches to **Cork Harbour** pass through 1 cSAC (Great Island) and 1 SPA (Cork Harbour).
- This is the same number as for Galway Bay.
- Like Galway, the two Natura sites that are present within Cork Harbour are marine-based.

Thus, it is clear that all the potential alternatives - Foynes, Dublin and Cork – are potentially problematic from a Natura 2000 perspective, and one cannot conclude beyond reasonable doubt that there is an alternative that causes less damage to Natura 2000 sites.

2.3.4 Land Transport-Related Environmental Impacts

- Quite apart from the Natura 2000-related environmental issues, there are a large number of Irish and EU environmental policies and obligations that relate to reducing (specifically land-based) transport and the related pollution, and to encouraging modal shift in favour of sea transport.
- Transport is responsible for around a quarter of all EU greenhouse gas (GHG) emissions, second only to the energy sector. Road transport alone contributes about one-fifth of the EU's total emissions of carbon dioxide (CO_2), the main greenhouse gas.
- This is relevant because GHE is expected to cater for large volumes of cargo (in excess of two million tonnes per annum in the Base Case compared to 500,000 tonnes per annum currently), arising in its hinterland, which in the absence of the project would have to be diverted by road to other more distant ports, or indeed in many cases would not be commercially viable, with related socio-economic costs.
- There seems little doubt that, given Ireland's and the EU's long term strategy in the transport sector, the pressure will continue to mount for further and more significant reductions in GHG emissions across all areas of economic activity, but notably, given its environmental footprint, in road transport.
- GHC handles bulk (high volume) cargo, servicing its hinterland. In the absence of the investment, the cargo would have to be transported by land to/from another port (subject to the proviso that much of the business in question would not be commercially viable if forced to use a more distant port).
- Of the other ports which were not ruled out in short order, the nearest of these (albeit still 130 km away from Galway and significantly further again from customers west and north of Galway) is Shannon-Foynes (specifically Foynes). We use this for the purposes of our estimation of environmental impacts, bearing in mind that the figure would be greater for other more distant ports[13].
- The following table sets out the position, on the hypothetical basis that (i) all the future estimated cargo transfers to Foynes, and (ii) only the estimated additional cargo – comparing the with and without development scenarios – transfers. (This is hypothetical however as a number of Galway's customers have indicated that they would not be in a position to carry the additional costs associated with such transfer, and in the absence of the development there would be a question mark over whether Galway could continue catering for its previous level of traffic, in the long term). We present this for the Base and High Cases.

[13] Planned upgrades to the N18 road will make Foynes Port more accessible from Galway, but while journey time is expected to be reduced (by approximately 12 minutes), distance will be unchanged so our calculations of environmental impact are not affected.

Table 2.3: ADDITIONAL ROAD-BASED TRANSPORT IF GHC CARGO TRANSFERS TO OTHER PORT*

	Base Case		High Case	
	Cargo Transferred to Other Port		Cargo Transferred to Other Port	
	All	Additional	All	Additional
Total Cargo Tonnage ('000)	1,932	1,404	2,162	1,634
Additional Tonne KM of Road Transport ('000)	254,193	170,109	284,700	200,616
Additional **Diesel** usage ('000 litres)	88,968	59,538	99,645	70,216

*based on diversion to Foynes. Would be greater if moved to more distant ports.

- We estimate that an additional 170 million tonne km of road transport per annum would be generated on Irish roads, leading to additional fuel usage of approximately 60 million litres per annum[14], if GHE does not proceed and the additional identified cargo is diverted to Foynes, in the Base Case. Under certain scenarios, this could reach almost 300 million tonne km and 100 million litres per annum. Diversion to more distant ports would have greater impacts.
- This would have a significant environmental impact. The additional 60 million litres of diesel equates to an additional 110,000 tonnes of CO_2 per annum, and significant tonnages of CO, HC, NO_x, SO_x and particulates, all of which are subject to national and EU targets, and have implications for global warming and human health. The table below indicates a very significant cost to society from these additional emissions.
- Environmental damage from additional emissions to air stabilises at over €7 million per annum. Over the period to 2035 (the period over which the Business Case and CBA were analysed) the present value of the pollution (net of carbon tax) would be over €54 million. Even net of the Irish carbon tax, the equivalent damage costs would be €4.4 million and €27 million respectively.
- In the High Case, with all the GHC cargo diverted, these damage costs grow to €12 million and €69 million respectively (€7.4 million and €36 million net of the carbon tax respectively).
- To this must be added the additional impacts on road damage, noise and congestion, which would also be significant, given the nature of the traffic being generated.
- Another environmental benefit is that, with the movement of petroleum-related activities out of the Inner Dock as part of the proposed development, the Seveso-restricted area of the port will be moved away from the city centre. Apart from health and safety benefits and reductions in risk, this is likely to have a positive impact on future planning applications in the city centre by removing obstacles to redevelopment. It will also further improve local residents' living conditions in terms of visual impact, noise and air emissions, and allow for the existing harbour's use and development as a

[14] Assumes fuel efficiency of 35 litres diesel/100km, laden weight of 44 tonnes and unladen weight of 14 tonnes, and empty return journeys. Relates to 2028 when tonnages with and without the development projected to stabilise. More details can be found in Report entitled *Galway Harbour Extension Business Case & Cost Benefit Analysis*, dated 13th December 2013, which is contained in *Vol. 2C: Appendices to EIS – [Part 1 of 3 Parts]*, Appendix 2.2.1.

stronger civic amenity than at present. Thus significant social/community gain benefits can be expected to ensue.

Table 2.4: Annual Pollution & Damage Costs if Additional GHE Cargo Diverted to Other Port* (Base Case)

	Additional Diesel usage (million litres)	Emissions per '000 Litres Diesel (tonnes)	Additional Emissions to Air generated (tonnes)	Damage Cost per Tonne €	Total Damage Cost €'000	Total Damage Cost Net of Carbon Tax €'000
Carbon dioxide (CO_2)	59.5	1.84126	109,625	55	6,029	3,289
Carbon monoxide (CO)	59.5	0.00146	87	2.70	0	0
Hydrocarbons (HC)	59.5	0.00052	31	811	25	25
Nitrogen oxides (NO_x)	59.5	0.00400	238	4,499	1,073	1,073
Sulphur oxides (SO_x)	59.5	0.00001	0.3	5,786	2	2
Particulates (PM)	59.5	0.00006	3	6,159	21	21
Total per annum					**7,150**	**4,410**
Total to 2035 (present value)					**54,194**	**27,275**

*based on diversion to Foynes. Would be greater if moved to more distant ports.

Notes: Damage costs are expressed in today's money. Carbon tax is assumed to be €25 per tonne of CO_2. Distance travelled is assumed to be extra-urban. Quantities of emissions are less than those presented in the Alternative Solutions report included in the EIS, as more appropriate data have been used in the current report. Discount rate = 4% real (net of inflation), for consistency with CBA report contained in EIS.

Sources: EU Commission, SEAI, DKM estimates.

Utilisation of the nearest other port – the Port of Foynes - would be significantly inferior from an environmental point of view to proceeding with the proposed development (quite apart from the fact that much of the business would not be commercially viable if it had to transfer to a more distant port). Utilising a more distant port would have even more severe environmental impacts.

2.4 Summary

In summary, there are compelling reasons why the possibility of moving the additional port traffic to a different port is not viable from the environmental and socio-economic perspectives (as reflected in national and regional policies), and would not be consistent with sustainable development and proper planning. Notably, it cannot be concluded that utilising alternative ports would not result in less damage to Natura 2000 sites. **Thus we conclude that there is no feasible alternative to the proposed project.** The table overleaf summarises the impacts of proceeding with GHE compared with not proceeding:

Table 2.5: IMPACTS OF PROCEEDING WITH AND NOT PROCEEDING WITH GHE

Dimension	Impact of GHE Proceeding	Impact of GHE Not Proceeding
	•	•
National spatial, industrial development & employment policy	GHE is in accordance with and contributes to meeting *National Spatial Strategy*, IDA Ireland's *Horizon 2020 Strategy*, and *Action Plan for Jobs,* specifically regarding balanced regional development.	Regional aspects of these policies will be more difficult to deliver, as infrastructure of West and BMW regions will be less competitive vis à vis other regions.
Socioeconomic	Project caters for GHC's natural catchment, and generates substantial wider socio-economic benefits for the region. It also generates and maintains significant employment. The project has been demonstrated to be commercially viable.	• Wider economic benefits will be reduced and in many cases lost (notably tourism). • Extra distance to other ports would impose significant costs on port customers and in many cases would make their goods uncompetitive. • This extra cost would put existing direct and down-stream employment in jeopardy and would hinder the creation of additional employment. • The extra capital cost that certain customers would be required to spend on storage and warehousing facilities would be such that it would make it unfeasible to progress. • Commercial future of GHC would be endangered.
Environmental (land-transport-related)	• GHE will cater for the relevant trade in a significantly less land-transport-intensive way, reducing global, regional and local emissions to air, as well as minimising road damage and congestion. • Seveso site will be more distant from city centre, with health and safety benefits and positive implications for planning in city centre through the removal of obstacles to redevelopment	• Significant increases in global, regional and local emissions to air, as well as road damage and congestion, if business has to be catered for via more distant port (subject to questions of commercial viability). • Seveso impacts on city centre will remain.
National Ports Policy (NPP)	Realisation of national policy requires the project to proceed, specifically in terms of: • Servicing Galway's substantial hinterland. • Accommodation of larger vessels in deeper waters. • Strategic hub for petroleum logistics & storage. • Refocusing of the Inner Harbour towards leisure and tourism, and reconnection with the city. Servicing the offshore renewable energy, oil and gas sectors.	• GHC's hinterland will be less well served by port infrastructure, and will suffer competitiveness disadvantage vis à vis other regions. • GHC will remain unable to cater for the larger vessels that are increasingly serving the Irish market • Continuing role as petroleum hub in question. • Inner harbour's capacity to cater for leisure/tourism traffic remains constrained, and disconnected from city. Servicing of offshore energy sector will migrate to more distant port, or outside of State.

Having concluded that the alternatives are not feasible, the next step is to assess whether there are **Imperative Reasons of Overriding Public Interest (IROPI)** which require the realisation of the proposed plan or project. This is considered in the following chapters.

3. NECESSITY OF THE DEVELOPMENT

The necessity of the proposed investment can be understood along the following dimensions:

- Regional importance of Galway and its port;
- Removal of operational constraints and consolidation of the port's future;
- Project's necessity in terms of regional, national and EU policy;
- Environmental and commercial non-sustainability of other options in terms of additional land transport costs;
- Health & safety benefits of the investment.

3.1 REGIONAL IMPORTANCE OF GALWAY AND ITS PORT

As indicated, the NSS designates Galway as a **National Gateway**, and the only Gateway in the West NUTS III region. Gateways are designated drivers of economic activity, and centres of key economic infrastructure, such as ports. Galway is also the "**major urban centre" in IDA Ireland's West region**, and IDA has one of its regional offices in Galway. The city has been one of the most successful in attracting Foreign Direct Investment (FDI) in recent decades.

The **West NUTS III region**, along with the Border and Midlands regions, form the BMW NUTS II region, which is accepted as less developed than the rest of the country, and is eligible for increased regional aid under EU Commission rules[15].

Galway Port is a long-established and crucial element in the transport infrastructure of the West Region. The port of Galway has been of importance since at least the Norman times, and the original raison d'être of the city.The future continuation of a commercial port in Galway is vital to the region, and to the businesses that use it, who support some 800 FTE jobs, plus many more through indirect and induced impacts. Galway is a bulk port primarily serving its own region and typically handles high volume-to-value cargos. These are basic economic commodities that are used throughout the economy of the region served by Galway, or are important exports.

3.2 REMOVAL OF OPERATIONAL CONSTRAINTS AND CONSOLIDATION OF THE PORT'S COMMERCIAL FUTURE

Constraints in the existing port have reached a stage where Galway's medium to long term future as a commercial port is at risk. The port is tidal, accessible for only four hours out of every 24, and can only cater for ships of a maximum of 7,000 tonnes (in some cases considerably less depending on the cargo and on beam and

[15] See the 2007-2013 Regional Aid Map (http://www.djei.ie/publications/enterprise/2006/commissiondecisionmap2007-2013.pdf). This is continued under the 2014-2020 Regional Aid Map (http://ec.europa.eu/ireland/press_office/news_of_the_day/commission-approves-regional-aid-map-for-ireland_en.htm).

draught constraints). These represent a severe and growing constraint as economical ship size continues to increase over time.

The average ship tonnage serving Irish ports has been growing significantly in recent years, and specifically for the bulk cargoes that Galway primarily caters for (see table).

Table 3.1: LIQUID & DRY BULK AVERAGE SHIP TONNAGES, 2000 - 2013

	2000	2013	%age Change
Liquid Bulk			
National average	4,497	9,073	102%
Galway	2,655	3,407	28%
Dry Bulk			
National average	4,935	11,021	123%
Galway	1,867	2,528	35%

Source: CSO, National Port Statistics

Galway is not only significantly below the average in terms of the size of ship it can cater for, but is also falling further behind. The average tonnage of liquid and dry bulk cargo ships now serving Irish ports is greater than the current capacity of Galway port.

It is clear, therefore, that a failure by the Port of Galway to cater for an increase in vessel size will impact its ability to provide operational efficiencies, to compete and to handle its customers' requirements. It also impacts the Port's ability to attract new trade and business. This will result in a loss of trade affecting not only the Port's viability but also the competitiveness of its customers who might be forced to seek and potentially relocate to other ports, thus adding to their transport costs or resulting in a loss of employment to the region served by Galway port.

The importance of ensuring the appropriate infrastructure is in place has been highlighted in a recent report by Forfás, Ireland's policy Board for Enterprise and Science,[16] on the main infrastructure issues for Enterprise, which notes that the international trend toward larger shipping vessels will reduce the ability of Irish ports to continue to offer the current range and frequency of services, unless adequate deeper water facilities are provided. The report notes that the absence of such deepwater facilities would lead to increases in costs because of reduced capacity.

[16] *Overview of the Main Infrastructure Issues For Enterprise, Forfás, May 2012.* http://www.forfas.ie/media/ffs20120509-Infrastructure_Briefs.pdf

This view is also echoed in the report[17] by Engineers Ireland in its 2014 review of Irish infrastructure which pointed out that:

> "the changing market conditions are driving the need to invest in new port infrastructure, for example, the international trend towards larger vessels." (p.17)

The businesses using the port facilities are major employers, directly supporting some 800 full time employment (FTE) jobs (including the port company itself). Significantly more employment is dependent on the port via indirect and induced impacts.

As indicated in the previous chapter, **the future continuation of a commercial port in Galway is vital to those businesses within the region using the port.** Loss of the port facility would put a question mark over a number of its lines of business, given the extra distance that would have to be travelled to other ports. A number of the port's existing bulk customers have indicated that attempting to use any of the other large ports in Ireland for their exports would not be commercially feasible. They have also provided data that highlights the extra cost of shipping via Shannon-Foynes or Dublin, compared to Galway.

With respect to the bitumen business in Galway, for instance, the operator envisages major development at Galway. Transfer to any of the other large ports would require the construction of a new tank farm which, apart from the cost, would be a major undertaking. By contrast, the tank farm at Galway has planning permission for extension, and the planned development could proceed with minimum cost and delay.

In other jurisdictions in which the Habitats Directive applied involving port developments the following criteria were included in an assessment of whether Imperative Reasons of Overriding Public Interest existed which justified the harbour development[18]:

- The fact that the port was a major employer and a gateway;
- removal of operational constraints and capacity to retain and grow port business, and serve its customers.
- It was also noted that imperative encompassed in such development a need to put in place such developments and the consents for same in adequate time.

These criteria are all satisfied in the case of Galway Harbour.

[17] *The State of Ireland 2014 – a Review of Infrastructure in Ireland*, Engineers Ireland, 2014. http://www.engineersireland.ie/EngineersIreland/media/SiteMedia/communications/publications/EI_Report_TheStateOfIreland_2014_Web.pdf

[18] Hull Harbour Revision Order Decision Letter (22 December 2005), as quoted in Van Hooydonk, E., 2006, *The Impact of EU Environmental Law on Waterways and Ports*, Maklu Press, Antwerp. http://www.maritime-transport.net/mtso/downloads/Public_Information/MTCP_report_Environmental_Transport_Legislation_study.pdf

To properly cater for cruise traffic, the port needs to be able to accommodate docking as opposed to merely offering tendering to cruise liners.

Docking is always preferable to tendering, for passenger convenience, safety and to save time. This is particularly so in Galway Bay, which, being on the Atlantic, is susceptible to rough weather, sometimes making tendering unfeasible. Galway city, at the end of Galway Bay, with its attractive skyline, strong recognition factor and tourism reputation as well as short distance from tourist attractions in Connemara, comprises a unique selling point for cruise liners, and a different docking point will not hold the same attraction. Cruise firms have indicated to GHC that they will be happy to bring future business to Galway, but this would be greatly enhanced when they can dock as opposed to tendering. In the longer run, docking as opposed to tendering will increasingly be a prerequisite (see for instance the submission to ABP regarding this application, from V. Ships). In addition, a higher proportion of cruise passengers will disembark where there are docking facilities, thus increasing the economic benefit to be derived from cruise tourism.

3.3 Project's Necessity in Terms of Regional, National and EU Policy

This project, and Galway's future continuation as a commercial port, is in line with EU and National Policy and is in accordance with proper planning and sustainable development:

- EU policy actively encourages transport by sea as opposed to by road, as articulated for instance in its *Short Sea Shipping* policy[19].

- The 2013 *National Ports Policy* (NPP)[20] indicates that Galway is one of Ireland's ports of regional significance, which "function as important facilitators of trade for their regional and local hinterland". Galway's proposed investment is **designed not to detract from any of the Tier 1 ports, but to cater for its own regional needs**.

- **If the inner harbour is to be redeveloped for leisure/tourism,** in accordance with Government policy – as articulated in the NPP - then it is necessary to build a facility to accommodate commercial traffic displaced thereby.

- At the launch of the draft Harbours (Amendment) Bill 2014, the Minister for Transport noted that:

  > "The National Ports Policy encourages each port, whether small or large, to develop its full potential to ensure that they can all contribute to further growth in the ports sector."[21]

- GHC performs a strategic role in fuel storage, and it holds part of the National Oil Reserve Agency's (NORA) reserves. The NPP states:

---

[19] http://ec.europa.eu/transport/modes/maritime/short_sea_shipping/index_en.htm
[20] http://www.transport.ie/upload/general/13776-NATIONAL_PORTS_POLICY_2013-1.PDF
[21] http://www.imdo.ie/IMDO/newsroom/CabinetapproveddraftHarbourbill.htm

> "Galway Harbour Company is an important strategic regional hub for petroleum importation, storage and distribution". (p.32)

Arising from membership of both the European Union (EU) and the International Energy Agency (IEA), Ireland has obligations to maintain 90 day reserves of national strategic stocks[22]. Government policy in recent years has been to increase the proportion of Ireland's strategic reserves that are held on the island of Ireland[23]. This further underscores the continuation of commercial port activities at Galway.

- The Irish Marine Development Agency (IMDO) in its *Irish Ports offshore renewable energy services (IPores)* report identifies Galway as an important port for servicing the offshore energy sector[24]:

  > "Galway Harbour is located in the heart of the city and occupies a strategic location on the west coast that could service the developing offshore marine renewable energy and oil and gas sector." (P.46)

  This is further endorsed in the NPP (p.45).

- The *National Spatial Strategy*[25] (NSS) designates Galway as a national Gateway, and the only Gateway in the West NUTS (nomenclature of territorial units for statistics) III region. Gateways are seen as drivers of economic activity, and centres of key economic infrastructure, such as ports.

- Galway is also situated in the Border Midland and West (BMW NUTS II) region as referenced in the European Structural Funds, which includes the least economically developed parts of the country, and is a particular focus for Government and EU efforts at economic development.

- The NSS makes several relevant references to Galway, including:

  > "The successful aspects of the Greater Dublin Area's development need to be emulated in other areas to deliver a more even distribution of successful economic development. The growing strengths of Cork, Limerick/Shannon, Galway and Waterford suggest that the co-ordinated development of these cities has the potential to offer a counterweight to the pull eastwards on the island." (p.18)
  >
  > "Strengthening the critical mass of the existing gateways of Cork, Limerick/Shannon, Galway and Waterford, to complement Dublin's successful national spatial role offers the most immediate prospects of establishing more balanced patterns of development over the next few years." (p.38)

---

[22] http://www.dcenr.gov.ie/Energy/Oil+Security+Division/Oil+Stock+Policy.htm

[23] Per the 2007 White Paper *Delivering A Sustainable Energy Future For Ireland - The Energy Policy Framework 2007 – 2020* http://www.dcenr.gov.ie/NR/rdonlyres/54C78A1E-4E96-4E28-A77A-3226220DF2FC/30374/EnergyWhitePaper12March2007.pdf.
See also http://www.kildarestreet.com/wrans/?id=2013-07-17a.69

[24] http://oar.marine.ie/bitstream/10793/838/1/IMDOIPORESReport.pdf

[25] http://nss.ie/pdfs/Completea.pdf

> "The existing gateways of Cork, Galway, Limerick and Waterford are strategically located in different parts of the country. They have considerable potential for further development and expansion to achieve more balanced regional development." (p.41)
> "Another of the existing designated gateways, Galway, also needs to be strengthened further on the basis of the Land Use and Transportation Strategy now being developed for the city." (p.44)

The NSS goes on to describe one of the roles of gateways as:

> "A focal point in transportation and communications terms: (a) on the national roads and rail networks (b) within 1 hour of an airport either with international access or linking to one with such access (c) adequate, reliable, **cost effective and efficient access to port facilities** (d) effective, competitive broadband access." (p.40, DKM emphasis)

With regard to ports, the NSS notes:

> "For sea access, transit between Ireland and other countries passes principally through four main bands of routes which contain one or more ports. These are
> - the *Central* band – to and from Dublin/Dun Laoghaire/Drogheda
> - the *Northern* band – to and from Belfast/Larne/Warrenpoint/Greenore/Derry
> - the *Southern/South Eastern* band – to and from Cork/Waterford/New Ross and Rosslare
> - the *Western* band – to and from the Shannon Estuary and Galway." (p.63)

and

> "The export-oriented nature of the Irish economy is highly dependent on effective access to foreign markets. Therefore it is important to maintain a wider international perspective in order to identify critical interventions abroad that would improve Ireland's onward connections and thus reduce the time and cost of moving people and goods between Ireland and the EU. Initiatives in this regard will be undertaken through trans-national collaboration within the EU context." (p.63)

- Industrial development policy, as articulated in IDA Ireland's *Horizon 2020 Strategy*[26], has a specific target of 50% jobs generation outside Dublin and Cork, and to support regional economic development:

  > "IDA has identified key areas of infrastructure improvement that are essential if we are to be successful in winning new investments into the regions outside Dublin and Cork. Transport and energy are vital. The importance of delivering next-generation networks is arguably the most important of all."

[26] http://www.idaireland.com/news-media/publications/library-publications/ida-ireland-publications/IDA-Ireland-Strategy-2020.pdf

Galway Harbour is thus a key element of transport infrastructure. Enterprise Ireland's ongoing approach likewise focuses on regional development[27], and its largest landholding outside Dublin is in Galway[28].

- The **Western Regional Planning Guidelines 2010-2022**[29] indicates that:
  "Galway Sea Port is of strategic importance to the West Region ... The plans for the relocation and extension of Galway Harbour area which includes deepwater port facilities has the potential to contribute to both tourism and enterprise in the local economy and is considered critical for growth in the region." (P.81)

- **Galway City Development Plan 2011-2017** indicates: "Redevelopment of the Galway Port facilities is proposed. This would include for the relocation of the port to a deepwater location and development of the existing facilities as a marina. This would increase the potential to improve linkage for both passengers and freight into the city. The integrated transportation study scheduled by the GTU will look at the strategic implications and opportunities this would afford the city and explore the tie-in with both the rail and road network." (p.18)
  and
  "The Plans for the re-location and extension of the Harbour area which include for deepwater port facilities has potential to contribute to both tourism and enterprise in the local economy. It is acknowledged that such a development could have strategic importance for the city and is supported subject to assessment on economic viability, environmental, visual and transport grounds." (p.67)

3.4 LAND TRANSPORT-RELATED ENVIRONMENTAL & COMMERCIAL UNSUSTAINABILITY OF REMOVAL OF PORT SHIPPING TO OTHER PORTS IN IRELAND

As demonstrated in this and the previous chapter, the transfer of Galway's business to another port is both commercially and environmentally unsustainable:

- Environmental sustainability, as articulated in the EU's *Short Sea Shipping* policy and elsewhere, favours sea transport over road transport, due to the lower carbon footprint and lower congestion costs.

- Transport is responsible for around a quarter of all EU Greenhouse Gas (GHG) emissions, second only to the energy sector. Road transport alone

[27] See for instance http://www.enterprise-ireland.com/en/Publications/Reports-Published-Strategies/Enterprise-Ireland-Corprate-Strategy-2008-2010-eng-.pdf
[28] http://www.enterprise-ireland.com/EI_Corporate/en/Publications/Reports-Published-Strategies/2013-Annual-Report-and-Accounts-English.pdf
[29] http://www.galway.ie/en/Business/WestRegionalAuthority/RegionalPlanningGuidelinesOtherPlans/Regional%20Planning%20Guidelines%202010%20-%202022%2019%2010%202010%20-%20Chapter%205%20to%20End.pdf

contributes about one-fifth of the EU's total emissions of carbon dioxide (CO_2).

- There seems little doubt that, given Ireland's and the EU's long term strategy in the transport sector, the pressure will continue to intensify for further and more significant reductions in GHG emissions across all areas of economic activity, but notably, given its environmental footprint, in road transport.

- This is relevant because GHE is projected to cater for large volumes of additional bulk cargo (in excess of two million tonnes per annum compared to 500,000 tonnes per annum currently) to serve businesses in its hinterland. If this cargo was to be handled by another port – and noting that in many cases this would not be commercially viable (see discussion below) – significant additional road transport would be generated. The nearest large other port is the Port of Foynes; Foynes is approximately 130km from Galway.

- As indicated, we estimate that an additional 170 million tonne km per annum would be generated on Irish roads, if the cargo forecast to be shipped through Galway were diverted to the Port of Foynes, in the stabilised Base Case. Under certain scenarios, this could reach almost 300 million tonne km per annum. The Base Case estimate translates into approximately 60 million extra litres of diesel consumed in Ireland per annum.

- This will generate significant emissions to air. Net of the Irish carbon tax, environmental damage from additional emission to air comes to over €4 million per annum. Over the period to 2035 (the period over which the Business Case and CBA were analysed) the present value of the pollution (net of carbon tax) would be over €27 million in the base case and up to €36 million.

- To this would have to be added impacts on road damage, noise and congestion, as well as greater risk of accidents, notwithstanding planned improvements to the N69 to improve access to the Port of Foynes.

- While the risk of accident is low, the consequences are high, and over the long term one could expect accidents to be avoided as a result of the project.

- The inclusion of a rail link in the proposed Harbour Extension offers customers the option of a modal switch to a more environmental friendly and sustainable transport option. This also complies with the goals set out in the Government's policy document: *Smarter Travel - A Sustainable Transport Future – A New Transport Policy 2009 – 2020* and, in particular, the goals of a reduction in reliance on fossil fuels and a reduction in transport emissions.

- A survey of major customers undertaken by GHC confirms that Galway is the lowest cost origin-destination option for catering for their traffic of all the Irish ports, and this will be strengthened by the proposed project.

3.5 ECOLOGICAL IMPACTS COMPARISON (NATURA 2000 SITES)

As demonstrated in the previous chapter, the other ports that might be used are problematic from a Natura 2000 perspective:

- **Shannon-Foynes** is located within two Natura 2000 sites; the River Shannon and River Fergus Estuaries SPA (Site Code 0004077) and Lower River Shannon SAC (Site Code 0002165), which takes in both the freshwater and estuarine components of the River Shannon and its tributaries. Coastal Lagoons are identified as an Annex I priority habitat for which the Lower River Shannon SAC is designated, in addition to fourteen other Annex I habitats.

- The SAC is designated for seven Annex II species including the Bottlenose Dolphin, for which the Shannon estuary is home to a significant population and for which only two SACs are designated in Ireland. The River Shannon and River Fergus Estuaries SPA is designated for 21 species of special conservation importance and is considered of great ornithological significance, being of international importance on account of the numbers of wintering birds it supports. It supports internationally important numbers of three species: Dunlin, Black-tailed Godwit and Redshank, and also supports 16 species that have populations of national importance.

- In conclusion, the following ecological issues have been arrived at based on the NIR :
  1. The bottle nosed dolphin (which is a qualifying interest species for the Lower Shannon cSAC) is a highly mobile and gregarious species could be impacted by the increased shipping through greater disturbance (including noise) and physical damage (collision).
  2. The proposed expansion of port facilities will require the destruction of qualifying interest habitats such as intertidal muds and sands and shallow bays and inlets.
  3. Operational maintenance of the ports in the Shannon Estuary requires regular dredging within the cSAC which gives rise to permanent increases on levels of suspended sediments in the water column.

  The proposed expansion of facilities in the Shannon Estuary is therefore considered to have greater ecological impacts than the planned Galway Harbour Extension project. Due to the lack of information in the SFPC Vision 2041 NIR but nevertheless based on the precautionary principal, the level of impact of the proposed expansion of shipping in the Shannon Estuary must be considered as being significant.

- The approaches to the **Dublin Docks** pass through or close to 3 cSACs (North Dublin Bay, South Dublin Bay and Rockabill to Dalkey Island). The qualifying interests for the Rockabill to Dalkey Islands are harbour porpoise and common seal.

- With regard to SPAs, 10 (North Bull, Rockabill, Rogerstown Estuary, South Dublin Bay and River Tolka Estuary, Malahide Estuary, Lambay Island, Howth Head, Ireland's Eye, Skerries Island and Dalkey Islands) are located within or close to the approach channel to the Dublin Docks. This high number of Natura sites makes Dublin Bay a more environmentally sensitive area than Galway Bay.

- The approaches to **Cork Harbour** pass through 1 cSAC (Great Island) and 1 SPA (Cork Harbour). This is the same number as for Galway Bay.

- Of the other two ports examined as part of the Alternatives, i.e. Dublin and Cork, it is clear that as Dublin Bay hosts 13 Natura sites, it is considerably more sensitive than Galway where there are only two Natura sites. It should be noted that all of the Natura sites in Dublin Bay are marine in character. Cork Harbour is of the same level of sensitivity as Galway as two Natura sites are present within it. Like Galway, the two Natura sites that are present within Cork Harbour are marine-based.

3.6 HEALTH & SAFETY BENEFITS OF THE INVESTMENT

There are significant health and safety benefits to the development:

- The above analysis has indicated substantial emissions to air if business forecast for Galway is transferred to any other port, with consequent negative impacts not only for the environment but for human health.

- Another environmental benefit is that, with the movement of petroleum-related activities out of Galway Inner Dock, the Seveso-restricted area of the port will be moved away from the city centre.

- Apart from health and safety benefits and reductions in risk, this is likely to have a positive impact on future planning applications in the city centre by removing obstacles to redevelopment.

- Finally, as indicated, there are significant passenger safety benefits from being able to provide docking to cruise ships as opposed to tendering at Galway.

4. LONG TERM NATURE OF THE DEVELOPMENT

GHE is a proposal designed not only to address the current shortcomings and constraints of the existing port facilities, but also to serve the city's region's needs into the long term.

Ports are extremely long–lived infrastructure assets – Galway has been a significant port since at least the 13th century. Adding or renewing capacity – as with all infrastructure - is invariably complex and involves significant upfront investment, and tends to be undertaken infrequently: the previous enhancement in the 1960s had been the first since the 19th century.

It makes sense to design for foreseeable demand levels well into the future. This is particularly the case for smaller ports such as Galway, where additions to capacity can be significant compared to the pre-existing capacity. Furthermore, given the location, undertaking a single large increase in capacity, sufficient to cater for foreseeable traffic increases into the long term, will cause less damage and disruption to the site, than a number of smaller-scale enhancements over time.

The project is designed to enable the relocation of commercial activities out of the Inner Dock area of Galway Harbour and essentially free the commercial port from tidal and capacity limitations, whereby it is, at present, only accessible 4 hours out of every 24, and the maximum size ship that can be catered for is limited to 7,000 tonnes (less in the case of some cargos). These constraints have already meant a medium term decline for Galway port, as ships have become larger and less able and prepared to operate within such a short tidal window.

The proposed new facility will be freed of tidal restriction and capable of handling vessels sized up to and above 20,000 tonnes, which will future-proof the port's operations.

5. PROJECT OF PUBLIC INTEREST

Galway Harbour Company is in public ownership/control and its board is currently appointed by central Government. The NPP foresees future governance being transferred to the control of Local Government. Because of the significant economic benefits and direct and indirect employment generated and facilitated by the port, as detailed in the previous sections of this report, this project is of important public interest.

As detailed in previous sections, Galway port is a key infrastructural asset for the city and region, and its continuance and development is in line with EU and national economic, transport and environmental policy. The port also directly and indirectly supports significant employment in the city and region, and this will be maintained and increased of foot of the proposed investment.

The port is a public facility and an integral part of Galway city. A practical example of this is the Volvo Ocean Race[30], which has stopped in Galway twice in recent years, and generated significant economic benefits and publicity for the city and region[31]. The capacity for Galway Bay to cater for similar and other events with public access will be greatly enhanced by the proposed investment.

The project will generate significant economic benefits not only for the port and the city, but for the region. As per DKM's *Galway Harbour Extension Business case and Cost Benefit Analysis* report[32], these important benefits will include:

- A positive socio-economic Net Present Value (NPV) of almost €150 million, including substantial benefits for the key customers of the port, the regional tourism sector, and the construction industry while also securing its own future.

- One of the most significant economic benefits is based around the existing bitumen-processing and storage facilities at Galway, whereby the opportunities delivered by increased capacity and constraint removal at the port are to be used to facilitate Galway to become a west European transhipment centre for bitumen.

- During the construction phase of three years just under 600 years of employment would be generated. Once operational some 73 additional FTE permanent jobs will be generated in the tourism industry and beyond. This is on top of underpinning existing employment in the port, its suppliers and

[30] http://www.volvooceanracegalway.ie/
[31] http://www.nuigalway.ie/about-us/news-and-events/news-archive/2012/november2012/volvo-ocean-race-report-finds-economic-benefit-of-605-million-to-host-city.html
[32] Report entitled *Galway Harbour Extension Business Case & Cost Benefit Analysis*, dated 13th December 2013, which is contained in *Vol. 2C: Appendices to EIS – [Part 1 of 3 Parts]*, Appendix 2.2.1, as well as being summarised in Chapter 2 of *Vol. 2B: Main EIS [Part 1 of 2 Parts].*

customers. The port company and businesses associated with the port employ approximately 800 FTE staff in addition to significant additional indirect and induced employment.

- The extended Galway port is designed to handle larger and more economical ships, leading to cheaper cargo, and reducing costs within the economy of the region in general.

- By minimising land transport requirements the carbon footprints of the port's customers are also minimised.

- With the movement of petroleum-related activities out of the Inner Dock, the Seveso-restricted area of the port will be moved away from the city centre (while the storage facilities will not be moved, the ship discharging fuel is a Seveso site while discharging). This reduces risk and may have a positive impact on the future potential for residential and service-industry development of the city centre.

6. SOCIAL & ECONOMIC NATURE OF THE PROJECT

As highlighted by the importance attached to them by policy (see earlier chapters), **ports represent vital economic infrastructure, and play a significant role in the socio-economic life of cities and regions**.

Galway port is already a significant generator of employment, directly supporting some 800 FTE jobs (including the port company itself). Significantly more employment is dependent on the port via indirect and induced impacts.

This project is of significant social and economic importance to the city and the region, as it will **enable Galway to continue as an important regional asset into the future**, in compliance with Government policy, and maintaining and enhancing economic activity and employment. .

As specified in the previous chapters and in *Galway Harbour Extension Business case and Cost Benefit Analysis* report[33], the **economic** value of GHE is very substantial:

- Identifiable economic benefits flow to the port's customers, as well as to the wider community via -
  - (i) indirect and induced impacts, and
  - (ii) the additional tourism and leisure-related activities that will be facilitated.
- Other important economic benefits flow in terms of -
  - (a) lower costs in the region as GHC can cater for larger more economical ships,
  - (b) greater security of energy supply as more of NORA's strategic fuel stores can be held at GHC,
  - (c) Greater scope for redevelopment of the Inner Harbour and its reintegration with the city centre, and for development in the city generally, as commercial activity and fuel off-loading in particular is moved from the Inner Harbour.

Substantial **employment** benefits will also flow from the project, related to:

- Construction of the project: almost **600 work years** of employment.
- Maintenance and enhancement of employment in the port company and its customers as the port is enabled to develop and grow: **current employment of 800 FTE jobs** in the port and businesses associated with it. This could be expected to grow on foot of the development, with related indirect and induced impacts.
- Increased employment in tourism and leisure as growth in these sectors is facilitated:

[33] Report entitled *Galway Harbour Extension Business Case & Cost Benefit Analysis*, dated 13th December 2013, which is contained in *Vol. 2C: Appendices to EIS – [Part 1 of 3 Parts*], Appendix 2.2.1, as well as being summarised in Chapter 2 of *Vol. 2B: Main EIS [Part 1 of 2 Parts].*

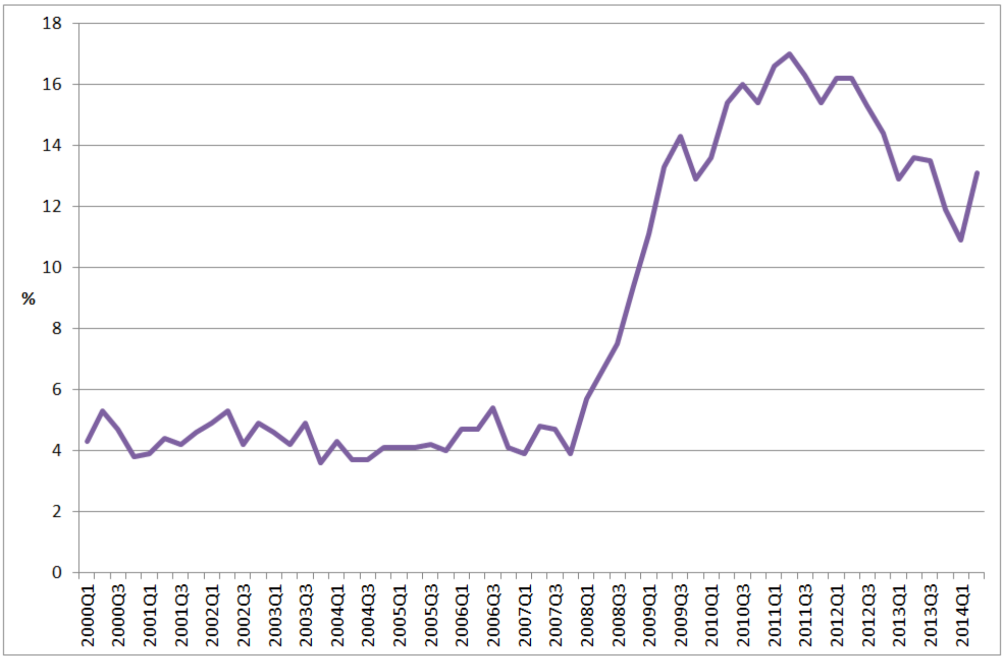
- Increased cruise tourism would generate additional economic activity in the region, growing to over €4 million per annum and over 50 additional FTE jobs.
- Increased marina-based tourism would generate over €1.7 million pa in additional economic activity and over 20 additional FTE jobs in the region.

- Scope for urban regeneration, and reintegration with the city, of the Inner Harbour, which would generate further construction-related and subsequent permanent employment.

These impacts must be set against the current socio-economic conditions in the West region. As indicated, the West NUTS III region is part of the BMW NUTS II region, which is disadvantaged relative to the rest of Ireland. Disposable incomes per capita in the BMW region, even after social transfers, have averaged 10% less than the State average over the last decade or so[34].

The West region, in common with the rest of Ireland, has suffered significantly as a result of the economic crash, as the next two charts indicate. The first presents the increase in unemployment in the West region per the QNHS since 2000. The second presents the increase in the Live Register - those claiming unemployment benefits and similar – throughout County Galway since 2002. While the Live Register does not strictly speaking represent unemployment, it tracks it closely (actual unemployment data is not available below NUTS III level except in the Census).

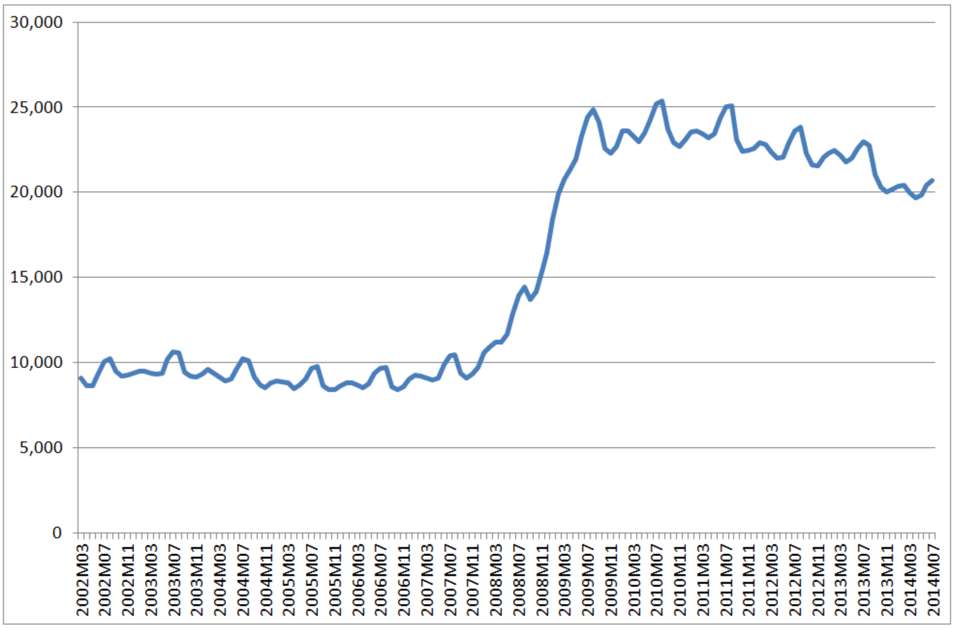
Figure 6.2: UNEMPLOYMENT RATE, WEST NUTS III REGION, 2000Q1 TO 2014 Q2



Source: CSO QNHS

34 CSO, *Estimates of Household Income by County & Region*.

Figure 6.3: LIVE REGISTER, GALWAY CITY & COUNTY, MARCH 2002- JULY 2014



Source: CSO Live Register

Both charts demonstrate graphically the drastic increase in unemployment in Galway and the West region over the last decade (notwithstanding recent gradual improvement), and hence the socio-economic importance of the proposed investment.

It also provides the context for the Government's annual **Action Plans for Jobs**[35]**,** which articulates the priority that the State and society attach to tackling unemployment.

Our analysis indicates that in the absence of the proposed development at GHC, the bulk of the identified additional business that would be catered for at the redeveloped Galway Port would not migrate to another port, but would be **lost to Ireland**, as would the related economic and employment benefits.

There is a significant **safety** enhancement of the port, as Seveso sites (ships offloading petroleum products) will be moved away from the city centre, which as indicated above will allow reintegration of the Inner Harbour with the city, and may facilitate redevelopment of the surrounding city centre area.

Finally, there is a significant **environmental** benefit, in terms of reduction in transport-generated pollution.

[35] 2014 edition: http://www.djei.ie/publications/2014APJ.pdf

7. SCALE OF IMPORTANCE

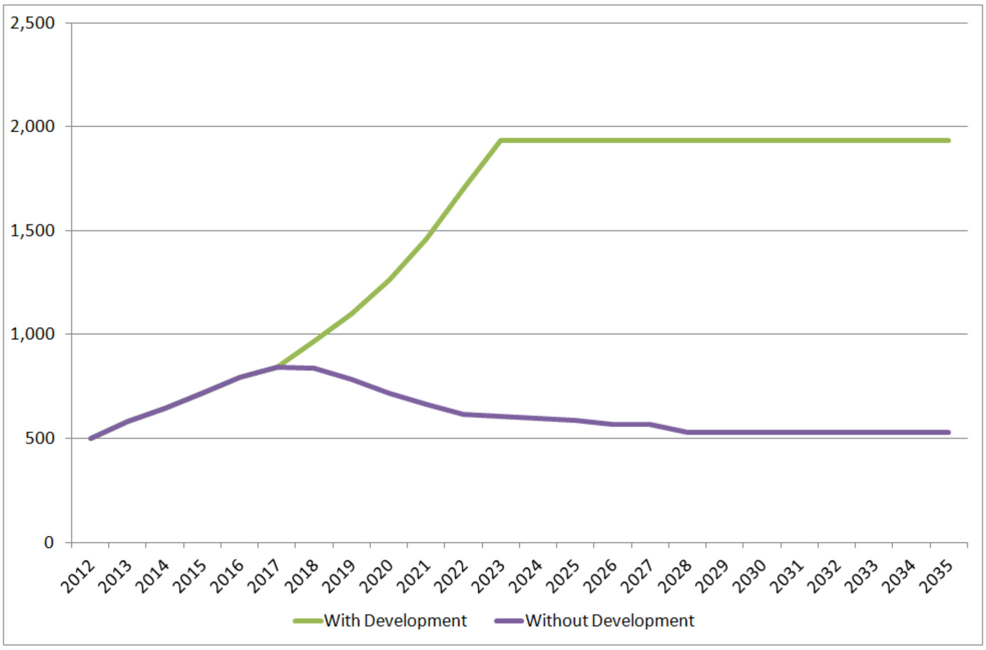
An analysis has been undertaken to assess the the scale of importance of the GHE proposal in comparison with any likely or possible ecological impacts on the relevant sites in the locality forming part of the Natura 2000 network. In doing so the precautionary principle has been applied.

The scale of impact on Natura 2000 arising from the construction of GHE has been identified in the NIS and comprises the loss of designated land (26.93 HA), designated intertidal (5.93 HA) and sub/tidal (21.0 HA) areas immediately adjacent to the existing port. In the context of the overall inner Galway Bay SAC, this represents 0.20% and in the context of the SPA, 0.19%. In the context of the overall scale of the inner Galway Bay SAC & SPA, this represents a relatively small proportion of the designated site, nevertheless this has to be balanced against the importance of the project. Consideration has been given to direct and indirect as well as cumulative effects.

The foregoing chapters have demonstrated that there is a pressing need to redevelop the port facilities, to serve the socio-economic needs of the city and region going forward and to avoid the inevitable decline of the existing commercial port.

The importance of the project cannot be over-estimated. Without the development of GHE, the existing port will continue to decline in terms of servicing the needs of the region. The following chart summarises the forecast volumes of traffic with and without the investment:

Figure 7.1: Forecast Tonnage Volumes at GHC with and without Development



Source: GHE Business Case

There is also a not insubstantial risk that GHC would cease altogether to be a commercial port in the long run without the proposed investment.

This will undermine the role of Galway City as the region's gateway and the achievement of balanced regional development, a key national policy priority.

It will also undermine (i) expansion plans by a number of the port's customers, (ii) scope to build on the tourism and leisure potential of the port, notably in leisure boating and cruise ships.

8. SUMMARY

The proposed development at Galway Harbour Company (GHC) encroaches on Natura 2000 sites (i.e. SAC & SPA). The Natura Impact Statement (NIS) prepared as part of this planning application has concluded that an adverse impact on the integrity of the Natura 2000 sites cannot be ruled out beyond reasonable scientific doubt.

In accordance with the European Commission Document *Managing Natura 2000 Sites*[36]*,* in the absence of feasible alternatives, or in the presence of solutions having an even more negative environmental effects on Natura 2000 sites, the next step is to determine whether there are Imperative Reasons of Overriding Public Interest (IROPI), which require the realisation of the proposed plan or project.

There is thus a two-step process involved:
(i) assess whether **feasible alternatives** exist, and
(ii) if they do not, determine whether there are **Imperative Reasons of Overriding Public Interest (IROPI)** which require the realisation of the proposed plan or project.

Assessment of possible Alternatives

This in turn comprises two steps –
1. Identification of potential alternatives, and
2. Assessment of whether any of these are feasible.

A comprehensive exercise was undertaken, identifying and then assessing the full range of options from:
- Do Nothing,
- other investment within the existing harbour space,
- other locations in Galway Bay, to
- other ports and transport modes.

This exercise concluded that none of the alternatives was feasible. In particular, the other major ports in Ireland – Foynes, Dublin and Cork – are problematic from the perspective of causing less damage to Natura 2000 sites.

Having concluded that none of the alternatives is feasible, the next step is to assess whether there are **Imperative Reasons of Overriding Public Interest (IROPI)** which require the realisation of the proposed plan or project.

Commission guidance is that it should be demonstrated that the balance of interest between the conservation objectives of the site affected by the project, and the

[36] Commission Document, *Managing Natura 2000 Sites - The Provisions of Article 6 of the 'Habitats' Directive 92/43/EEC*. http://ec.europa.eu/environment/nature/natura2000/management/docs/art6/provision_of_art6_en.pdf

imperative reasons why the project should proceed, should weigh in favour of the latter.

This Document has assessed the GHE project in accordance with the following criteria, in relation to the IROPI test:

- Necessity
- Long term
- Of Public Interest
- Of a Social & Economic Nature
- Scale of Importance.

The assessment of the project in accordance with the criteria listed above encapsulates the essential elements of IROPI, namely that the rationale for proceeding is:

- Imperative
- Over-Riding
- Of Public Interest.

The key issues that have been highlighted and addressed and which demonstrate that IROPI applies in the case of the proposed development are:

- Galway functions as and is a national Gateway under the National Spatial Strategy (NSS), and the only Gateway in the West NUTS III region. Gateways are drivers of economic activity, and centres of key economic infrastructure, such as ports. Indeed the NSS identifies one of the characteristics of a gateway as having "cost effective and efficient access to port facilities".

- Galway is also in the BMW NUTS II region, which is less developed than the rest of the country, and is eligible for increased regional aid. Average incomes are below the State average; unemployment has risen sharply since the economic crisis, and is only starting to stage a very gradual recovery.

- Galway Port is a long-established and crucial element in the transport infrastructure of the West Region. Constraints in the existing port have reached a stage where Galway's medium to long term future as a commercial port is open to question if this development were not to proceed.

- Galway is a bulk port serving its region and typically handles high volume-to-value cargos. However, the current configuration imposes severe constraints on the commercial operations of the port. Galway is not only significantly below the Irish average in terms of the size of bulk cargo ship it currently caters for, but has also been falling further behind over the last decade. The average tonnage of liquid and dry bulk cargo ships now serving Irish ports is beyond the capacity of Galway port as it stands.

- If the inner harbour is to be redeveloped for leisure/tourism, which will render Galway City a more attractive location to live and work in and visit, and as

Government policy articulates in the 2013 *National Ports Policy* (NPP), then it is necessary to build a facility to which commercial traffic can be relocated.

- The businesses using the port facilities are major employers, directly supporting some 800 FTE jobs (including the port company itself). Significantly more employment is dependent on the port via indirect and induced impacts.

- Galway's future continuation as a commercial port is in line with EU and National Policy. In particular, Galway's proposed investment is designed not to detract from any of the Tier 1 ports, but to cater for its own regional commercial port needs.

- GHC performs a strategic role in fuel storage regionally, and it holds part of the National Oil Reserve Agency's (NORA) reserves, while the Irish Marine Development Agency (IMDO) in its *Irish Ports offshore renewable energy services (IPores)* report identifies Galway as an important port for servicing the offshore energy sector. Other national, regional and local policy documents and plans likewise highlight the importance of Galway and its port.

- The other option - in effect the transfer of the identified cargos to a more distant port – is commercially and environmentally unsustainable, in terms of the cargo types and additional costs for port customers. If transferred, the additional road transport would generate increased emissions to air, accidents, road damage and congestion. In many cases the business will not transfer, and may simply be lost to Ireland.

- To properly cater for cruise traffic – a key source of tourism growth - the port needs to be able to dock as opposed to tendering cruise liners. Apart from the commercial and passenger desirability aspects of this, tendering is a less desirable option from a health and safety perspective.

- There are further significant health and safety benefits to the development, in terms of the movement of petroleum-related activities out of Galway Inner Dock, away from the city centre.

- The inclusion of a rail link in the proposed Harbour Extension offers customers the option of a modal switch to a more environmental friendly and sustainable transport option. This also complies with the goals set out in the Government's policy document: *Smarter Travel - A Sustainable Transport Future – A New Transport Policy 2009 – 2020* and, in particular, the goals of a reduction in reliance on fossil fuels and a reduction in transport emissions

- Ports are extremely long–lived infrastructure assets – adding or renewing capacity is invariably complex and involves significant upfront investment, and tends to be "lumpy" by its nature. It makes sense to design for foreseeable demand levels well into the future.

- Thus GHE is a proposal designed not only to address the current shortcomings and constraints of the existing port facilities, but also to serve the city's region's needs into the long term. The last major upgrade of the port occurred over 50 years ago.

- Galway Harbour Company is in public ownership/control and its board is currently appointed by central Government, with governance being transferred to the control of Local Government in the near future.

- The port is a public facility, a major generator of employment, and an integral part of Galway city. A practical example of this is the Volvo Ocean Race, which has stopped in Galway twice in recent years, and generated significant economic benefits and publicity for the city and region.

- As specified here and in the *Galway Harbour Extension Business case and Cost Benefit Analysis* report, the economic value and employment impact of the proposed project is very substantial. The Government's annual *Action Plan for Jobs* articulates the priority that the State and society attach to tackling unemployment.

- The level of anticipated impact on the Natura 2000 sites, which might arise from the construction and operation of the proposed development herein, even applying the precautionary principle is of a small scale nature as demonstrated in the NIS and additional information submitted, particularly when balanced against the demonstrated importance of the proposed development for the sustainability of Galway and the Western Region.

In summary, this report has demonstrated that:

(i) there is no feasible alternative to the project, and

(ii) there are Imperative Reasons of Overriding Public Interest (IROPI) which require the realisation of the proposed project.

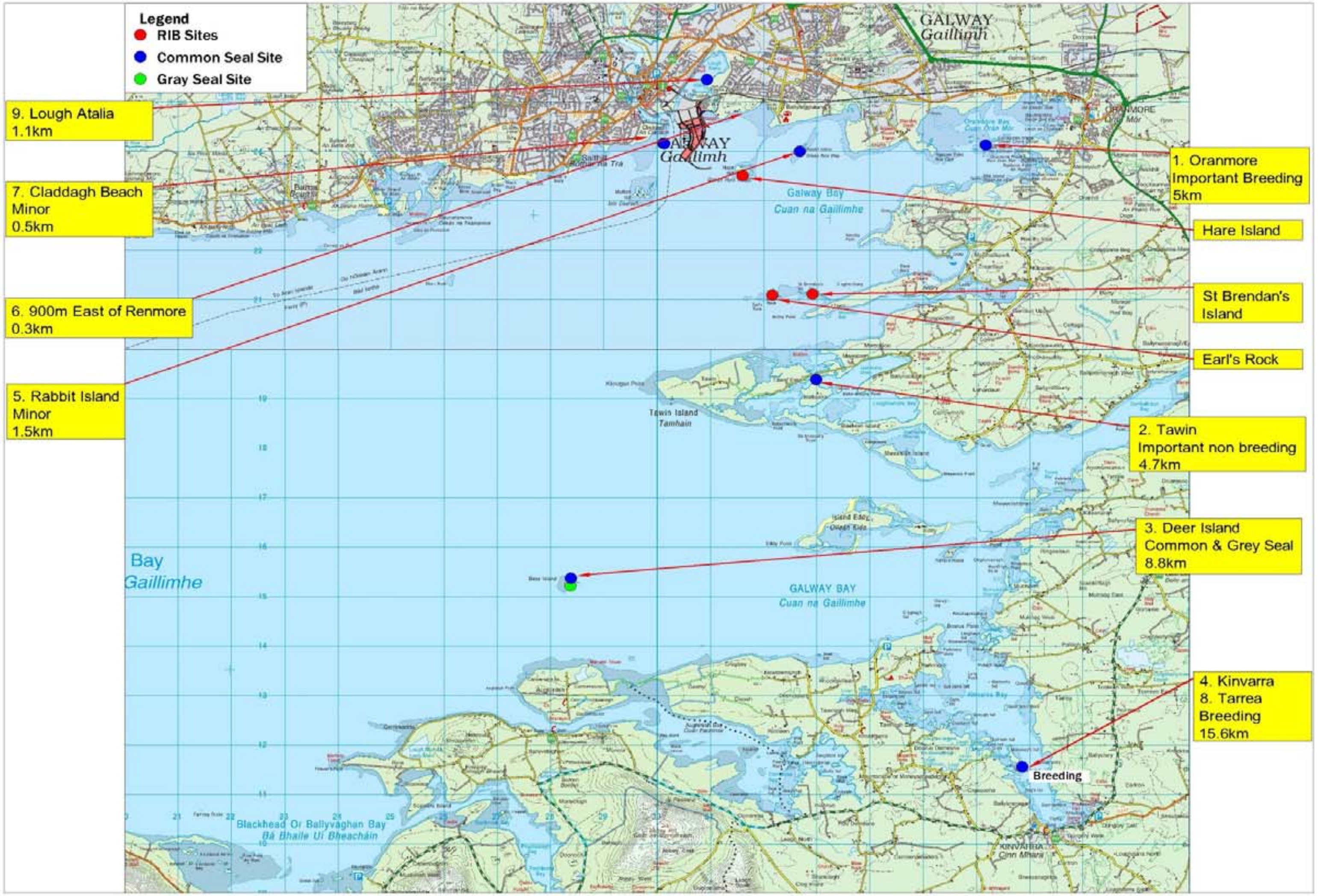
Galway Harbour Company

Galway Harbour Extension

Appendix RFI 2 - Mammals

RFI 2.1 **Seal Raw Data**
RFI 2.2 **Kelp Report**
- + **Risk Assessment for all Marine Mammals**
- + **Aquatic Habitat Use of the Harbour Seal**

RFI 2.1 Seal Raw Data



RFI Addendum / Errara Appendix 2.1

Figure 1 - Harbour Seal haul out locations and distance by sea to Development. Range of Vision generally 2km from land (Hare Island, Earl's Rock and St Brendan's Island viewed from RIB)

Seal Observations - Aquafact, Nimmo's Pier

2009		2010			2011		2012		2013		2014	
21.2.2009	0	24.1.2010	0		6.1.2011	29	23.03.2012	0	13.01.2013	0	26.01.2014	1
29.3.2009	1	21.2.2010	2		19.1.2011	6	26.03.2012	0	03.02.2013	0	09.02.2014	1
26.4.2009	3	28.3.2010	4		31.1.2011	2	27.03.2012	1	24.03.2013	0	23.02.2014	3
24.5.2009	2	31.3.2010	2		10.2.2011	0	28.03.2012	0	17.04.2013	2	09.03.2014	2
21.6.2009	4	18.4.2010	1		28.2.2011	1	29.03.2012	0	09.05.2013	4	16.03.2014	1
19.7.2009	0	4.5.2010	1		11.3.2011	3	3.04.2012	0	16.06.2013	1	05.04.2014	0
30.8.2009	1	5.5.2010	2		19.3.2011	0	4.04.2012	1	14.07.2013	2	13.04.2014	2
27.9.2009	6	6.5.2010	1		29.3.2011	0	6.04.2012	1	28.07.2013	0	27.04.2014	1
11.10.2009	2	11.5.2010	1		5.4.2011	0	11.04.2012	0	17.08.2013	1	11.05.2014	2
22.11.2009	0	13.5.2010	3		6.4.2011	0	13.04.2012	0	31.08.2013	3	24.05.2014	0
13.12.2009	1	19.5.2010	2		7.4.2011	0	16.04.2012	2	08.09.2013	1	08.06.2014	1
		21.5.2010	0		15.4.2011	0	19.04.2012	0	14.09.2013	2	22.06.2014	3
		25.5.2010	2		18.4.2011	0	23.04.2012	0	06.10.2013	1	05.07.2014	1
		26.5.2010	3		21.4.2011	1	24.04.2012	1	27.10.2013	1	16.08.2014	0
		27.5.2010	1	grey seal	27.4.2011	3	30.04.2012	0	16.11.2013	0		
		31.5.2010	2		29.4.2011	0	1.05.2012	0	01.12.2013	0		
		1.6.2010	1	grey seal	3.5.2011	0	2.05.2012	0	14.12.2013	3		
		8.6.2010	0		5.5.2011	2	4.05.2012	0				
		10.6.2010	1		10.5.2011	0	9.05.2012	1				
		11.6.2010	1		11.5.2011	0	10.05.2012	0				
		14.6.2010	3		13.5.2011	2	11.05.2012	0				
		15.6.2010	1		16.5.2011	2	14.05.2012	0				
		16.6.2010	0		18.5.2011	1	19.05.2012	0				
		20.6.2010	0		23.5.2011	4	21.05.2012	0				
		30.6.2010	0		25.5.2011	0	22.06.2012	2				
		3.7.2010	2		26.5.2011	1	10.07.2012	0				
		5.7.2010	0		30.5.2011	0	16.08.2012	3				
		14.7.2010	4		1.6.2011	0	27.09.2012	1				
		10.8.2010	0		6.6.2011	2	11.10.2012	2				
		19.8.2010	1		8.6.2011	0	21.11.2012	1				
		3.9.2010	3		13.6.2011	0	16.12.2012	1				
		21.9.010	0		14.6.2011	0						
		5.10.2010	6		16.6.2011	1						
		26.10.2010	23		20.6.2011	2						
		10.11.2010	18		21.6.2011	0						
		26.11.2010	33		22.6.2011	0						
		1.12.2010	50									
		20.12.2010	50									

Seal Observations - Chris Peppiatt, Current Galway Harbour Park

2011

	Common	HO Renmore	HO Rabbit
31.03.2011	1	0	0
17.04.2011	5	5	5
17.05.2011	1	0	1
15.06.2011	0	0	0
11.07.2011	1	0	0
11.08.2011	0	0	0
26.09.2011	0	0	0
12.10.2011	0	0	4
11.11.2011	0	1	0
03.12.2011	0	0	0
29.12.2011	1	0	0

2012

	Common	HO Renmore	HO Rabbit
01.01.2012	0	0	0
13.01.2012	1	1	0
20.01.2012	1	0	0
05.02.2012	1	0	0
28.02.2012	1	0	0
06.03.2012	1	0	0
25.03.2012	0	0	2
10.10.2012	1	0	0
30.10.2012	3	1	14
16.11.2012	2	0	2
27.11.2012	1	0	0
21.12.2012	1	0	0
27.12.2012	2	3	0

2013

	Common	HO Renmore	HO Rabbit
22.01.2013	0	0	0
02.02.2013	1	0	0
22.02.2012	1	0	0
25.02.2013	3	5	13
04.03.2013	1	0	0
14.03.2013	2	0	0

2014

	Common	HO Renmore	HO Rabbit
04.03.2014	1	3	0
08.04.2014	0	0	0
14.05.2014	1	0	0
14.06.2014	1	0	0
17.07.2014	2*	0	0
27.08.2014	0	0	0

* Fighting

HO Renmore = Renmore Barracks Haul Out M\313\246
HO Rabbit = Rabbit Island Haul Out M\326\239

Seal Observations - Chris Peppiatt, Mutton Island Lighthouse

2011

17.06.2011	1
15.07.2011	0
15.08.2011	0
22.09.2011	0
19.10.2011	0
10.11.2011	0
15.12.2011	0

2012

11.01.2012	0
07.02.2012	1
09.03.2012	0
10.04.2012	0
17.05.2012	0

Seal Observations - Marine Mammal Observer, John Olney - during site investigation works within development site

2012	No.	MM Type	Activity	Distance to Barge
11/03/2012	1	Adult common seal, possibly cow (size). Approx. 1.2m long.	Possibly feeding. Head briefly above water.	80m
12/03/2012	1	Adult common seal.	Swimming near harbour lock gates.	>500m
12/03/2012	3	Adult common seals, feeding.	Feeding. Heads occasionally briefly above water.	300m
12/03/2012	3	Adult common seals, heads occasionally above water.	Feeding. Heads occasionally briefly above water.	300m
12/03/2012	2	Adult common seals, feeding.	Feeding. Heads occasionally briefly above water.	250m
13/03/2012	1	Adult common seal.	Swimming near shoreline, head occasionally above water.	350m
13/03/2012	1	Adult common seal, only head visible.	Swimming, milling about shoreline.	350m
13/03/2012	1	Adult common seal, possibly male. Approx. 1.4m long.	Milling about barge, curious.	50m
14/03/2012	1	Adult common seal, possibly male. Approx. 1.4m long.	Milling about barge, curious.	20m
15/03/2012	1	Adult common seal, only head visible.	Possibly feeding. Head briefly above water.	250m
16/03/2012	1	Adult common seal, only head visible.	Swimming, head briefly above water.	250m
22/03/2012	2	Probable European otters, one measuring c.1m long	Swimming and playing along shoreline.	>100m

RFI 2.2 Kelp Report

+ **Risk Assessment for all Marine Mammals**
+ **Aquatic Habitat Use of the Harbour Seal**

REPORT

Additional risk assessment of the Galway Harbour Extension for all marine mammals (excluding otter), including a review of the aquatic habitat use of the harbour seal (*Phoca vitulina*).

Report commissioned by McCarthy Keville O'Sullivan Ltd. under the Galway Harbour Extension Project

Author: Kelp Marine Research
Contact: info@kelpmarineresearch.com
Date: October 2014
Version 3.1 (FINAL)

Table of Contents

1.

1. Background and Aim

The aim of this report is to provide 1) an additional risk assessment for all marine mammal species (excluding otter) and 2) a comprehensive desktop analysis of harbour seal aquatic habitat use, to support in the assessment of potential effects of the Galway Harbour Extension on marine mammals as part of the full risk assessment within the Environmental Impact Statement (EIS) for the Galway Harbour Extension Project by McCarthy Keville O'Sullivan Ltd.

Two species of pinnipeds, harbour seal and grey seal, and four species of cetaceans, harbour porpoise, common and bottlenose dolphin and minke whale, occur in the Galway Bay candidate Special Area of Conservation (cSAC). The site for the Galway Harbour Extension is listed as a cSAC for the harbour seal under European legislation.

This independent report serves only to extend information previously submitted in the EIS to the National Parks and Wildlife Service and An Bord Pleanala, as part of the Strategic Infrastructure Development (SID) application of the Galway Harbour Extension project (January 2014), specific to requests for further information and points of concern for marine mammals. This document is not a stand-alone report, or stand-alone risk assessment. The risk assessment and EIS of the Galway Harbour Extension, including marine mammals, remains under full responsibility of McCarthy Keville O'Sullivan Ltd.

The EIS and project planning documentation are available at: http://www.galwayharbourextension.com.

2. Risk assessment for all marine mammals (excluding otter)

2.1 Risk assessment procedure

The additional risk assessment of the Galway Harbour Extension conducted here, for all marine mammal species occurring in the Galway Bay cSAC, was executed following the National Parks and Wildlife Service guidelines as outlined in the report "*Guidance to manage the risk to marine mammals from man-made sound sources in Irish waters*" (DAHG 2014; available at http://www.npws.ie).

All information provided in this report was derived from existing scientific literature and reports, including site-specific reports detailing survey, monitoring and acoustic recording and modelling results, executed for the Galway Harbour Extension Project, available at http://www.galwayharbourextension.com. No targeted surveys or observations of marine mammals were conducted in the area of proposed construction activities for the purpose of this report. The risk assessment provided here focuses primarily on potential impacts of the proposed construction activities in the marine habitat.

The risk assessment for marine mammals focuses on two main types of potential disturbances, physical hearing damage and changes in behaviour. Whereas a large body of effort to investigate the effects of noise in the marine environment has focused on the likelihood of physical (hearing) damage, it has become apparent that changes in behaviour and/or habitat-use resulting from sound exposure or construction activities are often equally, or more likely to translate to a negative effect at the population-level, given the apparent fitness consequences of these responses (e.g. Southall et al. 2007, de Ruiter et al. 2013). Mild to severe behavioural responses to anthropogenic disturbance, including changes in vocalisations, area avoidance and cessation of vital activities such as foraging have been recorded across a wide range of species, areas and types of disturbances (e.g. Goldbogen et al. 2013). The type and strength of behavioural responses can vary widely between and within species and between types of disturbances and are often highly context dependent, calling for case-by-case, in depth study of biological relevance and severity of effects (e.g. Goldbogen et al. 2013).

The risk assessment conducted here provides likelihoods of effects based on available published information. Due to the general lack of detailed knowledge of many aspects of seal and cetacean marine habitat use, behaviour and temporal presence in Ireland, including in the Galway Bay cSAC, it may be that specific dependencies of the species concerned could not be evaluated, and could therefore not be taken into account in the risk assessment. Most notably, knowledge on (spatio-temporal variation in) dependencies on specific marine sites is limited. In recent years, site-specific surveys carried out as part of the Environmental Impact Statement have been undertaken (Galway Harbour Company 2014), providing visual and acoustic information on the presence of cetacean and pinniped species near the area proposed for construction, adding to survey efforts undertaken in the Galway Bay cSAC (Cronin et al. 2004, O'Brien 2009, Duck & Morris 2013a,b).

2.2 Marine mammal species concerned

Harbour seal (*Phoca vitulina*)
Grey seal (*Halichoerus grypus*)
Harbour porpoise (*Phocoena phocoena*)
Bottlenose dolphin *(Tursiops truncatus)*
Short-beaked common dolphin *(Delphinus delphis)*
Minke whale (Balaenoptera acutorostrata)

2.3 Risk assessment

Assessment 1.

Do individuals/populations of marine mammal species occur within the proposed area?

The harbour seal is resident in the Galway Bay cSAC (NPWS 2013, Galway Harbour Company 2014). Harbour porpoises are frequently recorded in the Galway Bay cSAC and near the proposed area (84% of monitoring days between June 2011 and October 2013; O'Brien 2009, CH7 Galway Harbour Company 2014). Bottlenose dolphins used to be frequently recorded (Berrow et al. 2002), but seemed to be declining (O'Brien 2009). Short-beaked common dolphins, minke whales and grey seals are recorded infrequently in the proposed area (O'Brien 2009, Duck & Morris 2013a, b, Galway Harbour Company 2014). However, dolphins (bottlenose or common dolphins) were recorded acoustically on 32% of monitoring days between June 2011 and October 2013, suggesting a more regular presence of dolphins than was found from visual monitoring studies (CH7, Galway Harbour Company 2014).

Assessment 2.

Is the plan or project likely to result in death, injury or disturbance of individuals?

2A. Dredging

Dredging will be performed by two different types of vessels in the proposed project: Trail Suction Hopper Dredgers (TSHD), and backhoe dredgers. The type of substrate determines which vessel type will be used. As one type of dredging is noisier than the other, there are two sets of peak levels that have to be taken into account. Peak levels are 133-185 dB re 1 µPa and 143-195 dB re 1 µPa for TSHD and backhoe dredgers respectively (De Jong et al. 2011, Robinson et al. 2011, Appendix 10.2 Galway Harbour Company 2014). Permanent and Temporary hearing Threshold Shifts (PTS and TTS) can occur for both pinnipeds and cetaceans, if they venture too close to the sound source (Galway Harbour Company 2014). Unless individual animals would be very close to, or attracted by the dredging activities, (hearing) injury or death resulting from these activities is unlikely. The proposed mitigation measures would effectively mitigate against these effects (Table 1).

Seals

The intensity and duration of noise related to dredging is such that it can cause PTS, TTS and behavioural changes (Table 1). In harbour seals, behavioural changes such as area avoidance have been estimated to occur from sounds with an intensity of 55 dB above hearing threshold (Thompson et al. 2013). The peak frequency of dredging noise lies around 125 Hz, which is in the most sensitive part of harbour seal hearing range. Therefore, dredging has the potential to cause behavioural disturbance for the resident harbour seal. Auditory sensitivity levels for grey seals are estimated to be similar to those of the harbour seal. However, grey seals only occur infrequently in the harbour, and are therefore less likely to be affected (Table 1).

Bottlenose and common dolphin, and harbour porpoise

While limited information is available on the direct effects of dredging activities on dolphin and porpoise populations, dredging activities in a UK harbour resulted in an avoidance response of the bottlenose dolphins in the area (Pirotta et al. 2013). The bottlenose dolphins had begun exploiting Aberdeen Harbour as a foraging patch several years before the activities commenced. Dredging occurred several times over a period of several years, but the population did not seem to habituate. The fact that even in an area with regular disturbance, bottlenose dolphins still responded strongly to dredging suggests that it has a high disturbance potential for this species in certain areas or habitats. The mechanism behind the disturbance remains open for research, as it can either be caused by direct avoidance of the noise, be mediated by a change in prey behaviour or visibility, or a combination of the three (Pirotta et al. 2013). However, in contrast, construction work in Broadhaven Bay, Ireland (an area of generally low anthropogenic disturbance) could not be linked to any changes in population density for bottlenose dolphins, common dolphins and minke whales, whereas interannual population fluctuations were detected for harbour seals and grey seals (Anderwald et al. 2013).

Hearing sensitivities of short-beaked common dolphins and harbour porpoises are similar to those of bottlenose dolphins for the noise frequencies of dredging activities. Acoustic deterrence and/or area avoidance resulting from exposure to other types of sound (e.g. seismic airgun shooting, wind turbines, pile driving) has been demonstrated for both common dolphins and harbour porpoises (Goold 1996, Tougaard et al. 2009, Brandt et al. 2012). However, shipping noise was modelled to have little impact on the population level of harbour porpoise in Danish waters (Nabe-Nielsen et al. 2014). Using a precautionary approach, it should be considered likely that dredging for the Galway Harbour Extension project may result in behavioural disturbance (e.g. temporal area avoidance) of bottlenose dolphins, common dolphins and harbour porpoises present in the area during these activities.

Minke whale
In minke whales, main hearing sensitivity is predicted to be between 30 Hz and 7.5 kHz, or between 100 Hz and 25 kHz, depending on location of the stimulus (Tubelli et al. 2012). Hence, they can hear well within the range of sound generated by dredging activities. As an added potential disturbance, minke whale vocalisations, typically low frequency sounds at 100-400 Hz (Mellinger et al. 2000), will be masked by dredging noise, which may hinder communication (Mellinger et al. 2000). A very strong response of an individual minke whale to playback of low-frequency sonar, at 1-2 kHz, suggested that this species can be heavily affected by anthropogenic noise (Kvadsheim et al. 2011). However, minke whales only occur infrequently in the Galway Bay cSAC (O'Brien 2009), and are unlikely to venture far into the bay. This makes the occurrence of behavioural disruption by the dredging activities unlikely.

2B. Pile driving
Since the construction of wind farms generally involves pile driving, a lot of documentation can be found on the effects of this sound source on marine mammals and fish alike (Carstensen et al. 2006, Bailey et al. 2010, Thompson et al. 2010, Brandt et al. 2012, Dähne et al. 2013, Kastelein et al. 2013). Because of its high intensity and pulse-like structure, pile driving noise is one of the most disturbing anthropogenic noises underwater to date. The intermittent temporal structure inhibits quick habituation (Neo et al. 2014), while the high intensity can cause TTS or and PTS (Southall et al. 2007).

Seals
For harbour seals, Thompson et al. (2013) simulated the construction of two piles in the Moray Firth, UK. Behavioural disturbance was modelled to start at 80 km from the sound source in open water. However, the amplitude of pile driving depends upon the diameter of the pile and the technique used to drive it into the ground. Since the piles used in the proposed project are smaller than average wind turbine piles, it is likely that the noise produced during the Galway Harbour Extension will be less. Furthermore, the shallow water depth in the Galway Bay cSAC, and the buffering effect caused by Mutton and Hare Island will result in a much smaller actual range of sound propagation, and hence disturbance. Impact levels have been predicted to be limited to the inner Galway Bay (EIS Appendix 10.3, Galway Harbour Company 2014). In addition, response of the harbour seal population could be affected by either habituation or sensitisation to the noise during actual construction activities (Götz & Janik 2010, Götz & Janik 2011). Pile driving can cause PTS and TTS when individual seals occur within 100 - 600 m from the sound source. The proposed mitigation measures will effectively mitigate against direct hearing injury, whereas behavioural disturbance remains likely for harbour seals (Table 1).

Harbour porpoise
The noise created by pile driving is sufficiently loud to be audible to harbour porpoises, and has been shown to deter this species for 9 to 70 hours within 20 km of a pile driving site in open waters (Tougaard et al. 2009, Brandt et al. 2012). Since generally more than one pile needs to be driven into the ground, depending on the time between two consecutive pile-

driving events, harbour porpoises can be deterred from an area during the entire period of development (Brandt et al. 2012). On the other hand, Kastelein et al. (2013), when exposing a single individual to pile-driving sounds in a large pool, found that behavioural responses were limited to the time of playback. Afterwards, the individual would soon return to its baseline behaviour. The lack of long-term responses in this study could be due to the fact that the animal was held in captivity and could therefore not show avoidance behaviour of a particular site. Another study by Scheidat et al. (2011) on the effect of a wind farm construction in the North Sea showed that harbour porpoise occurrence actually increased after construction of the farm. However, no observations were conducted during construction, so it is unclear whether the site was abandoned at that time. Overall, pile driving can be considered to trigger strong short-term (avoidance) responses, which may change behaviour for multiple hours after sound exposure. Driving of multiple piles could therefore result in a carry-over effect, and deter harbour porpoises for longer periods of time, resulting in temporal loss of habitat during the period of construction. Close proximity to the pile driving activities could result in injury (TTS or PTS), but this risk is likely reduced by the tendency of harbour porpoises to avoid the area with pile driving activities. Mitigation actions, including 30 min pre construction watches and soft-start protocols will effectively reduce the likelihood of direct impact on harbour porpoise, but behavioural changes remain likely to occur.

Bottlenose and common dolphin, and minke whale
The response of mid- and low-frequency cetaceans (cetaceans whose auditory range is within 150 Hz-160 kHz (mid) and 7 Hz – 22 kHz (low) (Southall et al. 2007), in this case, short-beaked common dolphins, bottlenose dolphins and minke whales, to pile-driving sounds has been modelled by Bailey et al. (2010) for the construction of an offshore wind farm in the Moray Firth, UK. In the Moray Firth, behavioural response to pile driving was modelled to occur up to 50 km from the construction site located in open water. Goold (1996) studied the distribution of common dolphins in response to seismic airgun surveys in offshore waters using passive acoustic monitoring. During the survey, individuals tended to stay at least 10 km away from the surveying site. The acoustic spectrum of airgun noise is different from pile-driving sounds, but the temporal structure is quite similar. However, response ranges will differ per area, based on background noise levels and the acoustic properties of the abiotic environment. The piles used in the present project are of a smaller diameter and will therefore require less force (i.e. noise) to be driven into the ground. Furthermore, as stated above, the shallow water and buffering effect of Mutton and Hare Island on the underwater sound propagation will result in much smaller response ranges as opposed to open water environments. Based on the propagation models, the behavioural response range for mid- and low-frequency cetaceans is estimated to stay within the inner Galway Bay (EIS Appendix 10.3, Galway Harbour Company 2014). For cetaceans, behavioural disturbance by pile driving at medium to large distance is likely to occur, whereas injury (TTS or PTS) is possible when individuals occur at close range (19 - 100 m) from the pile driving activities. Proposed mitigation actions, including 30 min pre construction watches and soft-start protocols will effectively reduce the likelihood of direct impacts, but behavioural changes remain likely to occur (Table 1).

2C. General construction in the marine environment
General marine construction noise will consist of underwater blasting and deposition of quarry material. Deposition of quarry material can be compared acoustically to dredging sounds, since it will consist of relatively short, continuous broadband noise. Therefore, the behavioural responses as described in section 2A concerning dredging can be also applied

here. Rock blasting will pose a heavier acoustic strain on the environment. Sound pressure levels for rock blasting during the Galway Harbour Extension are estimated to be 225 dB re 1 µPa at 1m.

Seals

The acoustic structure and sound levels of rock blasting are such that harbour seals will likely exhibit a startle response (Götz & Janik 2011). As repeated elicitation of the startle reflex can lead to sensitisation (Götz & Janik 2011), this would call for a minimisation of the number of blasts per day to avoid direct injury or deaths from seals in close proximity to the site. Blasting can cause TTS and PTS to seals within 50-160 m from the source (Table 1). Proposed mitigation actions will effectively reduce the likelihood of direct impacts, but behavioural changes remain likely to occur for animals present in the area (Table 1).

Bottlenose and common dolphin, harbour porpoise and minke whale

For all cetaceans, blasting sounds can invoke PTS or TTS, if animals venture too close to the site of explosion. Precise impact ranges can be calculated using the criteria set out by Southall et al. (2007), and will be in the range of 45-90 m for PTS and TTS, respectively (Table 1). Behavioural disturbance by blasting at medium to large distance is likely to occur. Proposed mitigation actions will effectively reduce the likelihood of direct impacts, but behavioural changes remain likely to occur for animals present in the area (Table 1).

2D. Shipping noise

As a relatively low-level, continuous sound source, shipping noise will not pose a physical threat to pinnipeds or any of the cetacean species concerned. Behavioural disturbance however, is possible, depending on the size and velocity of the vessels. In the case of the Galway Harbour Extension project, the size of vessels entering the harbour area will increase significantly post-construction. The new harbour will be able to hold 25.000 tonnes vessels, in contrast to the current 5.000 tonnes vessels (Galway Harbour Company 2014). At the same time, however, the number of vessels docking at the harbour will decrease from 180 to 107 vessels per year (medium scenario; Galway Harbour Company 2014), resulting in a reduction of disturbance events and possibly similar or less impact per ship if the larger ships are modern vessels carrying more silent engines.

Seals

Seal responses to shipping noise have received little study. In general, seals tend to dive when faced with disturbance, but in the case of underwater noise, a surfacing response might be expected (Harris et al. 2001). Sound pressure levels of low frequency sounds can decrease up to 7 dB closer to the water surface (Urik 1983, Green & Richardson 1988, Richardson et al. 1995). Australian fur seals respond to in-air motorboat noise above 75 dB re 20 µPa, by becoming more alert, or moving away (Tripovich et al. 2012). Conversely, Harris et al. (2001) showed that Arctic seals showed only localised avoidance responses to an approaching vessel doing seismic surveys, often remaining in areas with over 190 dB re 1 µPa noise levels. Of the Northwest coast of Co. Mayo, displacement of grey and harbour seals was correlated to increasing vessel abundance during the offshore construction of a pipeline in Broadhaven Bay, Ireland (Anderwald et al. 2013). Analysis of the vessel type showed that the negative correlation was more likely caused by increased levels of underwater noise, than by increased collision risk (Anderwald et al. 2013). A controlled behavioural response study was conducted to investigate the response of vessel approaches on harbour seal haul-out behaviour (Anderson et al. 2012). The study showed that harbour seals responded to approaching vessels at significant greater distances than to an approaching pedestrian. Seals were alerted by approaching vessels heading directly towards the animals at distances ranging from 560 to 850 m (Anderson et al. 2012). These patterns of response were consistent during pre-during and post breeding periods. Johnson and Acevedo-Gutierrez (2007) observed that harbour seals were less affected when powerboats and kayaks passed by, but did flee when powerboats were approaching within 400 m. This difference may relate to an approaching vessel possible blocking the direction of the seals escape route (Anderson et al. 2012). However, since these studies concern airborne noise, and vessels approaching seals directly, it is unlikely distances will be similar for underwater shipping noise. The current residency of harbour seals near the harbour suggests a level of tolerance to shipping noise. Higher short-term peak levels in vessel noise post-construction may elicit startle responses within seals, which could lead to area avoidance (Götz & Janik 2011). However, habituation to the noise may alter this response to some extent (Götz & Janik 2010).

Harbour porpoise
Very little conclusive information is available on the response of harbour porpoises to boat noise. The fact that harbour porpoises can currently be found in the Galway Bay cSAC suggests that current sound levels can be tolerated. On a population level, shipping noise has been modelled to have little impact for harbour porpoises (Nabe-Nielsen et al. 2014). On the other hand, studies by Amundin & Amundin (1973) and Polacheck & Thorpe (1990) show avoidance responses to shipping noise.

Bottlenose and common dolphins
Many studies, conducted across a wide range of areas and habitats have reported a broad range of behavioural changes in response to boat traffic, including population-level effects. Rako et al. (2013), for example, investigated the effect of leisure boat noise on a population of bottlenose dolphins in a Croatian archipelago, and found strong seasonal displacements of animals during periods of very high activity on the water. The results could not be explained by a change in prey abundance, and a strong correlation between vessel density and underwater noise suggests that both vessel presence and an increase in underwater noise could be the cause for the displacement. However, bottlenose dolphins did not adversely respond to increased shipping noise during construction activities in a nearby bay area, Broadhaven Bay, County Mayo (Anderwald et al. 2012). Leisure boat levels in the Galway Bay cSAC are lower than described in Rako et al. (2013), so the impact of boat traffic is expected to be lower. Furthermore, the number of ships entering the port yearly is estimated to decrease after the extension, which may help to reduce any impact.

Minke whale
In baleen whales, boat noise can cause changes in vocal behaviour (Miller et al. 2000). The acoustic properties of ship noise make it a masking sound for many baleen whale vocalisations, including those of minke whales. It may be that the future decrease in the number of ships entering the port will result in a decrease in masking time. Since the currently available information suggests that minke whales visit Galway Bay mainly during the summer months, and generally in very low numbers, masking of minke whale vocalisations during construction is deemed unlikely.

Behavioural effects of shipping noise have been shown for all species present in the Galway Bay cSAC, and short-term behavioural changes can be expected to occur for all species when present during and post construction (Table 1).

2E. Vessel collision

Both pinnipeds and cetaceans have been documented with mild to severe and lethal trauma after vessel collision (Moore et al. 2013). Distinctions can be made between blunt and sharp trauma, which are caused by rotating and non-rotating parts of the vessel, respectively (Moore et al. 2013). Different factors can affect the severity of the impact, such as vessel size and velocity, the angle at which collision takes place, and the anatomy of the body part that is hit (Laist et al. 2001, Vanderlaan & Taggart 2007, Moore et al. 2013). The likelihood of such collisions is thus far unclear, as frequency studies have only been conducted for species with very high incidences of collisions, such as right whales (Kraus et al. 2005).

Seals

Of the species here concerned, harbour seals will have the greatest likelihood of vessel-related injury (collision), since they are resident in the area and may be inquisitive towards vessels. In the UK, 27 stranded harbour seals with corkscrew motor injuries have been found since 2008 (SNCA 2012). Most observed lethal injuries were likely caused by seals being drawn through a ducted propeller such as a Kort nozzle or some types of Azimuth thrusters (Thompson et al. 2010). Since not all carcasses end up on the beach, actual number of deaths may be higher than currently reported. As a consequence, the effect on population levels cannot be estimated (SNCA 2012). However, it has been stated that the number of collisions generally does not pose a threat to a species on population level (Thompson et al. 2010, Weinrich et al. 2010). Possible mitigation measures include avoidance of the breeding season, and avoidance of certain engine types (SNCA 2014). Since no marine construction works will take place during the breeding season, the risk of vessel collision will be minimized during this vulnerable period. Given the absence of documentation of vessel collisions with harbour seals, and their general level of interaction with/presence in area with larger numbers of vessels, the likelihood of harbour seal trauma caused by vessel collision in the Galway Bay cSAC is expected to be limited, but increased during marine construction activities due to the increase in the number of vessels. However, the absence of documentation of vessel collisions with harbour seals may be due to the fact that these were not recorded and/or noticed. Grey seals rarely occur in the vicinity of the harbour and therefore the likelihood for this species to be injured by collision is considered small.

Harbour porpoise

The harbour porpoise is a frequently occurring species in the Galway Bay cSAC. It occurs in shallow coastal areas, where it hunts for prey using echolocation. The species is shy by nature, and generally will not venture closely to large vessels. Because of its habitat and prey choice, a harbour porpoise has a relatively high chance of coming into contact with humans. For example, the mortality caused by by-catch of harbour porpoises in commercial fishing gear is so large that population sustainability may suffer (Tregenza et al. 1997). However, documentation on trauma related to vessel collisions is scarce, and incidences seem lower than for by-catch. This could be explained by the shy nature of the species, or by inadequate documentation of collision-related injuries. It is believed that anthropogenic trauma from collision does not pose a major threat to small marine mammal species on the population level (Weinrich et al. 2010), which may be a reason for the lack of documentation. More documentation exists on vessel collision with large marine mammals such as whales (Laist et al. 2001, Weinrich et al. 2010; Silber et al. 2012), which is likely caused by the fact that such incidents are more easily noticed by the ship's crew.

Bottlenose and common dolphin
Documentation on bottlenose dolphin collision with vessels indicates that injuries may range from mild to severe (Moore et al. 2013). Incidences of collision are low, and will most likely occur during the presence of large numbers of vessels on the water. In the Sarasota Bay area, 4 cases of non-lethal strike injuries on bottlenose dolphins were reported in a time-span of 13 years (Wells et al. 1997). All were recorded immediately after a day with the highest vessel density of that particular year. Hence, the likelihood of bottlenose dolphin trauma caused by vessel collision in the Galway Bay cSAC will be limited, but increased during marine construction activities due to the increase in the number of vessels and their time spent actively operating in the area. Collisions between short-beaked common dolphins and vessels are scarcely documented, whereas they are often reported to bowride (actively associate with ship) without resulting injuries. It is possible that the lack of documentation is due to a low incidence of vessel-related trauma in common dolphins, however, it may also result from inadequate documentation. Since common dolphins may be attracted to boats, similar to bottlenose dolphins, the likelihood of collision could be similar to that of the bottlenose dolphin. Combined with the fact that common dolphin sightings in the Galway Bay cSAC are relatively rare, the risk of vessel collisions with common dolphins is expected to be limited.

Minke whale
Compared to other cetaceans, vessel related incidents with baleen whales have been recorded quite regularly. This is possibly due to the size of the animals, their behaviour, or simply due to the fact that a collision with a 20 m long animal is more easily noticed. Within the baleen whales, however, reports of collisions between ships and minke whales are relatively low in number. Since minke whales are also seen on only few occasions within the Galway Bay cSAC, the risk of vessel related injuries within the current project for this species is expected to be limited.

2E. Secondary impact due to localised disruption of normal ecological activity (e.g. via displacement or removal of prey species)

Seals
Secondary impacts of the Galway Harbour Extension on harbour seals, if any, are likely to be most prominent in the effect of marine construction noise on their prey. Several fish species can be affected by anthropogenic noise, and show distinctive responses based on the sound type. For example, Atlantic herring (*Clupea harrengus*) exhibits flight behaviour to engine noise, but not to low-frequency sonar (Doksæter et al. 2012). Strong pulsed sounds such as pile driving sounds can elicit behavioural responses in mackerel, causing them to change depth (Hawkins et al. 2014). If close, the blasts created by pile driving may be so intense that they cause physical trauma to the fish exposed (Halvorsen et al. 2012). The differences in behavioural response between sound type and fish species make it difficult to give an estimation of the likely effect on harbour seals, particularly given the general lack of information on prey species and foraging behaviour in Irish waters and in the Galway Harbour cSAC. As the harbour seal is an opportunistic predator and may readily shift prey species between seasons if prey abundance changes (Brown & Mate 1983, Tollit et al. 1998, Thomas et al. 2011), it is likely to be generally resilient to changes in prey behaviour, if only part of the fish species strongly respond. However, harbour seals also display a high site-fidelity to their foraging area (Härkönen & Harding 2001). It is currently unclear what the flexibility of the species is when confronted with a change in quality of foraging area. If prey species shift their distribution, or become less abundant on the longer term due to the

construction activities, this may impact the resident harbour seal population. This impact can result in a reduction in the overall energy budget of the population, resulting from lost or reduced foraging opportunities, and increased time and energy spent acquiring/searching for food in alternative, potentially less suitable, or more distant locations. Since grey seals only occasionally occur in the Galway Bay cSAC, secondary impact due to displacement or removal of prey species is unlikely to have an effect.

Harbour porpoise

Harbour porpoises are opportunistic predators and feed in both pelagic and demersal habitat (Santos & Pierce 2003). Known prey species comprise Atlantic herring, sandeel, sprat and members of the cod family (De Pierrepont et al. 2005). As mentioned before, Atlantic herring shows flight behaviour in response to engine noise. Likewise, avoidance reactions in cod were found during playback of trawler noise (Engås et al. 1995). Conversely, lesser sandeel distribution was not affected by the sound of seismic shooting (Hassel et al. 2004). Similar to the harbour seal, the impact of acoustic disturbance on harbour porpoise foraging success will therefore largely depend upon the relative abundance of different prey species, accessibility/proximity of alternative foraging locations, and preferred diet in the Galway Bay cSAC.

Bottlenose and common dolphin

Bottlenose dolphins in UK waters feed mostly on squid (*Loligo* sp.) and several cod species (De Pierrepont et al. 2005). Horse mackerel is also known as a prey species (De Pierrepont et al. 2005). Given the generally close proximity to shore of bottlenose dolphins in Irish waters, including in the Galway Bay cSAC (Oudejans et al. in press, O'Brien et al. 2009), this species likely forages mainly in inshore waters (< 5 km from shore). Fish species, most notably cod (*Gadus morhua*), can show anti-predatory responses to noise (Engås et al. 1995). Hence, the sound created by the proposed activities could disrupt the foraging efficiency of bottlenose dolphins in a similar way as described for the harbour seal. Squid can detect sound (Mooney et al. 2010), and were recently found to gain physical trauma from relatively low level (max. 175 dB re 1 µPa), low frequency sounds (André et al. 2011). Squid is generally distributed in deeper waters than found within the Galway Bay cSAC, and it is therefore unlikely that this species is affected within the proposed area. Short-beaked common dolphins are opportunistic feeders, and consume a variety of mackerel, sprat, squid, sardines, snipe fish, European hake, sand smelt, toothed goby and blue whiting (Pascoe 1986, Silva 1999). Most species are likely to occur in the Galway Bay cSAC (fishbase.org). The response to anthropogenic noise of most of those species remains unknown. However, as described above, both mackerel and squid can be affected. A goby species related to the toothed goby, however, which produces sound as a part of its sexual display, did not show a behavioural response after acoustic disturbance (Picciulin et al. 2010). As for the bottlenose dolphin, the severity of the secondary impact of the construction activities will therefore depend on the relative abundance of non-impacted prey. In addition, the general more offshore distribution of the common dolphin will make the species less dependant on near shore waters for foraging than bottlenose dolphins.

Minke whale

Minke whales, feeding predominantly on fish, are infrequent visitors of the Galway Bay cSAC during summer months. They are therefore unlikely to be affected at the population level by changes in fish behaviour due to acoustic disturbance.

Assessment 3.

Is it possible to estimate the number of individuals of each species that are likely to be affected?

Harbour seal

The harbour seal is a resident species in the Galway Bay cSAC. The harbour seal population in the inner Galway Bay area consisted of 221 individuals in 2012 (Duck & Morris 2013b). The species was regularly recorded present in the water at different locations in the bay during multiple surveys for the Galway Harbour Extension Project (Galway Harbour Project 2014). Depending on their flexibility to choose alternative, non-impacted sites for functional activities that occur in the water such as mating and foraging, individuals residing at or near the harbour might be affected. Individuals residing in haul-outs at or near the harbour will likely be impacted by increased noise levels during their time in the water (e.g. during travel to and from the haul-out).

Grey seal

In two consecutive monitoring periods, only 8 grey seals were recorded in the vicinity of Galway harbour (Duck & Morris 2013a,b). Since the monitoring study was not focussing specifically on grey seals, this can be an underestimation. However, considering this low density, it is unlikely that a substantial number of individuals will be affected by the procedures.

Bottlenose dolphin

The coastal population of bottlenose dolphins conduct long-distance movements along the Irish west coast (O'Brien et al. 2009, Oudejans et al. 2010), utilising multiple areas for foraging and other life functions, within a large home range. Bottlenose dolphins were considered a regularly occurring species in the Galway Bay cSAC. However, surveys across several years have shown a decreasing trend in occurrence. Whereas between 1994 and 1999 bottlenose dolphins were the most sighted species from Fanore, on the south end of the Galway Bay cSAC (Berrow et al. 1996), surveys conducted from 2006 found only between 4-11% of sighted species to be bottlenose dolphins (0.3 groups per survey; O'Brien 2009). A recent cetacean survey did not record any dolphin species inside in the proposed development area (Galway Harbour Company 2014). An acoustic survey using one C-POD located of the south coast of Mutton Island recorded dolphin vocalisations on 32% of 804 monitoring days (Galway Harbour Company 2014). These vocalisations likely consisted of bottlenose or common dolphins, and indicate a more regular presence of dolphins than indicated by visual observations. Currently no abundance estimate is available for the population of coastal bottlenose dolphins in Irish waters, hence it is not possible to determine the number of individuals potentially affected by the development.

Harbour porpoise
The density of harbour porpoises in the outer part of Galway Bay in 2008 was estimated at 0.73 individuals per km^2 (Berrow et al. 2008), at a surface area of 547 km^2. More recently, acoustic monitoring in the inner bay using CPOD acoustics showed harbour porpoise presence 84% of monitoring days within 1 nm from the proposed area (Galway Harbour Company 2014). A dedicated cetacean survey recorded one sighting of two harbour porpoise approximately 800 m south of the proposed development (Galway Harbour Company 2014). The number of individuals affected depends on their distribution in the bay, and flexibility to choose alternative, non-impacted sites for functional activities such as resting and foraging.

Short-beaked common dolphins
Short-beaked common dolphins occur infrequently in the vicinity of the proposed area of development or in the Galway Harbour Bay cSAC (O'Brien 2009). Due to the sporadic sightings of this species, the number of individuals affected is estimated to be small.

Minke whale
This species occurs sporadically, and likely seasonally, in the proposed area. Given the current available information, it is estimated that the potential number of individuals affected is small.

2. Assessment 4.

Will individuals be disturbed at a sensitive location or sensitive time during their life cycle?

Harbour seal
The mating season of harbour seals takes place in the water near the end of the breeding season (Coltman et al. 1997, see 3.5 *Mating Behaviour*). In the Galway Bay cSAC, this is in June-July. Nursing of pups takes place in the water, during the breeding season, in May-July (Leopold et al. 1992). Since marine construction activities will cease during that period, this part of their life cycle is unlikely to be disrupted. The mating season is followed by the annual moulting season, which takes place in August-September (NWPS 2011). Most of the harbour seal population will be hauled out on shore in this period. Harbour seals increase their time foraging in the water in the winter (see section 3.3 *Foraging behaviour*). During this period, individuals may be more susceptible to disturbance from ongoing construction activities within the proposed area.

Harbour porpoise
The calving period of harbour porpoises takes place from May till July (Van Utrecht 1978, Verwey & Wolff 1983, Evans et al. 1986, Evans 1990, Kinze, 1990). In the North Sea, relatively high calf densities in certain areas suggested the presence of preferred calving grounds (Sonntag et al. 1999). These high calf densities have not been found for the Galway Bay cSAC (Berrow et al. 2008), but high proportions further south along the Irish coast suggest harbour porpoises along the Irish coast also have preferred calving grounds (Leopold et al. 1992, Sonntag et al. 1999). Since the main calving period takes place in summer, this will not be directly affected by anthropogenic disturbances due to marine construction activities.

Bottlenose dolphin
Reproduction in bottlenose dolphins is only partly seasonal, with females being able to give birth throughout the year (Urian et al. 1996). Populations at the same latitude can have distinctly different breeding seasons, so breeding is not related to day length, as it is in many other species. However, breeding mostly took place within the period March-August (Urian et al. 1996). In Ireland, young calves and newborn bottlenose dolphins have been observed throughout the year (Oudejans, unpublished data), so the period of calving could possibly be affected by the proposed marine activities in the Galway Bay cSAC. Bottlenose dolphin calves remain dependant on their mothers for several years, and the majority of groups will be partly composed of dependant young animals throughout the year. Some records exist of cetacean mother-calf separations following severe disruption or disturbance, resulting from high intensity sounds sources (e.g. killer whales; Miller et al. 2012). These separations are considered highly stressful, and may be lethal for the calf. Hence, while these occurrences would be rare (also given the low number of animals recorded), the risk involved in these rare occurrences is very high. The same may apply for common dolphin and harbour porpoise. The proposed mitigation measures, including 30 min pre-construction monitoring and soft start procedures, will effectively mitigate against these possible effects.

Short-beaked common dolphin
Conception in short-beaked common dolphins is estimated to take place in July-August (Westgate et al. 2006). Gestation takes about a year, so giving birth occurs in the same period. It is unclear whether common dolphins give birth in special calving grounds. It is assumed therefore, that dolphins that are present in the Galway Bay cSAC during that July-August, may also mate and give birth there. These activities therefore can potentially be interrupted by construction activities. However, occurrences of common dolphins in the Galway Bay cSAC have been rare. Hence, for groups present in the bay during the breeding period, breeding activities could potentially be affected. However, given the limited number of common dolphin sightings in the Galway Bay cSAC, and near the area proposed for construction, this is unlikely to occur and the number of animals potentially affected is estimated to be low.

Minke whale
Minke whale breeding grounds are currently unknown, but are believed to lie in waters of the North Atlantic Ocean near the equator (Víkingsson & Heide-Jørgensen 2005). It is unclear when the minke whale breeding season takes place, but since this is not likely to occur near the Galway Bay cSAC, minke whale breeding activities are unlikely to be affected by the construction activities.

Assessment 5.

Are the impacts likely to focus on a particular section of the species' population, e.g., adults vs. juveniles, males vs. females?

Seals
Harbour seals show large intraspecific differences in foraging behaviour (see 3.3 *Foraging Behaviour*). Differences related to size and sex have been recorded in the Moray Firth, Scotland (Thompson et al. 1998). Males and large individuals venture out further to search for food than females. In other locations, however, juveniles were found to conduct larger movements than adults (Lowry et al. 2001). As one of the resting sites of harbour seals is

located in the vicinity of Galway Harbour, this means that females, and most notably pupping and nursing females, are more likely to be affected by the proposed activities than males. Since very low numbers of grey seals are sighted in the proposed area, disturbance due to the construction activities is unlikely to impact a specific section of the population.

Harbour porpoise
Limited information is currently available on the harbour porpoise population structure. Harbour porpoises in the Galway Bay live in groups of two individuals, on average (Berrow et al. 2008). Of the population about 7% of individuals consists of juveniles, which is similar to the ratio found in other coastal waters of Ireland. Differences between males and females and juveniles in habitat-use have so far not been investigated.

Bottlenose dolphins
The social structure of bottlenose dolphins is a fission fusion society (Connor et al. 2000). This entails that group formations may change on a day-to-day basis, and group composition frequently changes. Aggregations and groups of animals are generally composed of mixed age- and sex-classes. Therefore, outside of the generally larger sensitivity of mother-calf pairs, it does not appear that any particular section of the species' population might be more affected than others.

Short-beaked common dolphin
Short-beaked common dolphins live in large aggregations of mixed sex- and age-classes. Therefore, outside of the generally larger sensitivity of mother-calf pairs, it does not appear that any particular section of the species' population might be more affected than others.

Minke whale
There is insufficient information available to consider different impacts on a particular section of the population of minke whales visiting the Galway Bay cSAC.

Assessment 6.

Will the plan or project cause displacement from key functional areas, e.g., for breeding, foraging, resting or migration?

Harbour seal
Harbour seals forage mainly within coastal waters and are a resident species of the Galway Bay cSAC. As a non-migratory species, they may have specific preferred areas for foraging. The quality of a foraging site is based on distance to the haul-out site, prey abundance and bathymetry. Individuals are known to generally forage within 50 km of their haul-out site, staying in the same area for over a decade (Bjørge et al. 1995, Härkönen & Harding 2001). Preferential foraging areas are generally within 20 km from the haul-out site (Tollit et al. 1998, Härkönen & Harding 2001, Grigg et al. 2009). Furthermore, harbour seals will choose areas with a long-term stable high prey abundance (Grigg et al. 2009). The high site-fidelity for both foraging and resting classifies harbour seals as central-place foragers (Orians & Pearson 1979, Thompson et al. 1998, Grigg et al. 2009).

If situated in the area of construction activities, harbour seals might not be able to use their preferred foraging location during these works. However, no preferred foraging areas have been identified from land-based surveys within the proposed area (Galway Harbour Company 2014). Furthermore, changes in prey distribution due to the acoustic disturbance could cause a deterioration of the quality of the patch. The effects of any impacts on foraging sites will depend on the availability of other suitable foraging areas in the area, and the increased time and energy spent acquiring/searching for food in alternative, potentially less suitable, or more distant locations. Harbour seals are known to be a flexible species, as can be concluded from their opportunistic prey selection and seasonal change of prey choice (Brown & Mate 1983, Tollit et al. 1998). Given the presence of alternative foraging opportunities, these characteristics make the species generally resilient to changes in the environment relating to food abundance.

Grey seal
Grey seals occur infrequently in the area (O'Brien 2009). Grey seals generally conduct large offshore movements and individuals tagged on the Blasket Islands, Co. Kerry, did not utilize the inner Galway Bay, despite individuals travelling multiple times up and down the west coast passing Galway Bay (Jessops et al. 2013). Hence, it is therefore unlikely the developed area comprises important habitat for the species.

Harbour porpoise
Harbour porpoises are currently the most frequently recorded cetacean species in the Galway Bay cSAC (O'Brien 2009). Given the general lack of knowledge on the fine-scale habitat use including foraging and mating/breeding areas, currently insufficient information exists to conclude whether construction activities would result in displacement from key functional areas.

Bottlenose dolphin
The population of bottlenose dolphins that frequents the Galway Bay cSAC is likely to be part of a coastal population that travels along the entire west coast of Ireland. It is possible that the Galway Bay cSAC is used as a part of their coastal habitat (Oudejans et al. in review). If the area is used as a migratory corridor, increased noise levels might cause the population to venture further offshore.

Short-beaked common dolphin
Short-beaked common dolphins occur occasionally in the area (O'Brien 2009). Generally, insufficient scientific information exists to conclude whether construction activities would result in displacement from a key functional area for this species. In Ireland, the common dolphin is mainly distributed in offshore waters and waters covering the coastal shelf (Wall et al. 2013). As such, the shallow waters of the proposed site likely do not comprise important habitat for this species.

Minke whale
Minke whales occur infrequently in the area (O'Brien 2009). Given the low number of sightings, it can be assumed the area does not comprise of important habitat for this species.

Assessment 7.

How quickly is the affected population likely to recover once the plan or project has ceased?

Seals

The marine development work will be interrupted for several months (April-July) every year, which will give all species time to recover from the disturbances. The recovery period will be most important for harbour seals, since they reside in the area permanently, which increases their levels of disturbance and decreases possibility for recovery during development. Stress levels may be elevated for some time after cessation of activities, but will likely have returned to normal at the start of the breeding season in June (Tougaard et al. 2009). Habituation in seals occurs quickly when exposed to non-startling, long-duration sounds (Götz and Janik 2010), such as shipping and dredging noise. Sounds with a short rise-time can elicit startle-reflexes, to which seals will sensitize if exposed multiple times in a row (Götz and Janik 2011). These sounds, i.e. blasting and pile-driving, have the potential of causing long-term behavioural effects, impact individual fitness and decrease longevity (Götz and Janik 2011). Therefore, the within-project recovery of seals will depend upon the presence of pile-driving or blasting activities during the winter construction periods. A study investigating harbour seal movements after completion of two wind farms in the Danish Wadden Sea, indicated no significant long-term effect of the operational wind farms on seal behaviour (McConnell et al. 2013). Short-term displacement effects were reported during the construction and operation of a wind farm in the Wadden Sea, Denmark (Edren et al. 2010). Here, no long-term effects were found, and harbour seals continued to use the area, and population increased in accordance with an increase observed in other areas (Edren et al. 2010). In contrast, longer-term displacement of seals was recorded in Broadhaven Bay, Ireland during an offshore construction of a pipeline (Anderwald et al. 2013). Current post-construction monitoring will enable to determine long-term effects and identify if seals return to pre-construction levels. After completion of the project, the population might return to pre-construction distribution ranges within a few months (Tougaard et al. 2009). Based on the currently available information, with grey seals only sighted occasionally in the Galway Bay cSAC, the proposed activities are not expected to cause an impact at population-level.

Harbour porpoise

Knowledge of harbour porpoise population structure and disturbance effects on population level are currently limited. Short term responses have been reported during the construction of a windfarm, where harbour porpoise activity was reduced between 24 and 70 h after pile driving activities (Brandt et al. 2012). Studies of long-term responses of harbour porpoises to acoustic disturbance have shown conflicting results. Teilmann and Carstensen (2012) studied the effects of the construction of an offshore wind farm in the Baltic, and found that ten years after construction population numbers were still not up to their previous level. On the other hand, Scheidat et al. (2011) found that harbour porpoise presence in the Dutch North Sea actually increased during and after the construction of the wind farm. This phenomenon was explained by the fact that previously the site was on a busy travel pathway for commercial shipping, which was rerouted for the windfarm. Furthermore, the two areas probably differed in significance for the respective populations, which would influence the necessity of return: In the Baltic, harbour porpoise presence had been infrequent already before construction, suggesting the area was relatively unimportant for the population. Galway Bay is currently an urbanised but relatively undisturbed marine area, and harbour porpoise sightings are common. The probability and speed of recovery after the construction period will therefore depend on the relationship between the relative importance of the area for harbour porpoises and area quality post-construction.

Bottlenose and common dolphin, and minke whale

The relatively small number of sightings of bottlenose dolphins, common dolphins and minke whales in the Galway Bay cSAC suggest that impacts on animals of these species frequenting the bay will not lead to population-level effects (Table 1). However, in general, information on population sizes, habitat-use and behaviour in Irish waters is limited, and conclusive evidence for the likelihood of population-level effects resulting from the project is currently unavailable.

Table 1. ***Summary of the likelihood of physical hearing and behavioural effects on individual marine mammals exposed to noise from five types of marine construction activities for the Galway Harbour Extension Project: 1a) Dredging Backhoe; 1b) Dredging TSHD; 1c) Pile driving; 1d) Blasting and 1e) Shipping noise in the absence (no mitigation) and presence (mitigation) of proposed mitigation measures.*** *Physical hearing effects include Permanent Threshold Shift (PTS) and Temporal Threshold Shift (TTS). Species' specific threshold levels for effects (SPL(peak)/SEL threshold) are published data from Southall et al. (2007). The impact zone (m) from source states the maximum distance or estimated range category from the source at which either SEL or SPL threshold levels are exceeded. Impact zones were calculated using received sound levels quantified in Appendix 10.2 of the EIS (Galway Harbour Company 2014), using a precautionary approach. For all sound types other than single pulses, threshold levels for behavioural effects (*) are not included, but are assumed to occur more commonly at levels below PTS/TTS threshold levels (Southall et al. 2007), and are defined as Medium (0 - 2500 m), and Large (>2500 m; Appendix 10.2 Galway Harbour Company 2014). Definitions: Likely: The likelihood of occurrence of the impact is high; Unlikely: The likelihood of occurrence of the impact is low; Possible: The impact is likely if animals are present in the area (for occasional- infrequently recorded species). Abbreviations: Trail Suction Hopper Dredgers (TSHD), Sound Pressure Level (SPL), Sound Exposure Level (SEL), Does not occur (d.n.o.). Not available (N/A), Behaviour (Beh.).*

1a) BACKHOE DREDGING					
Species	Acoustic impact	SPL(peak)/SEL threshold	Impact zone (m)	Impact (no mitigation)	Impact (mitigation)
Harbour seal	PTS	218/203	8	Likely	Unlikely
	TTS	212/183	80	Likely	Unlikely
	Beh. effect	*	Large	Likely	Likely
Grey seal	PTS	218/203	8	Possible	Unlikely
	TTS	212/183	80	Possible	Unlikely
	Beh. Change	*	Large	Possible	Possible
Bottlenose dolphin	PTS	230/215	2	Unlikely	Unlikely
	TTS	224/195	15	Unlikely	Unlikely
	Beh. effect	*	Large	Likely	Likely
Common dolphin	PTS	230/215	2	Unlikely	Unlikely
	TTS	224/195	15	Unlikely	Unlikely
	Beh. effect	*	Large	Likely	Likely
Harbour porpoise	PTS	230/215	1	Unlikely	Unlikely
	TTS	224/195	15	Likely	Unlikely
	Beh. effect	*	Large	Likely	Likely
Minke whale	PTS	230/215	N/A	Unlikely	Unlikely
	TTS	224/195	N/A	Unlikely	Unlikely
	Beh. effect	*	N/A	Unlikely	Unlikely

1b) TSHD DREDGING					
Species	Acoustic impact	SPL(peak)/SEL threshold	Impact zone (m)	Impact (no mitigation)	Impact (mitigation)
Harbour seal	PTS	218/203	10	Likely	Unlikely
	TTS	212/183	100	Likely	Unlikely
	Beh. effect	100	Large	Likely	Likely
Grey seal	PTS	218/203	10	Possible	Unlikely
	TTS	212/183	100	Possible	Unlikely
	Beh. effect	*	Large	Possible	Possible
Bottlenose dolphin	PTS	230/215	2	Unlikely	Unlikely
	TTS	224/195	20	Unlikely	Unlikely
	Beh. effect	*	Large	Likely	Likely
Common dolphin	PTS	230/215	2	Unlikely	Unlikely
	TTS	224/195	20	Unlikely	Unlikely
	Beh. effect	*	Large	Likely	Likely
Harbour porpoise	PTS	230/215	9	Unlikely	Unlikely
	TTS	224/195	90	Likely	Unlikely
	Beh. effect	*	Large	Likely	Likely
Minke whale	PTS	230/215	N/A	Unlikely	Unlikely
	TTS	224/195	N/A	Unlikely	Unlikely
	Beh. effect	*	N/A	Unlikely	Unlikely

1c) PILE DRIVING					
Species	Acoustic impact	SPL(peak)/SEL threshold	Impact zone (m)	Impact (no mitigation)	Impact (mitigation)
Harbour seal	PTS	218/186	100	Likely	Unlikely
	TTS	212/171	600	Likely	Unlikely
	Beh. effect	212/171	Large	Likely	Likely
Grey seal	PTS	218/186	100	Possible	Unlikely
	TTS	212/171	600	Possible	Unlikely
	Beh. effect	212/171	Large	Likely	Likely
Bottlenose dolphin	PTS	230/198	17	Possible	Unlikely
	TTS	224/183	100	Possible	Unlikely
	Beh. effect	224/183	Large	Likely	Likely
Common dolphin	PTS	230/198	17	Possible	Unlikely
	TTS	224/183	100	Possible	Unlikely
	Beh. effect	224/183	Large	Likely	Likely
Harbour porpoise	PTS	230/198	16	Likely	Unlikely
	TTS	224/183	90	Likely	Unlikely
	Beh. effect	224/183	Large	Likely	Likely
Minke whale	PTS	230/198	N/A	Unlikely	Unlikely
	TTS	224/183	N/A	Unlikely	Unlikely
	Beh. effect	224/183	N/A	Unlikely	Unlikely

1d) BLASTING					
Species	Acoustic impact	SPL(peak)/SEL threshold	Impact zone (m)	Impact (no mitigation)	Impact (mitigation)
Harbour seal	PTS	218/186	50	Likely	Unlikely
	TTS	212/171	160	Likely	Unlikely
	Beh. effect	212/171	Large	Likely	Likely
Grey seal	PTS	218/186	50	Possible	Unlikely
	TTS	212/171	160	Possible	Unlikely
	Beh. effect	212/171	Large	Likely	Likely
Bottlenose dolphin	PTS	230/198	45	Possible	Unlikely
	TTS	224/183	90	Possible	Unlikely
	Beh. effect	224/183	Large	Likely	Likely
Common dolphin	PTS	230/198	45	Possible	Unlikely
	TTS	224/183	90	Possible	Unlikely
	Beh. effect	224/183	Large	Likely	Likely
Harbour porpoise	PTS	230/198	45	Likely	Unlikely
	TTS	224/183	90	Likely	Unlikely
	Beh. effect	224/183	Large	Likely	Likely
Minke whale	PTS	230/198	N/A	Unlikely	Unlikely
	TTS	224/183	N/A	Unlikely	Unlikely
	Beh. effect	224/183	N/A	Unlikely	Unlikely

1e) SHIPPING NOISE				
Species	Acoustic impact	SPL(peak)/SEL threshold	Impact zone (m)	Impact (no mitigation)
Harbour seal	PTS	218/203	d.n.o.	Unlikely
	TTS	212/183	3	Possible
	Beh. effect	*	Large	Likely
Grey seal	PTS	218/203	d.n.o.	Unlikely
	TTS	212/183	3	Possible
	Beh. effect	*	Large	Possible
Bottlenose dolphin	PTS	230/215	d.n.o.	Unlikely
	TTS	224/195	d.n.o.	Unlikely
	Beh. effect	*	Medium	Possible
Common dolphin	PTS	230/215	d.n.o.	Unlikely
	TTS	224/195	d.n.o.	Unlikely
	Beh. effect	*	Medium	Possible
Harbour porpoise	PTS	230/215	d.n.o.	Unlikely
	TTS	224/195	d.n.o.	Unlikely
	Beh. effect	*	Large	Likely
Minke whale	PTS	230/215	N/A	Unlikely
	TTS	224/195	N/A	Unlikely
	Beh. effect	*	N/A	Unlikely

2.3 Mitigation

Mitigation measures as proposed in the EIS (Galway Harbour Company 2014) are likely to minimise strong and direct effects of the construction activities, thereby also mitigating population-level effects resulting from those effects. Harbour seals, grey seals, bottlenose dolphins, short-beaked common dolphins, harbour porpoises and minke whales have all been observed in the area of the proposed activities. Due to differences in abundance, behaviour and life-strategy, some species are more likely to be affected by the construction activities than others. In light of the possible impacts of the proposed activities, qualified marine mammal observers should conduct visual observations before and during developmental work in the water, and all activities will be put to a halt or postponed if the situation so requires. Mitigation measures should be performed as described in detail in “The Guidance to Manage the Risk to Marine Mammals from Man-made Sound Sources in Irish Waters” by the Department of Arts, Heritage and Gaeltacht (DAHG 2014). All construction activities (see 4.3.1. NPWS 2014), that may impose an impact on marine mammals should adhere to these technical guidelines. A brief summary of the main topics of the guidelines are provided below:

- One or more qualified marine mammal observer(s) (MMO) conduct monitoring in the "monitored zone" or exclusion zone for a minimum of 30 min (pre-start monitoring) before the start of construction activity (pile driving, dredging, drilling and blasting), and when construction activities cease for more than 30 min.
- Construction activities shall start only after confirmation given by the MMO, and will not commence if marine mammals are detected within a 500 - 1,000 m radial distance of the sound source, depending on activity type (see DAHG 2014).
- Ramp-up (soft start) mitigation procedures should be implemented for all pile driving and geophysical surveys undertaken, and only commence after confirmation given by the MMO.
- Marine mammal observers will provide daily reports including the monitoring and construction operations, mitigation measures undertaken, and description of any observed reaction by marine mammals, using the standard operation forms for Coastal/Marine works.
- Daily reports are to be submitted to the relevant regulatory authority within 30 days after completion of the operations.

Next to direct monitoring during the construction activities, we recommend that dedicated research is undertaken in the Galway Bay cSAC, with a focus on the area affected by the construction activities, investigating:

1) Distribution and abundance of all marine mammals species prior, during and post-construction, including mark-recapture studies and ongoing acoustic monitoring.
2) Behavioural patterns and aquatic habitat-use of all marine mammals species prior, during and post-construction, including on-animal data loggers.
3) Prey species presence and abundance prior, during and post-construction.
4) Marine mammal responses to construction activities.

2.4 Summary

Two pinniped and four cetacean species occur in Galway Bay cSAC and the greater Galway Bay. Based on current available information, the harbour seal is resident in the area, harbour porpoises are frequently sighted, bottlenose dolphins and common dolphins are infrequently sighted but regularly recorded acoustically, and minke whales and grey seals are infrequently present.

Given the scale of the development and associated loss of marine habitat resulting from the project, significant impacts on marine life in the cSAC area cannot be ruled out. These activities have the potential of disturbing the marine mammals in the area, both physically and behaviourally. Dredging, pile driving, blasting, general construction in the marine environment and shipping will likely cause acoustic disturbance, while physical presence of vessels may increase the risk to collision. Acoustic disturbance in close proximity to the animals can cause temporary or permanent hearing threshold shifts and may lead to behavioural changes at larger distances. However, the proposed mitigation actions are likely to effectively reduce and minimise the risk of direct physical (hearing) injuries (PTS, TTS) and behavioural changes caused by underwater noise or collisions. Secondary impacts, by changes in prey abundance and distribution, may also occur.

In general, the current knowledge of fine-scale habitat use in Irish waters is insufficient to determine if marine mammals will be deterred from key functional areas, and to what extent essential parts of their life cycle might be affected. Of the marine mammal species present in the Galway Bay cSAC, harbour seals and harbour porpoises have the highest probability to be affected by the construction works, due to their residency/frequent occurrence in the Galway Bay cSAC, and, in case of the harbour seal, use of the area for essential life functions (foraging, nursing, breeding, mating, resting and moulting). Of these essential life functions, the terrestrial activities (terrestrial resting, breeding and moulting, not assessed here), are not directly affected by the marine construction works. These activities constitute of three of the five conservation objectives for harbour seals in the Galway Bay cSAC (NPWS 2013). The remaining two conservation objectives (access to suitable habitat and disturbance) will potentially be affected due to either direct or indirect effects of the construction activities. Marine mammals either are unlikely to be affected at a population level (grey seal, minke whale, common dolphin, bottlenose dolphin), or are likely to recover from any impacts of the construction activities (harbour seal, harbour porpoise). Here, the probability and speed of recovery will depend on the relative importance of the area for the species, behavioural characteristics and area quality post-construction. Proposed mitigation measures are likely to minimise strong and direct effects in close proximity to the construction activities for all marine mammals.

3. Aquatic habitat use of the harbour seal (*Phoca vitulina*)

3.1 Introduction

Harbour seals are one of the most widespread pinniped species, distributed from temperate to polar regions throughout the coastal waters of the Northern Hemisphere (Thompson & Härkönen 2008). In Ireland, the harbour seal inhabits bays, rivers, estuaries and intertidal areas, primarily along the western Atlantic coast (Cronin et al. 2004, Ó Cadhla et al. 2007, Duck & Morris 2013a, b). Adult males are up to 1.9 m long and weigh 70-150 kg. Females reach 1.7 m in length and 60-110 kg in weight. At birth, pups are 65-100 cm long and weigh 8-12 kg (Burns 2002).

Harbour seals require both terrestrial and marine habitat. The terrestrial habitat use includes periods of resting, breeding/nursing and moulting behaviour, while access to sea is required for obtaining food and for nursing and mating. The terrestrial localities, generally referred to as haul-out sites, are often used by the same individuals over consecutive years (Thompson et al. 1998, Cronin et al. 2009). However, shifts in preferred haul-out sites have been known to occur within an SAC (Cordes et al. 2011).

The high site-fidelity for both foraging and resting behaviours classifies harbour seals as central-place foragers (Orians & Pearson 1979) and offers the opportunity for the identification of key habitat and the development of Special Areas of Conservation for this species (Thompson et al. 1997, Cunningham et al. 2008). The dependence on terrestrial habitat for resting, moulting and rearing pups has provided opportunities to conduct large-scale population assessments, identifying population growth and decline in different regions worldwide (Lonergan et al. 2007).

In Ireland, national harbour seal censuses were conducted in 2003 (Cronin et al. 2004) and in 2011-2012 (Duck & Morris 2013a, b). These recorded an 18% increase in the overall number of harbour seals between 2003 and 2012, from a total of 2955 to 3489 individuals (Cronin et al. 2004, Duck & Morris 2013b). These estimates could not be corrected for the proportion of animals at sea at the time of the survey and hence likely underestimate the total number of individuals (e.g. due to age- and sex related differences in haul-out behaviour; Thompson et al. 1989, Härkönen et al. 1999).

Harbour seal in the Galway Bay cSAC
The harbour seal is a resident species of the Galway Bay cSAC and the species has been incorporated in the conservations objective target statement of the SAC (NPWS 2013). The inner Galway Bay is home to a significant population of harbour seals within Irish coastal waters (Duck & Morris 2013a, b). The area includes a number of haul-out, breeding and moulting sites for the species (NPWS 2013). Between 2003 and 2011, the number of harbour seals in the inner Galway Bay increased from 200 to 248 individuals (Duck & Morris 2013a, b). On a larger regional scale, harbour seals increased from 467 individuals in 2003, to 886 in 2011/12 in County Galway, an increase of 75% (Duck & Morris 2013b). Opposed to the terrestrial habitat use, relatively little is known about the aquatic habitat use of harbour seals in the Galway Bay cSAC.

During fish predation surveys 50 harbour seals were recorded foraging on sprat (Galway Harbour Company 2014). In addition, available water depth, habitat type, prey presence and proximity to haul-out sites suggest the Galway Bay cSAC likely functions as a foraging area for harbour seals.

3.2 Diving behaviour

The diving and foraging behaviour of harbour seals have been studied using a variety of electronic recorders, including time-depth (TDR) and satellite dive recorders. By combining dive profiles, stomach temperature, telemetry and swim speed recordings, these studies have allowed the allocation of function to different dive types (e.g. Lesage et al. 1999). No studies using TDR or other recorders of diving behaviour have been conducted with harbour seals in the Galway Bay cSAC. Hence, no specific or detailed data is available on the diving behaviour of the harbour seal in the area.

Dive types
Harbour seal dives typically fall into one of two broad categories: deep foraging dives referred to as "square" or "U-shaped" dives, and "V-shaped" dives, which are often more shallow (Schreer et al. 2001). The remaining dives are a variation of these two shapes. The U-shaped dive is the most common dive type exhibited by the harbour seal (Baechler et al. 2001, Eguchi et al. 2005, Wilson et al. 2014).

U-shaped or square-shaped dives are typically considered foraging dives based on the increased proportion of time spent at depth (Wilson et al. 2014). These dives are often longer in duration and have a greater mean depth than V-shaped dives (Lesage et al 1999, Schreer et al. 2001, Eguchi et al. 2005). However, male harbour seals conducted U-shaped dives while travelling within their home range (Baechler et al. 2001) and as part of mating behaviour (Hanggi & Schusterman 1994), indicating this dive type is not solely linked to foraging. V-shaped dives consist of more shallow dives, which are generally shorter in duration than U shaped dives, and are associated with travelling, predator avoidance and exploration behaviour (Lesage et al. 1999, Schreer et al. 2001). The reduction in drag during V-shaped dives enables more efficient travelling, while potentially increasing the chances to encounter prey (Williams & Kooyman 1985). Harbour seals in St Lawrence conducted both U- and V-shaped dives during foraging behaviour, which may suggest that dive types represent different foraging strategies (Lesage et al. 1999). Wiggles in the dive profile have been observed in both U- and V-shaped dives and likely refer to patchy prey distribution (Wilson et al. 2014). Harbour seals typically conduct consecutive foraging dives within a dive bout, with only a small percentage of foraging dives conducted outside of these bouts (Wilson et al. 2014).

The proportion of U- and V-shaped dives changes with age, season and age-class. Adult males conduct more U-shaped dives than females (Baechler et al. 2001). The proportion of U-shaped by male harbour seals declined from 63 to 45% between premating and mating periods, indicating a behavioural change and alteration of aquatic habitat use in this period (Baechler et al. 2001). Subsequently, the proportion of V-shaped dives significantly increased during the mating season. Adult females altered their diving behaviour during periods of lactation: U-shaped dives increased significantly from early to late lactation, whereas the number of V-shaped dives decreased (Baechler et al. 2001). During the breeding season, both male and female harbour seals shifted towards more V-shaped dives (Wilson et al.

2014). Suckling pups showed an increase in U-shaped dives, and subsequent decline in V-shape dives between the early and late lactation period (Baechler et al. 2001). Weaned pups showed an increase of U-shaped dives over the first month post weaning, while the proportion of V-shaped dives significantly decreased (Baechler et al. 2001).

Diurnal patterns

Several studies reported diurnal dive patterns of harbour seals. In St Lawrence, harbour seals conducted U-shape dives with an average depth of 20 m during daylight whereas dives occurred in shallower waters (~8 m) at twilight and during the night (Lesage et al. 1999). A greater percentage of V-shaped dives was exhibited at night during the breeding season in San Juan Islands, along the US Pacific coast (Wilson et al. 2014). Harbour seals in Prince William Sound spent more time in-water and diving at night between September and April (80%) compared to 50% in July (Frost et al. 2001). Similar night time diving behaviour was reported for individuals in the Moray Firth, which was thought to reflect the diurnal behaviour of vertically migrating prey, which becomes more accessible at night (Thompson et al. 1989).

Time-in-water

Harbour seals generally haul out on sandbanks and rocky shorelines that become available during low tide (Schneider & Payne 1983, Pauli & Terhune 1987, Cronin et al. 2009). Some populations also use high tide haul-out sites (London et al. 2012). In general, seals spend most of their time in the water: 61%-93% in Moray Firth, Scotland (Thompson et al. 1998), 76%-93% in the Dutch Wadden Sea (Ries et al. 1997) and 68%-75% in Monterey Bay, US (Frost et al. 2001). Males and females spend a similar percentage of time in the water (Thompson et al. 1998). In the water, harbour seals spend most of their time foraging (e.g. 76% of the time in Moray Firth; Thompson et al. 1998). Multi day foraging trips are common, and appear to be conducted by both male, female and juvenile seals (Thompson et al. 1998, Lowry et al. 2001, Sharples et al. 2012, Wilson et al. 2014).

Time-in-water shows fluctuations on both daily and seasonal scales. In Ireland, harbour seals spent the most time at sea during the winter months and remained the most time ashore post-moulting in October (Cronin et al. 2009). This pattern is consistently reported in other studies (Frost et al. 2001). Terrestrial habitat use increases during the breeding and moulting season when harbour seals spend approximately 60% of their time on the haul-out site and 40% in the water (Yochem et al. 1987, Thompson et al. 1989). Frost et al. (2010) suggested that prey may become more abundant in near shore waters in summer, resulting in seals spending less time in the water. Subsequently, a deeper mean dive depth was recorded during winter months compared to summer months, which suggests that prey becomes less accessible in shallow waters during this period (Frost et al. 2001). Harbour seals in Prince William Sound spent the least time in the water diving in the morning (0300- 0900), which increased throughout the day and was highest at night (2100-0300; Frost et al. 2001).

Diving depth

Harbour seals prefer water depths ranging from 4 to 100 m depth (Bjørge et al. 1995, Lesage et al. 1999, Lesage et al 1999, Frost et al. 2001, Bailey et al. 2014). For example harbour seals in Prince William Sound have nearby access to waters >200 m deep, while the majority of their foraging dives are confined to waters 20-100m deep (Frost et al. 2001). The at-sea distribution of harbour seals in the Moray Firth was related to water depth and seabed slope (Bailey et al. 2014). Here, harbour seals showed a preference for foraging in water depth between 10 and 50 m, and tended not to use waters less than 10 m deep (Tollit et al. 1998).

In contrast, in the St. Lawrence estuary in eastern Canada, fifty-four percent of the total dives of harbour seals were found to be in water less than 4 m deep (Lesage et al. 1999).

Diving and foraging strategies of harbour seals are tailored to their local habitat and hence differ within a heterogeneous marine landscape. Regional patterns in dive depth were identified as part of a large-scale study of harbour seal behaviour around Britain. Based on a large dataset including data from all main harbour seal haul-out sites, Sharples and colleagues (2012) found large regional variation in dive patterns coinciding with habitat type and available water depth surrounding the haul-out sites. Typically, individuals inhabiting the more shallow waters along the British east coast conducted longer distance foraging trips than seals inhabiting the deeper waters north and west coast of Scotland (Sharples et al. 2012). In addition, regional patterns showed a relation between maximum depth during foraging and accessible habitat (Sharples et al. 2012).

3.3 Foraging behaviour

Sensory detection of prey

Harbour seals use their whiskers to detect water movement and accurately follow hydrodynamic trails generated by fish, which enables long distance prey location (Dehnhardt et al. 1998, 2001). Seals maximally reduce the whiskers' basic noise by means of undulating the surface structure of the hair. This optimizes its signal to noise ratio and enhances its sensory performance (Miersch et al. 2011). In theory, a hydrodynamic trail of a fish (e.g. herring), might be detectable for a seal up to 180 m away (Dehnhard et al. 2001). Using its extraordinarily well-developed vibrissae, seals are capable of foraging at night and in murky waters, besides using vision to search and catch prey during daytime. As all other pinnipeds (and cetaceans), the harbour seal is considered to be functionally colour blind (Peich et al. 2001). The sensitivity of the eyes however, is high, and seals are probably able to orient visually even at great depth (Levenson & Schusterman 1999).

Diet

Harbour seals are opportunistic and catholic feeders (Harkonen 1987, Pierce & Santos 2003, Andersen et al. 2004, Kavanagh et al. 2010). Within the northeast Atlantic, they feed mainly on teleost fish species (Kavanagh et al. 2010). In the Moray Firth, harbour seals mainly foraged in waters between 10 and 50 m deep (Tollit et al. 1998). Mid-water dives recorded during foraging trips were thought to be encounters with pelagic prey (Tollit et al. 1998).

A relatively small number of species dominates the diet of harbour seals, but seasonal shifts in diet are seen in many areas, associated with seasonal fluctuations in prey availability (Brown and Mate 1983, Tollit et al. 1998). The diet of harbour seals in the Moray Firth consists primarily of bottom associated prey species (Tollit & Thompson 1996), including sand eel, lesser octopus, whiting, cod and flounder. Similar diets were recorded in Scotland (Pierce et al. 1991), Sweden (Harkonen 1987) and Iceland. Sand-eels consisted of the main prey during the summer months both in Scottish and Baltic coastal waters, gadoids contributed to the diet in winter, while cephalopods were mostly recorded in summer, coinciding with seasonal prey availability in coastal waters (Tollit and Thompson 1996, Tollit et al. 1998). Harbour seals along the Irish west coast hunt on a wide variety of prey, with a few dominant prey species (sole, sand eel and Trisopterus species) representing the majority (47%) of the diet biomass (Kavanagh et al. 2010). Harbour seals in Puget Sound, US, inhabiting rocky-reef sites, foraged on bottom dwelling species (Lance et al. 2012). A large part of their diet consisted of vertically migrating schooling fish including herring, Pacific hake and salmon (Lance et al. 2012).

Foraging strategy

The foraging behaviour of a harbour seal varies with season, species and locality. They are opportunistic predators, changing their foraging tactics depending on the behaviour and distribution of the prey species (Middlemas et al. 2006, Thomas et al. 2011), which correlate with habitat and sediment type (Payne et al. 1989). Seasonal differences in diet composition as well as inter-annual variations found within haul-out sites, further stipulate the ecological flexibility of the harbour seal diet. This opportunistic character is illustrated by a rare observation of a foraging event within the Galway Bay cSAC, whereby numerous harbour seals were feeding on a large shoal of sprat (Galway Harbour Company 2014).

In general, optimal foraging conditions are influenced by i) local bathymetry, ii) the ability to maximise foraging time, iii) and the availability of prey. Analysis of foraging behaviour using time depth recorders (TDRs) showed that harbour seals generally forage at or near the seabed (e.g. Harkonen 1987, Bjorge et al. 1995). Telemetric studies identified that the species forages within 50 km of haul-out sites, and primarily within 10-20 km (Tollit et al. 1998, Thompson et al. 1998, Cunningham et al. 2008, Wilson et al. 2014). In many areas, harbour seals exhibit two foraging strategies (Thompson et al. 1998, Grigg et al. 2009). In one strategy, harbour seals make short, daily trips to and from foraging areas near the haul-out site; in the alternative strategy, harbour seals make longer foraging trips to more distant foraging areas, often lasting for a number of days and followed by extended haul-out period. Grigg and colleagues (2009) reported a spatial overlap between harbour seal distribution at sea and distribution of prey within San-Francisco Bay. This overlap was found to be more accurate within 10 km and declined with increasing distance from the haul-out site. Furthermore, Grigg and colleagues (2009) revealed that harbour seals often return to the same foraging area, showing that they are able to identify foraging areas over long time scales. Similar preferences for and repeated usage of foraging areas were recorded in the Moray Firth (Thompson et al. 1994, Cordes et al. 2011, Bailey et al. 2014).

Recordings of foraging trip durations in the Moray Firth showed that over 70% of the harbour seals made foraging trips longer than 24 h. Similar trip duration was observed in south-west Scotland (25 h) and in north-west Scotland (35 h; Cunningham et al. 2009) and for individual seals along the Irish west coast (Cronin et al. 2009). In the Moray Firth, a positive relation was found between the length and the body mass of an individual and the duration and length of the foraging trip: larger males conducted the longest foraging trips (Thompson et al. 1998). No such correlation was found between forage trip distance and body mass during a study along the Scottish west coast (Cunningham et al 2008). Foraging behaviour of adult females changes during the breeding season (Thompson et al. 1994). During pre-pupping period, adult females conducted regular foraging trips. During the pupping period, long distance foraging trips ceased, and females remained within 2 km from the haul-out site, indicating a reduction in home range during this period. 10-24 days after the pupping period, long distance foraging trips resumed (Thompson et al. 1994).

Sex- and age-class specific foraging behaviour

Studies on harbour seals in the Moray Firth found a correlation between body mass, dive duration and dive depth, indicating larger adult seals conducted deeper and longer dives (Tollit et al. 1998). This likely results in a reduction in intraspecific competition for food resources in inshore areas. Here, both foraging range and foraging-trip duration were observed to be relatively short for the body size of females compared to males (Thompson et al. 1998). Thompson et al. (1998) furthermore suggested that harbour seals would forage as far as possible within the energy and time budget, which is constrained by their body-size. A positive relationship between body mass and dive duration of long dives was also reported for harbour seals in Monterey, California (Eguchi et al. 2005). In contrast, no body mass relationship was apparent for harbour seals along the Scottish west coast (Cunningham et al. 2008). The authors argued that food availability requirements for all individuals, regardless of sex or size, were accessible within easy range of the haul-out cluster throughout the year. Similarly, no body mass-dive correlation, or sex-related differences in at-sea movements were recorded in harbour seals inhabiting Prince William Sound (Lowry et al. 2001). In Prince William Sound, where the bathymetry is highly variable and a large range of water depths is available to seals within a few kilometres from their haul-out site, harbour seals prefer water depths between 20-100 m (Lowry et al. 2001). Interestingly, the horizontal foraging ranges of seals were found to be fairly similar to those for harbour seals in other areas (Lowry et al. 2001).

Pup foraging
Harbour seal pups are exceptional among phocids due to their ability to swim and enter the water soon after birth (Bowen et al. 1999). Pups perform dives associated with foraging before weaning (Jorgensen et al. 2001), and may accompany their mother at sea during foraging trips (Bowen et al. 1999). As a result, harbour seal pup development contains a large aquatic component. Studies using stomach temperature telemetry identified that pups primarily nurse in water (Schreer et al. 2010) and ingest approximately two-third (68%) of the milk when in water (Sauve et al. 2014). Accordingly, female harbour seals undertook foraging trips beyond the first week of lactation (Thompson et al. 1994).

3.4 Movement patterns

Range
Harbour seals are capable of travelling long distances, covering several hundreds of kilometres during foraging trips (Lowry et al. 2001). Several studies have investigated foraging behaviour and movements of harbour seals using VHF radio-telemetry (e.g. Allen 1988, Thompson et al. 1989, Thompson & Miller 1990, Bjørge, et al. 1995). Individual harbour seals foraged within 50 km of haul-out sites, with the majority of individuals remaining within 10-20 km from the haul-out site. More accurate satellite telemetry studies in recent years confirmed these small-scale movement patterns within coastal waters (Cunningham et al. 2008), while simultaneously identified offshore trips formed a larger component of the harbour seal movement patterns than previously described (Sharples et al. 2012, Peterson et al. 2012).

Several studies identified individual harbour seals to conduct multi-day foraging trips that covered several hundreds of kilometres from the haul-out location (Lowry et al. 2001, Cunningham et al. 2008, Cronin et al. 2009). Analysis of behavioural data of 118 tagged harbour seals in seven core regions around Britain showed a high variability between individual at-sea movements (Sharples et al. 2012). The results furthermore revealed that the observed variations in trip duration and distance travelled could not be explained by differences in size, sex and body condition of the tagged individuals, but concluded that foraging variability was best supported by habitat and environmental constrains at a regional level. In addition to the haul-out fidelity and adjacent movement in coastal waters, the study identified a more pronounced offshore component in the movement pattern of the harbour seal than previously identified, and wide-ranging movements into offshore waters were observed in all colonies along the British coasts (Sharples et al. 2012). Similarly, a high number of tagged adult males in Paddila Bay, near Vancouver Island, Canada, conducted long distance movements >100 km (Peterson et al. 2012). Preferential use of certain habitats or response to spatio-temporal changes in prey density may explain such movements (Peterson et al. 2012).

Age- and sex-specific variation in movement patterns

Individual variation in movement patterns was evident in most studies. In the Moray Firth, adult male seals conducted longer foraging trips and covered larger distances than females (Thompson et al. 1998). In contrast, Lowry et al. (2001) found that juvenile harbour seals in Prince William Sound (PWS) travelled larger distances, moved between more spread out haul-out locations, and ranged further offshore during foraging trips than adult seals. The average distance from haul-out sites of the smaller juvenile harbour seals in PWS was almost twice as far as for adults. Juvenile dispersal, emigration and establishment of new haul out sites are possible reasons for long-range movements of harbour seals (Burns 2002).

Home range

Thompson and colleagues (1998) reported that the mean foraging range, and hence the home range for adult males was larger than that for females. In contrast, females in Prince William Sound exhibited larger home ranges than males, and home range size variations showed large variations over the year (Lowry et al. 2001). Furthermore, juveniles were found to maintain a greater home range, and travelling longer distances between haul-out sites than adult seals in Prince William Sound (Lowry et al. 2001). Seasonal variation in home range size is linked to behavioural patterns during breeding and moulting. Female home range declined with the onset of pupping when females remained within 2 km from the haul-out site (Thompson et al. 1994). In Prince William Sound, both male and female harbour seals showed a similar decline in home range during the breeding season, however, male home range size showed more variation (Lowry et al. 2001).

Site fidelity

Intensive short-term studies have shown that harbour seals display high levels of site-fidelity over periods of months to years (Härkönen & Heide-Jørgensen 1990, Thompson et al. 1997). Observations in many regions have shown that harbour seal pupping sites are used consistently in successive years (Lonergan et al. 2007). Satellite derived telemetry data collected during two years revealed that harbour seals in southeast Scotland spent 39% of time within 10 km of haul-out sites between November and June (Sharples et al. 2009). Along the southwest coast of Scotland, individual seals used on average 13 haul-out locations (range 6-29, Cunningham et al. 2008). The number of sites was positively correlated with the duration of tag deployment, suggesting individuals do visit more haul out locations over time. The seals used different haul-out sites in the autumn/winter (October to February) compared to spring/summer (March to July) (Cunningham et al 2008). The distances between these seasonal haul-out sites ranged between 40 and 130 km. In addition, almost half of the identified haul-out sites were not used for return trips and described as transient sites, while only a small number of haul-out sites showed a high level of individuals returning back (Cunningham et al. 2008). Cordes and colleagues (2011) described changes in the long-term pattern of haul-out use in the Special Area of Conservation in the Moray Firth, Scotland, showing considerable inter-annual variability in both abundance and the relative importance of areas within the SAC, and nearby areas (Cordes et al. 2011). Over a 20 year period, the harbour seal distribution shifted from the SAC to a nearby estuary, resulting in a drastic decline in mother pup pairs within the SAC. The foraging areas used by females remained broadly the same during both periods, hence the redistribution was thought to be caused by a decline in the quality of the haul-out, rather than a change in foraging behaviour (Cordes et al. 2011).

3.5 Mating behaviour

The mating structure of the harbour seal is described as a lek-system in which males aggregate and display to attract females (Bradbury 1981). During the mating period, male seals use multiple tactics to acquire access to females (e.g. Hayes et al. 2004, Boness et al. 2006).
Mating behaviour of the harbour seal occurs mainly in the water (Van Parijs et al. 1997). The mating season has been described to start directly after the suckling period, at end of lactation (Thompson et al. 1994, Van Parijs et al. 1997). At the start of the mating period, males spend more time in the water and the size of the home range decreases, in order to increase their chances of encountering females (Boness et al. 2006, Cunningham et al. 2008). Male seals change their diving behaviour and show an increase in short shallow dives (Van Parijs, et al. 1997). These shorter dives form part of an underwater display behaviour, during which males produce simple stereotyped broadband roar vocalizations for the purpose of attracting females and competing with other males (Van Parijs et al. 1997, Bjørgesæter et al. 2004, Boness et al. 2006). Various acoustic vocalisation behaviours have been identified including single male display, and aggregations of multiple males (Hayes et al. 2004). This display behaviour may occur near haul-out sites, in foraging areas, and on transit between both sites (Van Parijs et al. 2000a, Hayes et al. 2004). Male seals established different acoustic and display based territories, through which females freely travelled (Hayes et al. 2004). Acoustic evidence indicated that areas were occupied by single males (Van Parijs et al. 2000b). Site-fidelity to territories was found to last at least 2-4 years (Van Parijs et al. 2000b, Hayes et al. 2004). Female harbour seals choose males based on the display and vocal display (Hanggi and Schusterman 1994, Boness et al. 2006).

3.6 Anthropogenic impacts

The type and the severity of a behavioural response as a result from an anthropogenic disturbance are variable and dependent on multiple abiotic (e.g. type of disturbance, the frequency of occurrence, time of day), and biotic factors (e.g. behavioural state, group size, habituation; Bejder et al. 2009). Biological disturbance due to anthropogenic noise has been receiving more and more scientific attention over the past decade. Leading in this field is the information on cetaceans, as they are known to rely heavily on sound and feature on most agreements of species protection. Pinnipeds have been somewhat less studied, possibly because they forage by sight and sense rather than sound (Schusterman et al. 2000). Currently however, there remains a large uncertainty about the extent to which predicted noise levels may impact individual seals (Thompson et al. 2013), illustrated by the preliminary nature of the noise exposure criteria developed by Southall et al. (2007).

Nevertheless, it is recognized that acoustic disturbance is an important issue in pinniped conservation, because of the relatively high sensitivity of these animals to low frequency sounds, which constitute most anthropogenic noise. For example, disturbance of foraging behaviour is predicted to lead to increased competition for food, greater energetic cost of foraging, or reduced foraging opportunities, which likely will cause a reduction in an individual seal's overall energy balance followed by a decline in reproductive success and consequences and population-level (Thompson et al. 2013).

Direct effects
Both pinnipeds and cetaceans have been documented with mild to severe and lethal trauma after vessel collision (Moore et al. 2013). Distinctions can be made between blunt and sharp trauma, which are caused by rotating and non-rotating parts of the vessel, respectively (Moore et al. 2013). Different factors can affect the severity of the impact, such as vessel size and velocity, the angle at which collision takes place, and the anatomy of the body part that is hit (Laist et al. 2001, Vanderlaan & Taggart 2007, Moore et al. 2013). The likelihood of such collisions is thus far unclear, as frequency studies have only been conducted for species with very high incidences of collisions, such as right whales (Kraus et al. 2005). It has been stated that the number of collisions generally does not pose a threat to a species on population level (Weinrich et al. 2010), but quantitative reports on this matter have yet to be written.
Seals can taste the water, when opening the mouth, and their eyes are continuously exposed to whatever dissolved irritants there may be in the water. Such chemical pollution, irritating or even harmful to the seals could potentially be present during construction.

Direct disturbance and/or injury due to sound and intensified motorised vessel/plant/construction activities
Few studies have investigated the effect of disturbance on harbour seal behaviour. A controlled behavioural response study was conducted to investigate the anthropogenic impact on harbour seal haul-out behaviour (Anderson et al. 2012). The study, conducted within a seal reserve in Denmark during the breeding season, recorded the flight initiation for two stimuli: an approaching vessel and a pedestrian. The results showed that harbour seal decision-making was strongly influenced by the fleeing of neighbouring seals and seals became alert at greater distances with increasing group size. Furthermore, harbour seals responded to boat disturbance at significant greater distances than to an approaching pedestrian. Seals were alerted by approaching vessels at distances ranging between 560 to 850 m, and a flight response was initiated at distances ranging between 510 to 830 m (Anderson et al. 2012). For pedestrian approaches distances were shorter and ranged between 200 to 425, and 165 to 260m respectively. These patterns of response were consistent during pre-during and post breeding periods.

Johnson and Acevedo-Gutierrez (2007) observed that harbour seals were less affected when powerboats and kayaks passed by, but did flee when powerboats were approaching within 400 m. This difference may relate to an approaching vessel possibly blocking the direction of the seal's escape route (Anderson et al. 2012). During the breeding period, harbour seals may be very reluctant to flee completely from the haul-out site on approaching boats, and harbour seals returned significantly sooner to the haul-out site than for non-breeding period (Anderson et al. 2012). This reluctance to leave has been reported in other harbour seal populations (Henry & Hammill 2001). Interestingly, seals did not return until sunset irrespective of disturbance type when disturbances occurred outside the breeding season

(Anderson et al. 2012). In addition, indirect effects, such as disturbed birds may cause an increased alert response by seals at a larger distance.

Grigg and colleagues (2012) identified that anthropogenic activity had a relative low influence on the aquatic distribution of seals in San Francisco Bay. Harbour seal distribution was primarily determined by high prey abundance and distance from the haul-out site. In fact, seals were found closer than expected to human activity, which included fishing activity, other (boat) activity and outflow locations. Harbour seals in Hood Canal, Washington, altered their haul-out pattern to coincide with peaks in anthropogenic activity. During periods of high human interactions in the summer, harbour seals were less likely to haul-out during the day, but instead hauled out more during night-time (London et al. 2012). In autumn and winter, when interaction rate was low, this shift was reversed.

Harbour seals may interact with fisheries, especially in coastal waters (Cosgrove et al. 2013). Cronin and colleagues (2014) conducted a review of fisheries interactions between harbour seal and fisheries in Irish waters. Grey seal interactions were found to be significant in inshore waters (<12 nautical miles from shore), and especially with static-net (or passive) fisheries (e.g. gill/tangle nets), which have increased following the driftnet ban in 2006. While little direct evidence is available, Cronin et al. (2014) assumed given the inshore distribution of the harbour seal, interactions are likely to be comparable between grey and harbour seals in Irish waters.

In Ireland, the use of pingers, or seal scarers, at salmon farms was effective, but only in the short term. Seals soon became habituated to the devices, which then were perceived to act as attractants (Cronin et al. 2014). Acoustic Deterrent Devices (ADD) were effectively used to reduce seal movements up Scottish rivers in which interactions between salmon rod and seals occurred (Graham et al. 2009). However multiple studies have reported the short effectiveness of acoustic deterrent devices with seals (Jacobs & Terhune 2002, Götz & Janik, 2013). In these cases, animals may tolerate or habituate to high noise levels (i.e. as the result of food motivation) and consecutively may suffer hearing damage, further reducing the responsiveness to ADDs (Götz & Janik, 2013). An additional side-effect of ADDs is that they may have an ecological effect on other marine species, in particular the harbour porpoise. New methods are currently developed that use selectively inflicted startle responses in harbour seals by using a frequency range that is sensitive to harbour seal, but less sensitive for non-target species including the harbour porpoise (Götz & Janik, 2014). The use of ADDs and pingers have the potential to be used as a conservation measure. During construction of offshore windpark in Denmark, seal scarers were used to keep seals and harbour porpoise away from the construction site, in order to prevent them from severe noise impact (see further below: Edrén et al. 2004). Likewise, Tougaard et al. (2006) found acoustic deterring devices (Aquamark 100, Lofitek seal scarer) to be efficient in order to deter seals and harbour porpoise out to safe distances, during piling, and anchoring of vessels during wind farm construction.

Industrial development

Long-term displacement of seals was recorded in Broadhaven Bay, Ireland during an offshore construction of a pipeline (Anderwald et al. 2013). The impact of the industrial construction resulted in a negative correlation between vessel number and seal abundance. Based on analysis of the vessel type, the authors stated that the observed decline was more likely caused by increased levels of underwater noise, than by increased collision risk. In recent years, the construction of offshore wind farms have resulted in an increase of studies investigating the effect of industrial developments on marine mammals. Koschinski and colleagues (2003) examined the reactions of harbour porpoise and harbour seal to playbacks of simulated noise from an offshore wind turbine (30 and 800 Hz peak source levels of 128 dB (re 1 μPa^2 Hz^{-1} at 1 m) at 80 and 160 Hz (1/3-octave centre frequencies). Underwater recordings were modified to simulate a 2 MW and used during a controlled playback scenario monitoring seal behaviour. The results showed harbour seals reacted at a distance of 200 m from the underwater speaker by making fewer surfacings. Madsen et al. (2006) criticised the research set-up and argued that the procedure introduced high frequency noise artefacts, to which species may have reacted instead of to the low frequency.

Short-term displacement effects were reported during the construction and operation of a wind farm in the Wadden sea, Denmark (Edren et al. 2010). Here, sheet pile driving during the construction phase caused a 10 to 60% reduction in the number of seals hauled-out on a sand bank approximately 10 km away, compared to periods with no pile-driving.

Simultaneously with the pile driving, a seal deterrent (189 dB re 1 _Pa at 10–15 kHz) and porpoise pingers (145 dB re 1 _Pa at 20–160 kHz) were deployed from the pile driving platform and activated 30 min prior to pile driving at the turbine foundation to limit the number of seals and porpoises exposed to physically damaging noise. After the construction period, seals continued to use the haul-out site and abundance increased similar as recorded in nearby sites, indicating no long-term effects (Edren et al. 2010). During the construction phase, sound levels were not measured and seal behaviour in water was not monitored. Therefore, it remains unknown whether the seals reacted to under-water noise by leaving the general area, or reacted to airborne sound by remaining in the water.

Harbour seal movement patterns using satellite tags, showed scattered presence of harbour seals around the construction site during baseline and construction periods and a more consistent presence during operation of the wind farm (Teilmann et al. 2006).

Unfortunately, the accuracy of the positions retrieved from satellite transmitters were found to be insufficient to conclude with certainty on the degree to which construction of the wind farm has affected seal movement patterns. After completion of two wind farms in the Danish Wadden sea, a study investigating harbour seal movements indicated no significant long-term effect of the operational wind farms on seal behaviour (McConnell et al. 2013). Seal dive and movement patterns showed individual seals moved inside and outside the wind farms within close proximity to individual wind farm towers. Operational noise from wind turbines at sites in Denmark and Sweden, was reported to be measurable only above ambient noise at frequencies below 500Hz, resulting in audibility for harbour seals from <100m to several kilometres (Tougaard et al. 2009). The authors concluded that operational sound levels may cause behavioural effects of harbour seals up to distances of a few hundred meters, while it was not thought to mask important biological sounds. Aerial counts of harbour seals during moulting in August, before and during the construction of the Øresund bridge, did not observe a reduction in the number of seals lying on rocks within 1.5 km of the bridge, although there was a tendency to use rocks further away from the work than previously (Heide-Jørgensen & Teilmann 1999).

To assess population-level impacts of a proposed wind farm construction on harbour seals using the Dornoch Firth and Morrich More SAC, Moray Firth, Thompson et al. (2013) developed a framework model. Based on the spatial overlap of received sound levels and seal distribution, in combination with estimates of the impacts of noise exposure, the impact assessment model predicted a potentially large number of seals being either displaced or experiencing PTS. However, the population modelling used within the framework showed these short term effects did not result in long-term changes to the viability of this population, and identified immediate recovery after the construction phase (Thompson et al. 2013). Despite the fact that the framework benefited from a long history of research on the Moray Firth harbour seal population, it was recognized that the impact assessment incorporated a considerable level of uncertainty.

3.7 Discussion and conclusions

The harbour seal occurs in estuarine, coastal and offshore waters and utilises aquatic habitat for foraging, mating, nursing and breeding. The species is widely distributed and shows large flexibility in habitat use. Generally, harbour seals forage in waters up to 100 m depth, at 10 to 50 km from their haul-out sites. Harbour seals mainly forage within 10 to 20 km from their haul-out sites, but offshore trips (20 - >50 km) form an important part of their foraging strategy. Furthermore, harbour seals can show site-fidelity to specific foraging areas.

Potentially strong variation in diving behaviour, habitat use, ranging patterns, diet and foraging strategies between age- and sex classes exists, and may render certain individuals more sensitive to disturbance, or to changes in their habitat. In addition, these differences between age- and sex-classes generally vary between areas, for example depending on prey availability or habitat-type. Most studies show large individual variation, which reduces the extent to which individual behaviour can be used to predict population level effects. With the exception of mothers with nursing calves, it is therefore not possible to conclude which part of the population in the Galway Bay cSAC may be more or less vulnerable to the proposed construction activities. Nursing calves may accompany their mothers on foraging trips and are often nursed in the water. Ranging patterns during pupping, and of nursing mothers and calves, are more limited than those of the other life stages in the population, restricted to the areas more proximate to haul-outs. This spatial restriction will render them more vulnerable to disturbance from the marine construction activities associated to the Galway Harbour Extension.

Information on the aquatic habitat use of harbour seals in Ireland remains limited. However, the proximity to harbour seal haul-outs, the presence of water depths preferred for foraging (10 – 100 m), and of suitable habitat types and prey species in the area, in combination with observations of foraging harbour seals, suggest that the area can be used for foraging. In addition, it is furthermore likely that areas in proximity to the haul-outs are used for mating, nursing and during breeding, or as a travelling corridor by individuals in the Galway Bay cSAC.

4. References

Allen, S.G. 1988. Movement and activity patterns of harbor seals at the Point Reyes Peninsula, California. MSc thesis, University of California, Berkeley, U.S.A.

Andersen, S.M., Teilmann, J., Dietz, R., Schmidt, N.M. and Miller, L.A. 2012. Behavioural responses of harbour seals to human-induced disturbances. Aquatic Conservation: Mararine Freshwater Ecosystems 22: pp. 113–121. doi: 10.1002/aqc.1244.

Anderwald, P., Brandecker, A., Haberlin, D., Coleman, M., Collins, C., O'Donovan, M., Pinfield, R. and Cronin, M. 2012. Marine mammal monitoring in Broadhaven Bay 2011. Progress Report to RSK Environment Limited Group. Coastal and Marine Research Centre, University College Cork, Ireland.

Anderwald, P., Brandecker, A., Coleman, M., Collins, C., Denniston, H., Haberlin, M.D., O'Donovan, M., Pinfield, R., Visser, F., Walshe, L. 2013. Displacement responses of a mysticete, an odontocete, and a phocid seal to construction-related vessel traffic. Endangered Species Research 21, pp. 231-240.

André, M., Solé, M., Lenoir, M., Durfort, M., Quero, C., Mas, A., Lombarte, A., van der Schaar, M., López-Bejar, M., Morell, M., Zaugg, S. and Houégnigan, L. 2011. Low-frequency sounds induce acoustic trauma in cephalopods. Frontiers in the Ecological Environment 9(9), pp. 489-493.

Amundin, M., Amundin, B. 1973. On the behaviour and study of the harbour porpoise (*Phocoena phocoena*) in the wild. In: Pilleri, G. (Ed.), Investigations on Cetacea, vol. 5. Hirnanatomisches Institut, Bern, Germany, pp. 317-328.

Austin, D., Bowen, W.D., McMillan, J.I. and Iverson, S. 2006. Linking movement, diving, and habitat to foraging success in a large marine predator. Ecology, 87(12), pp. 3095-3108.

Baechler, J., Beck, C.A., Bowen, W.D. 2002. Dive shapes reveal temporal changes in the foraging behaviour of different age and sex classes of harbour seals (*Phoca vitulina*). Canadian Journal of Zoology 80, pp. 1569-1577, 10.1139/z02-150.

Bailey, H., Senior, B., Simmons, D., Rusin, J., Picken, G., Thompson, P.M. 2010. Assessing underwater noise levels during pile-driving at an offshore windfarm and its potential effects on marine mammals. Marine Pollution Bulletin 60, pp. 888-897.

Bailey,H., Hammond, P.S., Thompson, P.M. 2014. Modelling harbour seal habitat by combining data from multiple tracking systems, Journal of Experimental Marine Biology and Ecology 450, pp. 30-39, ISSN 0022-0981, http://dx.doi.org/10.1016/j.jembe.2013.10.011.

Bejder, L., Samuels, A., Whitehead, H., Finn, H., Allen, S. 2009. Impact assessment research: use and misuse of habituation, sensitisation and tolerance in describing wildlife responses to anthropogenic stimuli. Marine Ecology Progress Series 395: pp. 177–185.

Berrow, S., Hickey, R., O'Brien, J., O'Connor, I. and McGrath, D. 2008. Harbour porpoise survey 2008. Report to the National Parks and Wildlife Service, Irish Whale and Dolphin Group, pp. 1-33.

Berrow, S.D., Holmes, B. and Kiely, O. 1996. Distribution and abundance of bottlenose dolphins *Tursiops truncatus* (Montagu) in the Shannon estuary, Ireland. Biology and Environment: Proceedings of the Royal Irish Academy Biology and Environment 96B(1), pp. 1-9.

Bjørge, A., Thompson, D., Hammond, P., Fedak, M., Bryant, E., Aarefjord, H., Roen, R., Olsen, M. 1995. Habitat use and diving behaviour of harbour seals in a coastal archipelago in Norway. Developments in Marine Biology 4, pp. 211-223.

Bjørgesæter, A., Ugland, K.I., and Bjørge, A. 2004. Geographic variation and acoustic structure of the underwater vocalization of harbor seal (*Phoca vitulina*) in Norway, Sweden and Scotland. Journal of the Acoustic Society of America 116 , pp. 2459-2468.

Boness, D.J., Bowen, W.D., Buhleier , B.M., and Marshall, G.J. 2006. Mating tactics and mating system of an aquatic-mating pinniped: the harbor seal, *Phoca vitulina*. Behavioural Ecology and Sociobiology 61, pp. 119-130.

Born, E.W., Outridge, P., Riget, F.F., Hobson, K.A., Dietz, R., Øien, N., Haug, T. 2003. Population substructure of North Atlantic minke whales (*Balaenoptera acutorostrata*) inferred from regional variation of elemental and stable isotopic signatures in tissues. Journal of Marine Systems 43, pp. 1-17.

Bowen, W.D., Boness, D.J., Iverson, S.J. 1999. Diving behaviour of lactating harbour seals and their pups during maternal foraging trips. Canadian Journal of Zoology 77, pp. 978–988.

Bradbury, J.W. (1981.) The evolution of leks. In: Alexander, R.D., Tinkle, D. (eds) Natural selection and social behavior. Chiron Press, New York, pp 138–169.

Brandt, M.J., Diederichs, A., Betke, K. and Nehls, G. 2012. Effects of offshore pile driving on harbor porpoises (*Phocoena phocoena*). Advances in Experimental Medicine and Biology 730, pp. 281-284.

Brown, R.F. and Mate, B. 1983. Abundance, movements and feeding habits of harbor seals, *Phoca vitulina*, at Netarts and Tillamook Bays, Oregon. Fisheries Bulletin 81, pp. 291-301.

Burns, J.J. 2002. Harbor seal and spotted seal *Phoca vitulina* and *P. largha*. In: Perrin, W.F., Wursig, B. and Thewissen, J.G.M. (eds), Encyclopedia of Marine Mammals, pp. 552-560. Academic Press.

Carstensen, J., Henriksen, O.D., Teilmann, J. 2006. Impacts of offshore wind farm construction on harbour porpoises: acoustic monitoring of echolocation activity using porpoise detectors (T-PODs). Marine Ecology Progress Series 321, pp. 295-308.

Coltman, D.W., Bowen, W.D., Boness, D.J. and Iverson, S.J. 1997. Balancing foraging and reproduction in the male harbour seal, an aquatically mating pinniped. Animal Behaviour 54, pp. 663-678.

Connor, R.C., Wells, R.S., Mann, J., Read, A.J. 2000. The bottlenose dolphins – Social relationships in a fission-fusion society. In: Cetacean Societies, pp. 91-126, Mann, J. Connor, R.C., Tyack, P.L., Whitehead, H. (Eds.) University of Chicago Press, Chicago, USA.

Cosgrove, R., Cronin, M., Reid, D., Gosch, M., Sheridan, M., Chopin, N., Jessopp, M 2013. Seal depredation and bycatch in set net fisheries in Irish waters. Fisheries Resource Series Vol. 10.

Cordes, L.S., Duck, C.D., Mackey, B.L., Hall, A.J. and Thompson, P.M. 2011. Long-term patterns in harbour seal site-use and the consequences for managing protected areas. Animal Conservation 14, pp. 430-438.

Christiansen, F., Vínkingsson, G.A., Rasmussen, M.H. and Lussea, D. 2013. Minke whales maximise energy storage on their feeding grounds. The Journal of Experimental Biology 216, pp. 427-436.

Cronin, M.A., Zuur, A.F., Rogan, E. and McConnell, B. 2009. Using mobile phone technology to investigate the haul-out behaviour of harbour seals in the Republic of Ireland, Endangered Species Research 10, pp. 255-267.

Cronin, M.A. Duck, C., Ó Cadhla, O., Nairn, R., Strong, D. and O' Keeffe, C. 2004. Harbour seal assessment in the Republic of Ireland: August 2003. Irish wildlife manuals, No. 11. National Parks and Wildlife Service, Department of Environment, Heritageand Local Government, Dublin, Ireland.

Cronin, M., Jessopp, M., Houle, J., Reid, D. 2014. Fishery-seal interactions in Irish waters: Current perspectives and future research priorities. Marine Policy 44, pp. 120–130.

Cunningham, L., Baxter, J.M., Boyd, I.L., Duck, C.D., Lonergan, M., Moss, S.E. and McConnell, B. 2009. Harbour seal movements and haul-out patterns: implications for monitoring and management. Aquatic Conservation: Marine Freshwater Ecosystems 19, pp. 398–407. doi: 10.1002/aqc.983.

DAHG 2014. Guidance to manage the risk to marine mammals from man-made sound sources in Irish waters, Department of Arts, Heritage and the Gaeltacht. Available online: http://www.npws.ie/media/npwsie/content/files/Underwater%20sound%20guidance_Jan%202014.pdf.

Dähne, M., Gilles, A., Lucke, K., Peschko, V., Adler, S., Krügel, K., Sundermeyer, J. and Siebert, U. 2013. Effects of pile-driving on harbour porpoises (*Phocoena phocoena*) at the first offshore wind farm in Germany. Environmental Research Letters 8, pp. 1-15.

Denhardt, G., Mauck, B., and Bleckmann, H. 1998. Seal whiskers detect water movements. Nature 394, pp. 235-236.

Dehnhardt, G., Mauck, B., Hanke, W., Bleckmann, H. 2001. Hydrodynamic Trail-Following in Harbor Seals (*Phoca vitulina).* Science 293(5527), pp. 102-104*.* DOI:10.1126/science.1060514.

De Jong, C.A.F., Ainslie, M.A., Jansen, E.W. and Quesson, B.A.J. 2011. Standards for measurement and reporting of underwater sound: Application to the source level of trailing suction hopper dredgers. Journal of the Acoustical Society of America 129(4), pp. 2461.

De Pierrepont, J.F., Dubois, B., Desormonts, S., Santos, M.B. and Robin, J.P. 2005. Stomach contents of English Channel cetaceans stranded on the coast of Normandy. Journal of the Marine Biological Association of the United Kingdom 85, pp. 1539-1546.

DeRuiter, S.L., Southall, B.L., Calambokidis, J., Zimmer, W.M.X., Sadykova, D., Falcone, E.A., Friedlaender, A.S., Joseph, J.E., Moretti, D., Schorr, G.S., Thomas, L. and Tyack, P.L. 2013. First direct measurements of behavioural responses by Cuvier's beaked whales to mid-frequency active sonar. Biology Letters 9: 20130223.

Doksæter, L., Handegard, N.O. and Godø, O.R. 2012. Behavior of captive herring exposed to naval sonar transmissions (1.0-1.6 kHz) throughout a yearly cycle. Journal of the Acoustical Society of America 131(2), pp. 1632-1642.

Duck, C. and Morris, C. 2013a. An aerial survey of harbour seals in Ireland: Part 2: Galway Bay to Carlingford Lough. August-September 2012. Unpublished report to the National Parks & Wildlife Service, Department of Arts, Heritage & the Gaeltacht, Dublin.

Duck, C. and Morris, C. 2013b. An aerial survey of harbour seals in Ireland: Part 2: Galway Bay to Carlingford Lough. August-September 2012. Unpublished report to the National Parks & Wildlife Service, Department of Arts, Heritage & the Gaeltacht, Dublin.

Edrén, S. M. C., Andersen, S. M., Teilmann, J., Carstensen, J., Harders, P. B., Dietz, R. and Miller, L. A. 2010. The effect of a large Danish offshore wind farm on harbor and gray seal haul-out behavior. Marine Mammal Science, 26, pp. 614–634. doi: 10.1111/j.1748-7692.2009.00364.x.

Eguchi, T. and Harvey, J. T. 2005. Diving behavior of the Pacific harbor seal (*Phoca vitulina richardii),* in Monterey bay California. Marine Mammal Science, 21, pp.283–295. doi: 10.1111/j.1748-7692.2005.tb01228.x.

Engås, A., Misund, O.A., Soldal, A.V., Horvei, B., Solstad, A. 1995. Reactions of penned herring and cod to playback of original, frequency-filtered and time-smoothed vessel sound. Fisheries Research 22, pp. 243-254.

Evans, P.G.H., Aguilar, A. and Smeenk, C. 1990. European Research on Cetaceans. 4. Proceedings of the fourth Annual Conference of the European Cetacean Society, Mallorca, Spain, pp. 1-140

Evans, P.G.H., Harding, S., Tyler, G. and Hall, S. 1986. Analysis of cetacean sightings in the British Isles, 1958-1985. Report to Nature Conservancy Council, pp. 1-71.

Frost, K.J., Simpkins, M.A. and Lowry, L.F. 2001. DIving behavior of subadult and adult harbor seals in Prince William Sound, Alaska. Marine Mammal Science, 17, pp. 813–834. doi: 10.1111/j.1748-7692.2001.tb01300.x.

Galway Harbour Company, 2014. Environmental Impact Statement. Available online: http://www.galwayharbourextension.com.

Goldbogen JA, Southall BL, DeRuiter SL, Calambokidis J, Friedlaender AS, Hazen EL, Falcone EA, Schorr GS, Douglas A, Moretti DJ, Kyburg C, McKenna MF and Tyack PL (2013). Blue whales respond to simulated mid-frequency military sonar. Proc. R. Soc. B 280, 20130657.

Goold, J.C. 1996. Acoustic assessment of populations of common dolphin *Delphinus delphis* in conjunction with seismic surveying. Journal of Marine Biology Association U.K. 76, pp. 811-820.

Götz, T. and Janik, V.M. 2010. Aversiveness of sounds in phocid seals: psycho-physiological factors, learning processes and motivation. The Journal of Experimental Biology 213, pp. 1536-1548.

Götz, T. and Janik, V.M. 2011. Repeated elicitation of the acoustic startle reflex leads to sensitisation in subsequent avoidance behaviour and induces fear conditioning. BMC Neuroscience 12(30). doi:10.1186/1471-2202-12-30

Götz, T. and Janik, V. M. 2014. Target-specific acoustic predator deterrence in the marine environment. Animal Conservation. doi: 10.1111/acv.12141.

Gotz, T and Janik, VM 2013, Acoustic deterrent devices to prevent pinniped depredation: efficiency, conservation concerns and possible solutions. Marine Ecology Progress Series 492, pp. 285-302.

Graham, I.M., Harris, R.N., Denny, B., Fowden, D., Pullan, D. 2009. Testing the effectiveness of an acoustic deterrent device for excluding seals from Atlantic salmon rivers in Scotland. ICES Journal of Marine Science; 66, pp. 860–864.

Greene, C.R.Jr., and Richardson, W.J. 1988. Characteristics of marine seismic survey sounds in the Beaufort Sea. Journal of the Acoustical Society of America 83, pp. 2246-2254.

Grigg. E.K., Klimley, A.P., Allen, S.G., Green, D.E., Elliott-Fisk, D.L., Markowitz, H. 2009. Spatial and seasonal relationships between Pacific harbor seals (*Phoca vitulina richardii*) and their prey, at multiple scales. Fisheries Bulletin 107, pp. 359-372.

Grigg, E.K., Allen, S.G., Craven-Green, D.E., Klimley, A.P., Markowitz, H., and Elliott-Fisk, D.L. 2012. Foraging distribution of Pacific harbor seals (*Phoca vitulina richardii*) in a highly impacted estuary Journal of Mammalogy, 93(1), pp. 282-293.

Halvorsen, M.B., Casper, B.M., Woodley, C.M., Carlson, T.J., Popper, A.N. 2012. Threshold for onset of injury in chinook salmon from exposure to impulsive pile driving sounds. PLoS ONE 7(6), e38968.

Hanggi, E.B. and Schusterman, R.J. 1994. Underwater acoustic displays and individual variation in male harbour seals, *Phoca vitulina*. Animal Behaviour 48, pp. 1275–1283.

Hassel, A., Knutsen, T., Dalen, J., Skaar, K., Løkkeborg, S., Misund, O.A., Østensen, Ø., Fonn, M. and Haugland, E.K. 2004. Influence of seismic shooting on the lesser sandeel (*Ammodytes marinus*). Journal of Marine Science 61, pp. 1165-1173.

Härkönen, T.J., 1987a. Seasonal and regional variations in the feeding habits of the harbour seal, *Phoca vitulina*, in the Skagerrak and the Kattegat. Journal of Zoology 213, pp. 535-543.

Härkönen, T.J., 1987. Influence of feeding on haul-out patterns and sizes of sub-populations in harbour seals. Netherlands Journal of Sea Research 21(4), pp. 331-339.

Härkönen, T. and Heide-Jørgensen, M.P. 1990. Comparative life histories of East Atlantic and other harbour seal populations. Ophelia 32 (3), pp. 211-235.

Härkönen T.J., Harding, K.C., Lunneryd, S.G. 1999. Age and sex specific behaviour in harbour seals leads to biased estimates of vital population parameters Journal of Applied Ecology 36, pp. 824–840.

Härkönen, T.J. and Harding, K.C. 2001. Spatial structure of harbour seal populations and the implications thereof. Canadian Journal of Zoology 79(12), pp. 2115-2127.

Harris, R.E., Miller, G.W., Richardson, W.J. 2001. Seal responses to airgun sounds during summer seismic surveys in the Alaskan Beaufort sea. Marine Mammal Science 17(4), pp. 795-812.

Hayes, S.A., Costa, D.P., Harvey, J.T. and le Boeuf, B.J. 2004. Aquatic mating strategies of the male pacific harbor seal (*Phoca vitulina richardii*): are males defending the hotspot? Marine Mammal Science, 20, pp. 639–656. doi: 10.1111/j.1748-7692.2004.tb01184.x

Henry, E. and Hammill, M.O. 2001. Impact of small boats on the haulout activity of harbour seals (*Phoca vitulina*) in Métis Bay, Saint Lawrence Estuary, Québec, Canada., Aquatic Mammals 27, pp. 140-148.

Heide-Jørgensen, M.P. and Teilmann, J. 1999. Sæler 1998. Østersøen, Kattegat og Limfjorden. Naturovervågning. Danmarks Miljø- undersøgelser. Arbejdsrapport fra DMU nr. 105. pp. 28f.

Jessopp, M., Cronin, M., Hart, T. 2013. Habitat-Mediated Dive Behavior in Free-Ranging Grey Seals. PLoS ONE 8(5): e63720. doi:10.1371/journal.pone.0063720

Kavanagh, A.S., Cronin, M.A., Walton, M., and Rogan, E. 2010. Diet of the harbour seal (*Phoca vitulina vitulina*) in the west and south-west of Ireland. Journal of the Marine Biological Association of the United Kingdom, 90, pp 1517-1527. doi:10.1017/S0025315410000974.

Kastelein, R.A., Van Heerden, D., Gransier, R., Hoek, L. 2013. Behavioral responses of a harbor porpoise (*Phocoena phocoena*) to playbacks of broadband pile driving sounds. Marine Environmental Research 92, pp. 206-214.

Kinze, C.C. 1990. The distribution of the harbour porpoise (*Phocoena phocoena*) in Danish waters 1983-1989. International Whaling Commission Scientific Committee SC/42/SM34.

Koschinski, S., Culik, B.M., Henriksen, O.D., Tregenza, N., Ellis, G.,Jansen, C., Kathe, C. 2003. Behavioural reactions of free-ranging porpoises and seals to the noise of a simulated 2 MW windpower generator. Marine Ecology Progress Series 265, pp. 263–273.

Kraus, S.D., Brown, M.W., Caswell, H., Clark, C.W., Fujiwara, M., Hamilton, P.K., Kenney, R.D., Knowlton, A.R., Landry, S., Mayo, C.A., McLellan, W.A., Moore, M.J., Nowacek, D.P., Pabst, D.A., Read, A.J., Rolland, R.M. 2005. North Atlantic right whales in crisis. Science 309, pp. 561-562.

Kvadsheim, P., Lam, F.P., Miller, P., Doksaeter, L., Visser, F., Kleivane, L., Van IJsselmuide, S., Samarra, F., Wensveen, P., Curé, C., Hickmott, L. and Dekeling, R. 2011. Behavioural response studies of cetaceans ton aval sonar signals in Norwegian waters – 3S-2011 cruise report. Forsvarets forskningsintitutt/Norwegian Defence Research Establishment (FFI) rapport 2011/01289.

Laist, D.W., Knowlton, A.R., Mead, J.G., Collet, A.S., Podesta, M. 2001. Collisions between ships and whales. Marine Mammal Science 17(1), pp. 35-75.

Lance, M.M., Chang, W-Y., Jefferies, S.J., Pearson, S., Acevedo-Gutierrez, A. 2012. Harbor seal diet in northern Puget Sound: implications for the recovery of depressed fish stocks. Marine Ecology Progress Series 464, pp. 257–271.

Leopold, M.F., Wolf, P.A. and van der Meer, J. 1992. The elusive harbour porpoise exposed: strip transect counts off south western Ireland. Netherlands Journal of Sea Research 29(4), pp. 395-402.

Lesage, V., Hammill, M.O., Kovacs, K.M. 1999. Functional classification of harbor seal (*Phoca vitulina*) dives using depth profiles, swimming velocity, and an index of foraging success. Canadian Journal of Zoology 77, pp. 74–87.

London, J.M., Ver Hoef, J.M., Jeffries, S.J., Lance, M.M., Boveng, P.L. 2012. Haul-Out Behavior of Harbor Seals (*Phoca vitulina*) in Hood Canal, Washington. PLoS ONE 7(6): e38180. doi: 10.1371/journal.pone.0038180.

Lonergan, M., Duck, C. D., Thompson, D., Mackey, B. L., Cunningham, L. and Boyd, I. L. 2007, Using sparse survey data to investigate the declining abundance of British harbour seals. Journal of Zoology, 271, pp. 261–269. doi: 10.1111/j.1469-7998.2007.00311.x

Lowry, L.F., Frost, K.J., Ver Hoef, J.M. and Delong, R.A. 2001. Movements of satellite-tagged sub-adult and adult harbor seals in Prince William Sound, Alaska. Marine Mammal Science 17, pp. 835–861.

Levenson, D.H. and Schusterman, R.J. 1999. Dark adaptation and visual sensitivity in shallow and deep-diving pinnipeds. Marine Mammal Science 15, pp. 1303.

Madsen P.T., Wahlberg, M., Tougaard, J., Lucke, K., Tyack, P. 2006. Wind turbine underwater noise and marine mammals: implications of current knowledge and data needs. Marine Ecological Progress Series 309, pp. 279-295. doi:10.3354/meps309279.

McConnell, B., Dietz, R., Teilmann, J., Lonergan, M. 2013. Effect of Danish operating wind farms on seal movements. Abstract from 20th Biennial Conference on The Biology of Marine Mammals, Dunedin, New Zealand.

Mellinger, D.K., Carson, C.D., Clark, C.W. 2000. Characteristics of minke whale (*Balaenoptera acutorostrata*) pulse trains recorded near Puerto Rico. Marine Mammal Science 16(4), pp. 739-756.

Mellish, J.E., Hindle, A.G., Horning, M. 2009. A preliminary assessment of the impact of disturbance and handling on Weddel seals of McMurdo Sound, Antarctica. Antarctic Science 22(1), pp. 25-29.

Miersch, L., Hanke, W., Wieskotten, S., Hanke, F.D., Oeffner, J., Leder, A., Brede, M., Witte, M. and Dehnhardt, G. 2011. Flow sensing by pinniped whiskers Philosophical Transactions of the Royal Society of London **366**, doi: 10.1098/rstb.2011.0155.

Middlemas, S.J., Barton, T.R., Armstrong, J.D., Thompson, P.M. 2006. Functional and aggregative responses of harbour seals to changes in salmonid abundance. Proceedings of the Royal Society of London. Series B: Biological Sciences vol. 273(1583), pp. 193-198.

Miller, P.J.O., Biassoni, N., Samuels, A., Tyack, P.L. 2000. Whale songs lengthen in response to sonar. Nature 405, pp. 903.

Miller, P.J.O., Kvadsheim, P.H., Lam, F.P.A., Wensveen, P.J., Antunes, R., Alves, A.C., Visser, F., Kleivane, L., Tyack, P.L., Sivle, L.D. 2012. The severity of behavioral changes observed during experimental exposures of killer (*Orcinus orca*), long-finned pilot (*Globicephala melas*), and sperm (*Physeter macrocephalus*) whales to naval sonar. Aquatic Mammals 38(4), pp. 362-401.

Mooney, T.A., Hanlon, R.T. Christensen-Dalsgaard, J., Madsen, P.T., Ketten, D.R. and Nachtigall, P.E. 2010. Sound detection by the longfin squid (*Loligo pealeii*) studied with auditory evoked potentials: sensitivity to low-frequency particle motion and not pressure. The Journal of Experimental Biology 213, pp. 3748-3759.

Moore, M.J., van der Hoop, J., Barco, S.G., Costidis, A.M., Gulland, F.M., Jepson, P.D., Moore, K.T., Raverty, S., McLeilan, W.A. 2013. Criteria and case definitions for serious injury and death of pinnipeds and cetaceans caused by anthropogenic trauma. Diseases of Aquatic Organisms 103, pp. 229-264.

Müller, G. and Adelung, D. 2008. Harbour seals, wind farms and dead reckoning: Experiences from the German Wadden Sea. In Proceedings of the ASCOBANS ECSworkshop: offshore wind farms and marine mammals: impacts and methodologies for assessing impacts. 21 April 2007 San Sebastian, Spain. (Ed. P. G. H. Evans.) ECS Special Publication Series No. 49.

Nabe-Nielsen, J., Sibly, R.M., Tougaard, J., Teilmann, J., Sveegaard, S. 2014. Effects of noise and by-catch on a Danish harbour porpoise population. Ecological Modelling 272, pp. 242-251.

National Parks and Wildlife Service, Department of Arts, Heritage and Gaeltacht 2012. Harbour seal pilot monitoring project, 2011. Unpublished report.

National Parks and Wildlife Service 2013. Conservation Objectives: Galway Bay Complex SAC 000268. Version 1. National Parks and Wildlife Service, Department of Arts, Heritage and the Gaeltacht. Available online: http://www.npws.ie/media/npwsie/content/images/protectedsites/conservationobjectives/CO000268_V1.pdf.

Neo, Y.Y., Seitz, J., Kastelein, R.A., Winter, H.V., ten Cate, C., Slabbekoorn, H. 2014. Temporal structure of sound affects behavioural recovery from noise impact in European seabass. Biological Conservation 178, pp. 66-73.

Northridge, S., Tasker, M.L., Webb, A. and Williams, J.M. 1995. Distribution and relative abundance of harbor porpoises (*Phocoena phocoena* L.), white-beaked dolphins (*Lagenorhynchus albirostris* Gray), and minke whale (*Balaenoptera acutorostrata* Lacepede) around the British Isles. ICES Journal of Marine Science 52, pp. 55-66.

O'Brien, J. 2009. The inshore distribution and abundance of small cetaceans on the west coast of Ireland: Site assessment for SAC designation and an evaluation of monitoring techniques. Thesis, Marine Biodiversity Research Group, Department of life Sciences, Galway-Mayo Institute of Technology.

O'Brien, J.M., Berrow, S.D., Ryan, C, McGrath, D., O'Connor, I., Pesante, P., Burrows, G., Massett, N., Klötzer, V. & Whooley, P. 2009. A note on long-distance matches of bottlenose dolphins (*Tursiops truncatus*) around the Irish coast using photo-identification. Journal of Cetacean Research and Management 11(1), pp. 71–76.

Ó Cadhla, O., Strong, D., O'Keeffe, C., Coleman, M., Cronin, M., Duck, C., et al. 2007. An assessment of the breeding population of grey seals in the Republic of Ireland, 2005. Irish Wildlife Manuals. National Parks and Wildlife Service, Department of the Environment, Heritage and Local Government. Dublin, Ireland. pp. 49.

Oudejans, M.G., Visser, F., Englund, A., Rogan, E., Ingram, S.N. in review. Distinct inshore and offshore communities of bottlenose dolphins in the North East Atlantic, PloS One.

Oudejans, M.G., Ingram, S.N., Englund, A., Visser, F., Rogan, E. 2010. Bottlenose dolphins in Connemara and Mayo 2008-2009. Movement patterns between two coastal areas in the west of Ireland. Report to the National Parks and Wildlife Service Department of the Environment, Heritage and Local Government

Orians, G.H. and Pearson, N.E. 1979. On the theory of central place foraging. In: Analysis of ecological systems. (D. Horn, G. Stairs, and R. Mitchell, eds.). pp. 155-177. Ohio State Univ. Press, Columbus, OH.

Pascoe, P.L. 1986. Size data and stomach contents of common dolphins, *Delphinus delphis*, near Plymouth. Journal of the Marine Biological Association of the United Kingdom 66, pp. 319-322.

Pauli, B.D. and Terhune, J.M., 1987. Tidal and temporal interaction on harbour seal haul-out patterns Aquatic Mammals 13.3, pp. 93-95.

Payne, P. M. and Selzer, L. A. 1989. The distribution, abundance and selected prey of the harbour seal *Phoca vitulina* concolor, in S. New England. Marine. Mammal. Science 5, pp. 173-192.

Peich, L., Behrmann, G., and Kröger, R.H.H. 2001. For whales and seals the ocean is not blue: a visual pigment loss in marine mammals. European Journal of Neuroscience. 13, pp. 1520-1528.

Peterson, S.H., Lance, M.M., Jeffries, S.J., Acevedo-Gutierrez, A. 2012. Long distance movements and disjunct spatial use of harbor seals (*Phoca vitulina*) in the inland waters of the Pacific Northwest. PLoS ONE 7(6): e39046. doi:10.1371/journal.pone.0039046.

Picciulin, M., Sebastianutto, L., Codarin, A., Farina, A., Ferrero, E.A. 2010. *In situ* behavioural responses to boat noise exposure of *Gobius cruentatus* (Gmelin, 1789; fam. Gobiidae) and *Chromis chromis* (Linnaeus, 1758; fam. Pomacentridae) living in a Marine Protected Area. Journal of Experimental Marine Biology and Ecology 286, pp. 125-132.

Pierce, G. J., Thompson, P. M., Miller, A., Diack, J. S. W., Miller, D. and Boyle, P. R. 1991. Seasonal variation in the diet of common seals (*Phoca vitulina*) in the Moray Firth area of Scotland. Journal of Zoology, 223, pp. 641–652. doi: 10.1111/j.1469-7998.1991.tb04393.x.

Pierce, G.J. and Santos, M.B. 2003. Diet of harbour seals (*Phoca vitulina*) in Mull and Skye (Inner Hebrides, western Scotland). Journal of the Marine Biological Association of the UK, 83, pp 647-650. doi:10.1017/S0025315403007604h.

Pirotta, E., Laesser, B.E., Hardaker, A., Riddoch, N., Marcoux, M., Lusseau, D. 2013. Dredging displaces bottlenose dolphins from an urbanised foraging patch. Marine Pollution Bulletin 74, pp. 396-402.

Polacheck, T., Thorpe, L. 1990. The swimming direction of harbor porpoises in relationship to a survey vessel. International Whaling Commission 40, pp. 463-470.

Rako, N., Fortuna, C.M., Holcer, D., Mackelworth, P., Nimak-Wood, M., Pleslić, G., Sebastianutto, L., Vilibić, I., Wiemann, A., Picciulin, M. 2013. Leisure boating noise as a trigger for the displacement of the bottlenose dolphins of the Cres-Lošinj archipelago (northern Adriatic Sea, Croatia). Marine Pollution Bulletin 68, pp. 77-84.

Ries, E.H., Paffen, P., Traut, I.M., Goedhart, P.W. 1997. Diving patterns of harbour seals (*Phoca vitulina*) in the Wadden Sea, the Netherlands and Germany, as indicated by VHF telemetry. Canadian Journal of Zoology, 1997, 75(12), pp. 2063-2068, 10.1139/z97-840.

Richardson, W.J., Greene, C.R.Jr., Malme, C.I. and Thomson, D.H. 1995. Marine mammals and noise. Academic Press, San Diego, CA.

Robinson, S.P., Theobald, P.D., Hayman, G., Wang, L.S., Lepper, P.A., Humphrey, V., Mumford, S. 2011. Measurement of noise arising from marine aggregate dredging operations. Marine Aggregate Levy Sustainability Fund (MALSF) MEPF Ref no. 09/P108.

Santos, M.B. and Pierce, G.J. 2003. The diet of harbour porpoise (*Phocoena phocoena*) in the northeast Atlantic. Oceanography and Marine Biology: an Annual Review 41, pp. 355-390.

Sauvé, C.C., Van de Walle, J., Hammill, M.O., Arnould, J.P.Y., Beauplet, G. 2014. Stomach temperature records reveal nursing behaviour and transition to solid food consumption in an unweaned mammal, the harbour seal pup (*Phoca vitulina*). PLoS ONE 9(2): e90329. doi:10.1371/journal.pone.0090329.

Scheidat, M., Tougaard, J., Brasseur, S., Carstensen, J., van Polanen Petel, T., Teilmann, J. and Reijnders, P. 2011. Harbour porpoises (*Phocoena phocoena*) and wind farms: a case study in the Dutch North Sea. Environmental Research Letters 6.

Schneider, D.C. and Payne, P.M. 1983. Factors affecting haul-out of harbor seals at a site in southeastern Massachusetts. Journal of Mammalogy 64, pp. 518-520.

Schreer, J.F., Kovacs, K.M., O'Hara Hines, R.J. 2001. Comparative diving patterns of pinnipeds and seabirds. Ecological Monographs 71, pp. 137–162.

Schreer, J.F., Lapierre, J.L., Hammill, M.O. 2010. Stomach temperature telemetry reveals that harbor seal (*Phoca vitulina*) pups primarily nurse in the water. Aquatic Mammals 36, pp. 270–277.

Schusterman R.J., Kastak D., Levenson D.H., Reichmuth C.J., Southall B.L. 2000. Why Pinnipeds don't echolocate. Journal of the Acoustic Society of America 107, pp. 2256-2264.

Sharples, R.J., Moss, S.E., Patterson, T.A., Hammond, P.S. 2012. Spatial variation in foraging behaviour of a marine top predator (*Phoca vitulina*) determined by a large-scale satellite tagging program. PLoS ONE 7(5): e37216. doi:10.1371/journal.pone.0037216.

Silber, G.K., Vanderlaan, A.S.M., Arceredillo, A.T., Johnson, L., Taggart, C.T., Brown, M.W., Bettridge, S., Sagarminaga, R. 2012. The role of the International Maritime Organization in reducing vessel threat to whales: Process, options, action and effectiveness. Marine Policy 36, pp. 1221-1233.

Silva, M.A. 1999. Diet of common dolphins, *Delphinus delphis*, off the Portuguese continental coast. Journal of the Marine Biological Association of the United Kingdom 79, pp. 531-540.

Slabbekoorn, H., Bouton, N., van Opzeeland, I., Coers, A., ten Cate, C. and Popper, A.N. 2010. A noisy spring: the impact of globally rising underwater sound levels on fish. Trends in Ecology and Evolution 25, pp. 419-427.

Sonntag, R.P., Benke, H., Hiby, A.R., Lick, R., Adelung, D. 1999. Identification of the first harbour porpoise (*Phocoena phocoena*) calving ground in the North Sea. Journal of Sea Research 41, pp. 225-232.

Southall, B.L., Bowles, A.E., Ellison, W.T., Finneran, J.J., Gentry, R.L., Greene, C.R.Jr., Kastak, D,. Ketten, D.R., Miller, J.H., Nachtigall, P.E., Richardson, W.J., Thomas, J.A. and Tyack, P.L. 2007. Marine mammal noise exposure criteria: Initial scientific recommendations. Aquatic Mammals 33(4), pp. 411-509.

Teilmann, J. and Carstensen, J. 2012. Negative long term effects on harbour porpoises from a large scale offshore wind farm in the Baltic-evidence of slow recovery. Environmental Research Letters 7. doi:10.1088/1748-9326/7/4/045101.

Teilmann, J., Tougaard, J., Carstensen, J., Dietz, R., Tougaard, S. 2006. Summary on seal monitoring 1999-2005 around Nysted and Horns Rev Offshore Wind Farms. Technical report to Energi E2 A/S and Vattenfall A/S. Available online: http://188.64.159.37/graphics/Energiforsyning/Vedvarende_energi/Vind/havvindmoeller/vvm%20Horns%20Rev%202/begge%20parker/Samle%20rapport%20s%C3%A6ler%20final.pdf.

Thomas, A.C., Lance, M.M., Jeffries, S.J., Miner, B.G., Acevedo-Gutiérrez, A. 2011. Harbor seal foraging response to a seasonal resource pulse, spawning Pacific herring. MEPS, 441, pp. 225–239, doi: 10.3354/meps09370.

Thompson, D., Bexton, S., Brownlow, A., Wood, D., Patterson, T., Pye, K., Lonergan, M., Milne, R. 2010. Report on recent seal mortalities in UK waters caused by extensive lacerations. pp. 20. Sea Mammal Research Unit, Available online: http://www.smru.st-and.ac.uk/documents/366.pdf

Thompson, P.M., Miller, D., Cooper, R., Hammond, P.S. 1994. Changes in the distribution and activity of female harbour seals during the breeding season: implications for their lactation strategy and mating patterns. Journal of Animal Ecology 63, pp. 24–30.

Thompson, P.M., Tollit, D.J., Wood, D., Corpe, H.M., Hammond, P.S. and McKay, A. 1997. Estimating harbour seal abundance and status in an estaurine habitat in north-east Scotland. Journal of Applied Ecology, 34, pp. 43-52.

Thompson, P.M., Mackay, A., Tollit, D.J., Enderby, S. and Hammond, P.S. 1998. The influence of body size and sex on the characteristics of harbour seal foraging trips. Canadian Journal of Zoology 76, pp. 1044-1053.

Thompson, P.M. and Miller, D. 1990. Summer foraging activity and movements of radio-tagged common seals (*Phoca vitulina l.*) in the Moray Firth Scotland. Journal of Applied Ecology 27, pp. 492–501.

Thompson, P.M., Lusseau, D., Barton, T., Simmons, D., Rusin, J., Bailey, H. 2010. Assessing the responses of coastal cetaceans to the construction of offshore wind turbines. Marine Pollution Bulletin 60, pp. 1200-1208.

Thompson, P.M., Hastie, G.D., Nedwell, J., Barham, R., Brookes, K.L., Cordes, L.S., Bailey, H., McLean, N. 2013. Framework for assessing impacts of pile-driving noise from offshore wind farm construction on a harbour seal population. Environmental Impact Assessment Review 43, pp. 73-85.

Tollit, D.J. and Thompson, P.M. 1996. Seasonal and between-year variations in the diet of harbour seals in the Moray Firth, Scotland. Canadian Journal of Zoology 74 (6), pp. 1110-1121.

Tollit, D.J., Black, A.D., Thompson, P.M., Mackay, A., Corpe, H.M., Wilson, B., Van Parijs, S.M., Grellier, K. and Parlane, S. 1998. Variations in harbour seal *Phoca vitulina* diet and dive-depths in relation to foraging habitat. Journal of Zoology 244, pp. 209-222.

Tougaard, J., Carstensen, J., Bech, N.I. and Teilmann, J. 2006. Final report on the effect of Nysted Offshore Wind Farm on harbour porpoises Annual Report to EnergiE2 (Roskilde: NERI).

Tougaard, J. and Henriksen, O.D., Miller, L.A. 2009. Underwater noise from three types of offshore wind turbins: estimation of impact zones for harbor porpoises and harbor seals. Journal of Acoustical Society of America 125 (6), pp. 3766-3773.

Tregenza, N.J.C., Berrow, S.D., Hammond, P.S. and Leaper, R. 1997. Harbour porpoise (*Phocoena phocoena* L.) by-catch in set gillnets in the Celtic Sea. Journal of Marine Science 54, pp. 896-904

Tripovich, J.S., Hall-Aspland, S., Charrier, I., Arnould, J.P.Y. 2012. The behavioural response of Australian fur seals to motor boat noise. PLoS ONE 7(5), e37228.

Tubelli, A.A. and Zosuls, A., Ketten, D.R. and Yamato, M., Mountain, D.C. 2012. A prediction of the minke whale (*Balaenoptera acutorostrata*) middle-ear transfer function. Journal of the Acoustical Society of America 132 (5), pp. 3263-3272.

Urian, K.W., Duffield, D.A., Read, A.J., Wells, R.S. and Shell, E.D. 1996. Seasonality of reproduction in bottlenose dolphins, *Tursiops truncatus*. Journal of Mammalogy, 77(2), pp.394-403.

Urick, R.J., 1983. Principles of underwater sound. Third edition. McGraw-Hill, New York, NY. Reprinted 1996, Peninsula Publishing, Los Altos, CA.

Van Utrecht, W.L. 1978. Age and growth in *Phocoena phocoena* Linnaeus, 1758 (Cetacea, Odontoceti) from the North Sea. Bijdragen tot de Dierkunde 48, pp. 16-28.

Vanderlaan, A.S.M., Taggart, C.T. 2007. Vessel collisions with whales: the probability of lethal injury based on vessel speed. Marine Mammal Science 23(1), pp. 144-156.

Van Parijs, S.M., Thompson, P.M., Tollit, D.J., Mackay, A. 1997. Distribution and activity of male harbour seals during the mating season. Animal Behaviour 54, pp. 35–43.

Van Parijs, S.M., Hastie, G.D., Thompson, P.M, 2000a. Individual and geographical variation in display behaviour of male harbour seals in Scotland. Animal Behaviour 59, pp. 559–568, doi:10.1006/anbe.1999.1307.

Van Parijs, S.M., Janik, V.M., Thompson, P.M. 2000b. Display-area size, tenure length, and site fidelity in the aquatically mating male harbour seal, *Phoca vitulina.* Canadian Journal of Zoology, 2000, 78(12), pp. 2209-2217, 10.1139/z00-165.

Verwey, J. and Wolff, W.J. 1983. The common or harbour porpoise (*Phocoena phocoena*). In: W.J. Wolff, Ecology of the Wadden Sea. Vol. 2, part 7: Marine Mammals. A.A. Balkema, Rotterdam: 51-58.

Víkingsson, G.A. and Heide-Jørgensen, M.P. 2005. A note on the movements of minke whales tracked by satellite in Icelandic waters in 2001-2004. Document SC/57/09. Ulsan, Republic of Korea: The Scientific Committee of the International Whaling Commission.

Visser, F., Hartman, K.L., Valavanis, V.D., Pierce, G.J., and Huisman, J. 2011. Timing of migratory baleen whales at the Azores in relation to the North Atlantic spring bloom. Marine Ecology Progress Series 44, pp. 267-279.

Wall, D., Murray, C., O'Brien, J., et al. 2013. Atlas of the distribution and relative abundance of marine mammals in Irish offshore waters 2005 - 2011. Irish whale and dolphin group, Merchant Quay, Kilrush, Co. Clare. pp. 58.

Weinrich, M., Pekarcik, C., Tackaberry, J. 2010. The effectiveness of dedicated observers in reducing risks of marine mammal collisions with ferries: A test of the technique. Marine Mammal Science 26(2), pp. 460-470.

Wells, R.S. and Scott, M.D. 1997. Seasonal incidence of boat strikes on bottlenose dolphins near Sarasota, Florida. Marine Mammal Science 13(3), pp. 475-480.

Weir, C.R., Stockin, K.A. and Pierce, G.J. 2007. Spatial and temporal trends in the distribution of harbour porpoises, white-beaked dolphins and minke whales off Aberdeenshire (UK), north-western North Sea. Journal of the Marine Biological Association of the United Kingdom 87, pp. 327-338.

Westgate, A.J., Read, A.J. 2006. Reproduction in short-beaked common dolphins (*Delphinus delphis*) from the western North Atlantic. Marine Biology 150, pp. 1011-1024.

Williams, T.M. and Kooyman, G.L. 1985. Swimming performance and hydrodynamic characteristics of harbor seals *Phoca vitulina*. Physiological Zoology 58, pp. 576–589.

Wilson, K., Lance, M., Jeffries, S., Acevedo-Gutiérrez, A. 2014. Fine-scale variability in harbor Seal foraging behavior. PLoS ONE 9(4): e92838. doi:10.1371/journal.pone.0092838.

Yochem, P.K., Stewart, B.S., DeLong, R.L., and DeMaster, D.P. 1987. Diel haul-out patterns and site fidelity of harbour seals (*Phoca vitulina richardsi*) on San Miguel Island, California, in autumn. Marine Mammal Science. 3, pp. 323–333.

Galway Harbour Company

Galway Harbour Extension

Appendix RFI 3 - Birds

RFI 3.1	**Birds Raw Data**
RFI 3.2	**Species Profiles by Chris Peppiatt**
RFI 3.3	**Bird Species Assessments by Dr. Tom Gittings**

Appendix RFI 3 - Birds

RFI 3.1 Birds Raw Data

Bird Count Data - 2012/2013

Development site survey details, 2012-2013

Date	Start Time	Finish Time	Duration	High tide	Low tide	Description	Sea state	Cloud	Wind	Temp	Visibility (km)	Rain
10.10.2012	10:00	18:00	8 hours	13:12	20:19	High tide mid, falling later	1	100%	E, Beaufort 0-1	11	2 +	None
30.10.2012	09:00	17:00	8 hours	17:25	10:56	Low tide early; high late	1; 2-3	30%	NW, SW later, Beaufort 1-2; 3-4	9	5 +	None
16.11.2012	08:30	16:30	8 hours	18:45	12:12	Low mid, rising later	1-2	100%	SSW, Beaufort 2	9	5 +	Occ. Drizzle
27.11.2012	09:00	17:00	8 hours	17:45	11:15	Low mid, rising later	1	100%	SW, Beaufort 1-2	6	5 +	None
21.12.2012	08:00	16:00	8 hours	11:25	17:19	High tide mid, falling later	1-2	100%	SW, later SE; Beaufort 1-2; 2-3	7	5 +	None
27.12.2012	08:00	16:00	8 hours	16:46	10:21	Low tide early; nearly high before end	0	25%	SW, Beaufort 0-1	7	2	None
22.01.2013	08:00	16:00	8 hours	14:08	07:41	Low start; high 2 hr before end	1	50%	E, Beaufort 1-2	0-3	2 +	None
02.02.2013	09:00	17:00	8 hours	08:53	14:55	High start; low 2 hr before end	0-1	0%	W, Beaufort 1-2	5	5 +	None
22.02.2013	09:00	17:00	8 hours	15:34	08:59	Low tide start; high tide before end	1-2	100%	E, Beaufort 1-2	3	5 +	None
25.02.2013	09:00	17:00	8 hours	17:22	10:53	Low tide early; nearly full end	1	0%	E, Beaufort 1	3	5 +	None
04.03.2013	09:00	17:00	8 hours	09:39	15:23	High tide start; Low tide end	1	100%	ESE, Beaufort 1	5	3 +	None
14.03.2013	09:00	17:00	8 hours	18:57	12:24	Low tide mid; rising later	1-2	60-75%	W, Beaufort 1 start; 2/3 end	9	3 +	One short shower

Development site marine counts, 2012-2013

Species	10 Oct 2012	30 Oct 2012	16 Nov 2012	27 Nov 2012	21 Dec 2012	27 Dec 2012	22 Jan 2013	02 Feb 2013	22 Feb 2013	25 Feb 2013	04 March 2013	14 March 2013
Black-headed Gull	**10 (0)**	**6 (0)**	**10 (0)**	**0**	**15 (0)**	**0**	**1 (1)**	**12 (0)**	**2 (0)**	**22 (15)**	**10 (0)**	**0**
Brent Goose	**17 (0)**	**7 (0)**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2 (0)**	**17 (0)**	**0**
Common Gull	**19 (0)**	**0**	**4 (0)**	**10 (10)**	**15 (0)**	**10 (0)**	**2 (1)**	**8 (0)**	**0**	**8 (8)**	**0**	**0**
Red-breasted Merganser	**1 (0)**	**0**	**4 (0)**	**3 (1)**	**2 (2)**	**0**	**2 (0)**	**3 (0)**	**2 (0)**	**1 (0)**	**1 (0)**	**5 (0)**
Cormorant	**7 (5)**	**20 (1)**	**2 (2)**	**1 (1)**	**1 (1)**	**0**	**2 (1)**	**1 (1)**	**4 (2)**	**2 (0)**	**23 (2)**	**8 (2)**
Great Northern Diver	**0**	**2 (1)**	**5 (4)**	**2 (2)**	**6 (3)**	**6 (4)**	**3 (1)**	**9 (4)**	**4 (3)**	**7 (3)**	**10 (10)**	**8 (4)**
Wigeon	**0**	**0**	**0**	**0**	**0**	**0**	**1 (0)**	**0**	**3 (0)**	**4 (0)**	**2 (0)**	**2 (0)**
Great-crested Grebe	1 (1)	0	1 (0)	0	1 (1)	1 (0)	1 (1)	1 (0)	0	2 (0)	3 (0)	0
Shag	2 (1)	56 (56)	7 (5)	0	4 (3)	4 (1)	0	17 (3)	24 (12)	10 (0)	19 (19)	12 (2)
Great Black-backed Gull	2 (2)	1 (0)	1 (0)	0	2 (2)	0	0	2 (0)	0	3 (3)	2 (0)	1 (0)
Herring Gull	1 (0)	4 (0)	12 (0)	0	1 (1)	6 (0)	1 (1)	15 (0)	0	19 (12)	7 (1)	3 (0)
Mute Swan	6 (0)	0	2 (0)	0	0	2 (0)	0	4 (0)	1 (0)	2 (0)	2 (0)	2 (0)
Red-throated Diver	0	1 (0)	0	0	0	0	0	0	0	0	0	1 (0)
Razorbill	0	4 (2)	0	0	0	2 (0)	0	0	0	0	0	2 (0)
Common Scoter	0	2 (0)	0	0	0	0	0	0	0	0	0	0
Common Guillemot	0	0	0	0	0	6 (0)	0	0	0	0	0	0
Black Guillemot	0	0	0	0	0	0	0	0	0	0	0	1 (0)

Development site shore counts, 2012-2013

Species	10 Oct 2012	30 Oct 2012	16 Nov 2012	27 Nov 2012	21 Dec 2012	27 Dec 2012	22 Jan 2013	02 Feb 2013	22 Feb 2013	25 Feb 2013	04 March 2013	14 March 2013
Black-headed Gull	**0**	**7 (7)**	**1 (0)**	**1 (1)**	**0**	**1 (0)**	**0**	**2 (0)**	**0**	**1 (0)**	**0**	**0**
Common Gull	**0**	**1 (0)**	**0**	**0**	**0**	**1 (0)**	**0**	**2 (0)**	**0**	**1 (0)**	**0**	**0**
Cormorant	**0**	**6 (0)**	**2 (0)**	**0**	**0**	**2 (1)**	**0**	**0**	**0**	**0**	**0**	**1 (0)**
Grey Heron	**2 (1)**	**2 (1)**	**2 (1)**	**1 (1)**	**1 (0)**	**2 (2)**	**0**	**2 (0)**	**0**	**1 (1)**	**0**	**0**
Wigeon	**0**	**0**	**3 (0)**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2 (0)**	**2 (0)**
Turnstone	**0**	**1 (1)**	**7 (0)**	**0**	**1 (0)**	**4 (1)**	**0**	**7 (0)**	**5 (5)**	**2 (2)**	**6 (0)**	**1 (0)**
Curlew	**0**	**0**	**3 (1)**	**0**	**0**	**0**	**0**	**1 (0)**	**2 (2)**	**2 (0)**	**1 (0)**	**2 (0)**
Redshank	**0**	**1 (1)**	**0**	**0**	**0**	**1 (1)**	**0**	**1 (0)**	**0**	**1 (0)**	**1 (0)**	**1 (0)**
Shag	0	10 (7)	0	1 (1)	1 (0)	2 (1)	0	3 (0)	1 (1)	1 (1)	0	0
Herring Gull	1 (0)	2 (1)	2 (0)	0	1 (0)	0	0	8 (0)	0	2 (2)	0	2 (0)
Oystercatcher	0	0	5 (1)	0	0	4 (2)	0	2 (0)	3 (3)	5 (2)	1 (0)	3 (1)
Greenshank	0	1 (1)	0	0	0	1 (0)	0	0	1 (1)	1 (1)	1 (0)	0

Bearna Comparison Site Survey Details, 2012-2013

Date	Start Time	Finish Time	Duration	High tide	Low tide	Description	Sea	Cloud	Wind	Temp	Visibility (km)	Rain
12-Oct-12	10:00	18:00	8 hours	13:49		High tide mid, falling later	2	50%	SW, Beaufort 3-4	-	5 +	None
31-Oct-12	09:00	17:00	8 hours	18:02	11:30	Low tide mid, rising later	1	75%	W, Beaufort 1-2	7	5 +	None
17-Nov-12	08:30	16:30	8 hours		12:59	Low tide mid, rising later	1-2	25%	WSW, Beaufort 2-3	-	5 +	None
28-Nov-12	09:00	17:00	8 hours	18:34	12:01	Low tide mid, rising later	2-3	33%	SW, Beaufort 3-4	9	5 +	None
22-Dec-12	08:00	16:00	8 hours	12:31	18:31	High tide mid, falling later	2-3	100%	SW, Beaufort 3-4	5	2-3	Showers
29-Dec-12	08:00	16:00	8 hours	18:02	11:35	Low tide mid, rising later	2-3	30%	SW, Beaufort 3-4	8	5	None
23-Jan-13	09:00	17:00	8 hours	15:08	08:39	Low start; high later, falling again	1-2	60%	SW, Beaufort 2-3	3	5 +	Showers later
03-Feb-13	09:00	17:00	8 hours	09:48	15:47	High start, low later, falling again	1-2	100%	SW, Beaufort 3-4	8	2 +	Occ. drizzle
23-Feb-13	08:30	16:30	8 hours	16:11	09:39	Low early; high at end	0-1	100%	E, Beaufort 0-1	2-5	5 +	None
23-Feb-13	09:00	17:00	8 hours	17:56	11:27	Low mid; almost high end.	1	100%	E, Beaufort 1-2	4	5 +	None
04-Mar-13	09:00	17:00	8 hours	10:42	16:30	Low early; high end.	1	33%	E, Beaufort 1	8-9	3 +	None
15-Mar-13	09:00	17:00	8 hours	07:18	12:58	Falling early; low mid; rising at end	2	50%	W, Beaufort 3	8	3 +	None

Bearna Comparison Site Marine Counts

Species	12 Oct 2012	31 Oct 2012	17 Nov 2012	28 Nov 2012	22 Dec 2012	29 Dec 2012	23 Jan 2013	03 Feb 2013	23 Feb 2013	26 Feb 2013	05 March 2013	15 March 2013
Black-headed Gull	**71 (71)**	**4 (0)**	**2 (0)**	**1 (0)**	**0**	**0**	**0**	**0**	**3 (0)**	**0**	**1 (0)**	**0**
Brent Goose	**4 (0)**	**0**	**1 (0)**	**0**	**0**	**0**	**0**	**0**	**0**	**4 (4)**	**23 (0)**	**1 (0)**
Common Gull	**20 (0)**	**4 (1)**	**0**	**0**	**0**	**0**	**0**	**0**	**10 (0)**	**0**	**1 (0)**	**0**
Red-breasted Merganser	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2 (2)**	**4 (0)**	**9 (0)**	**0**
Cormorant	**16 (16)**	**1 (0)**	**2 (0)**	**1 (1)**	**0**	**1 (0)**	**1 (0)**	**0**	**5 (0)**	**5 (3)**	**2 (1)**	**2 (1)**
Great Northern Diver	**0**	**6 (6)**	**3 (0)**	**0 (0)**	**6 (6)**	**6 (6)**	**2 (2)**	**5 (4)**	**25 (13)**	**20 (17)**	**13 (10)**	**7 (5)**
Teal	**0**	**0**	**0**	**5 (0)**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Great-crested Grebe	1 (0)	0	0	0	0	0	0	0	0	0	0	0
Shag	45 (43)	22 (22)	15 (10)	3 (3)	3 (3)	3 (3)	6 (4)	11 (7)	46 (33)	25 (15)	39 (15)	12 (12)
Great Black-backed Gull	11 (0)	5 (0)		0	0	0	0	0	4 (0)	0	1 (0)	0
Herring Gull	410 (12)	21 (15)	2 (0)	0	0	0	0	0	12 (0)	0	4 (0)	2 (0)
Red-throated Diver	1 (1)	0	0	0	0	0	2 (0)	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)
Mute Swan	2 (2)	0	0	0	0	0	0	0	0	0	0	0
Mallard	12 (11)	2 (0)	17 (0)	5 (0)	0	16 (2)	7 (7)	1 (0)	2 (2)	4 (0)	2 (0)	0
Common Scoter	0	1 (1)	0		0	0	0	0	0	0	0	0
Razorbill	45 (2)	0	1 (0)	1 (0)	0	1 (1)	12 (0)	0	2 (0)	2 (0)	9 (0)	5 (0)
Common Guillemot	11 (0)	0	0	0	0	0	0	0	0	0	2 (0)	0
Black Guillemot	0	0	0	0	0	0	0	0	0	1 (0)	0	0
Gannet	1 (1)	0	0	0	0	0	0	0	0	0	0	0

Bearna Comparison Site Shore Counts

Species	12 Oct 2012	31 Oct 2012	17 Nov 2012	28 Nov 2012	22 Dec 2012	29 Dec 2012	23 Jan 2013	03 Feb 2013	23 Feb 2013	26 Feb 2013	05 March 2013	15 March 2013
Cormorant	**11 (11)**	**3 (0)**	**7 (7)**	**0**	**0**	**0**	**1 (1)**	**0**	**1 (1)**	**5 (0)**	**0**	**1 (0)**
Grey Heron	**15 (0)**	**2 (1)**	**4 (4)**	**0**	**0**	**2 (0)**	**0**	**0**	**1 (0)**	**2 (2)**	**0**	**6 (0)**
Black-headed Gull	**63 (22)**	**5 (0)**	**6 (6)**	**10 (10)**	**0**	**10 (10)**	**65 (23)**	**0**	**1 (0)**	**7 (3)**	**0**	**3 (3)**
Common Gull	**29 (1)**	**6 (6)**	**3 (0)**	**10 (10)**	**0**	**1 (1)**	**13 (1)**	**1 (0)**	**14 (14)**	**15 (12)**	**3 (0)**	**8 (8)**
Sandwich Tern	**4 (0)**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Brent Goose	**0**	**0**	**1 (0)**	**23 (23)**	**0**	**0**	**14 (12)**	**0**	**39 (28)**	**20 (0)**	**23 (7)**	**21 (4)**
Teal	**0**	**0**	**0**	**3 (3)**	**0**	**0**	**0**	**0**	**0**	**0**	**1 (0)**	**0**
Bar-tailed Godwit	**4 (4)**	**5 (0)**	**4 (1)**	**13 (0)**	**12 (12)**	**12 (12)**	**4 (1)**	**25 (0)**	**21 (21)**	**20 (16)**	**6 (3)**	**16 (0)**
Redshank	**4 (1)**	**1 (1)**	**1 (0)**	**2 (0)**	**0**	**2 (2)**	**4 (4)**	**0**	**3 (1)**	**1 (0)**	**4 (0)**	**1 (0)**
Dunlin	**0**	**0**	**0**	**4 (0)**	**0**	**0**	**0**	**0**	**30 (30)**	**51 (49)**	**0**	**9 (0)**
Curlew	**4 (2)**	**3 (2)**	**5 (1)**	**2 (1)**	**2 (2)**	**5 (3)**	**3 (2)**	**5 (3)**	**4 (4)**	**2 (2)**	**5 (3)**	**5 (2)**
Turnstone	**30 (0)**	**11 (11)**	**5 (5)**	**3 (0)**	**0**	**0**	**4 (2)**	**25 (0)**	**0**	**3 (0)**	**21 (0)**	**1 (0)**
Ringed Plover	**0**	**1 (0)**	**0**	**3 (3)**	**0**	**0**	**1 (1)**	**0**	**2 (0)**	**4 (0)**	**2 (0)**	**0**
Shag	131 (56)	3 (1)	24 (24)	0	0	1 (1)	5 (5)	0	11 (3)	17 (11)	15 (5)	7 (0)
Little Egret	1 (0)	1 (0)	0	0	0	1 (0)	0	2 (0)	1 (1)	0	0	0
Great Black-backed Gull	18 (14)	3 (3)	4 (4)	1 (0)	0	0	0	0	4 (2)	2 (2)	1 (0)	2 (0)
Herring Gull	160 (3)	12 (12)	10 (10)	1 (1)	0	4 (4)	5 (2)	4 (1)	11 (9)	10 (3)	1 (0)	24 (1)
Mallard	2 (2)	6 (4)	4 (3)	6 (5)	0	3 (3)	6 (1)	0	2 (0)	2 (2)	1 (0)	0
Purple Sandpiper	0	1 (0)	0	0	0	0	0	0	0	0	0	0
Greenshank	1 (1)	3 (3)	1 (0)	0	0	0	2 (2)	2 (0)	2 (0)	1 (1)	1 (0)	1 (0)
Oystercatcher	16 (2)	11 (8)	13 (7)	7 (2)	8 (8)	6 (4)	14 (14)	11 (6)	9 (4)	9 (5)	26 (4)	7 (0)
Snipe	0	0	0	0	0	0	1 (1)	0	1 (0)	0	0	0
Grey Plover	0	0	0	0	0	0	1 (1)	1 (0)	0	1 (0)	0	0

Bird Count Data - 2014

Development site survey details, 2014

Date	Start Time	Finish Time	Duration	High tide	Low tide	Description	Sea	Cloud	Wind	Temp	Visibility (km)	Rain
04-Mar-14	08:00	16:00	8 hours	07:00	12:48	High start, low mid, rising at end.	1	100%	SW, Beaufort 0-1	9-10	3 +	None
08-Apr-14	12:00	20:00	8 hours	12:26	19:10	High start, through low, rising at end	2	50%	W, Beaufort 3	6-11	3 +	None
14-May-14	08:30	16:30	8 hours	17:52	11:26	Low mid, rising towards end	1	100%	W, Beaufort 1	13	5 +	None
14-Jun-14	08:45	16:45	8 hours	18:58	12:28	Low mid, rising towards end	0-1	100%	SW, Beaufort 0-1	16-20	3 +	None
17-Jul-14	09:00	17:00	8 hours	09:39	15:25	Rising start, high early, low and then rising at end	0-1	100%	SE, Beaufort 0-1	17	4-5	Light between 10:00 & 10:30
27-Aug-14	07:00	15:00	8 hours	07:12	12:43	High start, low mid, rising at end.	2-3	100%	E, Beaufort 3; then SE 4	16	3-5 +	Some after 14:00
27-Sep-14	11:00	19:00	8 hours	19:54	13:25	Falling start, low mid, nearly high by end	2	50-100%	SW, Beaufort 2	18-20	3 +	None

Development site marine counts, 2014

Species	04 Mar 2014	08 Apr 2014	14 May 2014	14 Jun 2014	17 Jul 2014	27-Aug-2014	27-Sep-2014
Black-headed Gull	**15 (0)**	**0**	**0**	**4 (0)**	**10(0)**	**0**	**0**
Common Gull	**2 (0)**	**0**	**0**	**0**	**0**	**0**	**0**
Red-breasted Merganser	**11 (3)**	**0**	**0**	**0**	**0**	**0**	**0**
Wigeon	**3 (0)**	**0**	**0**	**0**	**0**	**0**	**0**
Cormorant	**1 (0)**	**3 (3)**	**5 (0)**	**2 (0)**	**3(1)**	**2(0)**	**3(2)**
Great Northern Diver	**10 (6)**	**6 (6)**	**8 (5)**	**1 (1)**	**0**	**0**	**0**
Sandwich Tern	**0**	**6 (0)**	**6 (4)**	**2 (2)**	**2(0)**	**11(5)**	**4(1)**
Common Tern	**0**	**0**	**10 (8)**	**14 (2)**	**12(9)**	**10(4)**	**2(0)**
Shag	17 (6)	5 (4)	0	0	0	0	1(0)
Great Black-backed Gull	5 (0)	0	2 (0)	0	3(0)	1(0)	1(0)
Herring Gull	33 (0)	4 (0)	5 (0)	1 (0)	0	0	10(0)
Mute Swan	3 (0)	2 (0)	1 (0)	3 (0)	2(0)	0	1(0)
Mallard	0	0	1 (0)	0	0	0	0
Scaup	2 (0)	0	0	0	0	0	0
Manx Shearwater	0	28 (0)	0	0	0	0	0
Razorbill	0	2 (1)	0	0	0	0	0
Common Guillemot	1 (0)	4 (4)	1 (1)	0	0	0	0
Gannet	0	0	0	0	0	2(0)	0

Development site shore counts, 2014

Species	04 Mar 2014	08 Apr 2014	14 May 2014	14 Jun 2014	17 Jul 2014	27-Aug-2014	27-Sep-2014
Black-headed Gull	**7 (0)**	**0**	**0**	**0**	**0**	**4(0)**	**1(0)**
Common Gull	**2 (0)**	**0**	**0**	**0**	**0**	**0**	**0**
Common Tern	**0**	**0**	**1 (0)**	**0**	**0**	**0**	**0**
Cormorant	**1 (0)**	**0**	**0**	**0**	**0**	**0**	**2(0)**
Grey Heron	**2 (0)**	**0**	**1 (1)**	**1 (1)**	**1(0)**	**1(0)**	**1(0)**
Brent Goose	**0**	**2 (0)**	**0**	**0**	**0**	**0**	**0**
Turnstone	**10 (0)**	**0**	**0**	**0**	**0**	**0**	**3(0)**
Curlew	**3 (0)**	**0**	**0**	**0**	**0**	**1(0)**	**4(0)**
Ringed Plover	**0**	**0**	**1 (0)**	**0**	**0**	**0**	**0**
Redshank	**1 (0)**	**0**	**0**	**0**	**0**	**1(0)**	**2(0)**
Little Egret	0	0	1 (0)	0	0	0	0
Shag	1 (0)	0	0	0	0	0	1(0)
Mallard	0	1 (0)	0	0	0	0	0
Herring Gull	3 (0)	1 (0)	1 (0)	3 (0)	1(0)	8(0)	29(0)
Great Black-backed Gull	0	0	1 (0)	0	0	0	1(0)
Oystercatcher	3 (0)	0	0	0	0	1(0)	5(0)
Greenshank	1 (0)	0	0	0	0	1(0)	0

Bearna Comparison Site Survey Details, 2014

Date	Start Time	Finish Time	Duration	High tide	Low tide	Description	Sea	Cloud	Wind	Temp	Visibility (km)	Rain
05-Mar-14	09:00	17:00	8 hours	07:42	13:27	High early, then through low, rising at end	3	100%	SW, Beaufort 4	10	3 +	None
05-Apr-14	10:00	18:00	8 hours	09:44	15:24	High early, then through low, rising at end	1	100%	SW, Beaufort 0; 1-2	14-15	2 +	Shower @ 16:30
13-May-14	08:00	16:00	8 hours	17:15	10:52	Low mid, rising towards end	1	50%	NW, then W; Beaufort 2-3	10-12	3 +	Two light showers
13-Jun-14	08:00	16:00	8 hours	18:11	11:44	Low mid, rising towards end	2	80-100%	SW, Beaufort 3-4	16-18	2 early, 5 later	Some early drizzle
16-Jul-14	08:00	16:00	8 hours	08:49	14:35	Rising start, high early, low and then rising at end	2-3	50-80%	SW, Beaufort 3-4	20	3 +	Two short showers
26-Aug-14	07:00	15:00	8 hours	18:52	12:11	High early, low mid, rising at end	1-2	100%	NE, Beaufort 3	17-18	5 +	None
26-Sep-14	10:00	18:00	8 hours	19:27	12:50	Falling start, low mid, nearly high by end	1-2	15%	W, Beaufort 2-3	16-18	5 +	One short shower early

Bearna Comparison Site Marine Counts, 2014

Species	05 Mar 2014	05 Apr 2014	13 May 2014	13 Jun 2014	16 Jul 2014	26 Aug 2014	26 Sep 2014
Black-headed Gull	**2 (0)**	**1 (0)**	**3 (0)**	**0**	**0**	**0**	**18(10)**
Common Gull	**0**	**10 (0)**	**0**	**0**	**0**	**0**	**2(1)**
Cormorant	**2 (0)**	**3 (0)**	**2 (1)**	**1 (0)**	**1(0)**	**7(3)**	**2(2)**
Great Northern Diver	**7 (6)**	**39 (4)**	**5 (2)**	**1 (0)**	**0**	**0**	**0**
Sandwich Tern	**0**	**2 (0)**	**9 (0)**	**14 (0)**	**8(3)**	**9(5)**	**7(2)**
Common Tern	**0**	**0**	**13 (2)**	**1 (0)**	**3(2)**	**2(0)**	**0**
Red-throated Diver	1 (0)	9 (0)	0	0	0	0	0
Shag	12 (8)	16 (11)	2 (0)	0	0	8(6)	0
Great Black-backed Gull	0	2 (0)	0	0	1(0)	0	1(0)
Herring Gull	0	10 (0)	0	0	0	0	2(1)
KIttiwake	0	0	0	0	0	2(0)	0
Sabine’s Gull	0	0	0	0	0	1(0)	0
Arctic Skua	0	0	1 (0)	0	0	0	0
Mallard	0	2 (0)	0	0	0	5(0)	5(0)
Manx Shearwater	0	1 (0)	0	30 (15)	120(51)	1(0)	0
Balearic Shearwater	0	0	0	0	1(0)	0	0
Storm Petrel	0	0	0	0	1(0)	0	0
Razorbill	0	30 (0)	2 (0)	5 (2)	4(0)	16(4)	5(5)
Common Guillemot	0	15 (0)	4 (0)	2 (0)	0	0	0
Black Guillemot	0	2 (0)	1 (0)	0	0	0	0
Gannet	0	0	0	3 (0)	1(0)	4(0)	1(0)

Bearna Comparison Site Shore Counts, 2014

Species	05 Mar 2014	05 Apr 2014	13 May 2014	13 Jun 2014	16 Jul 2014	26 Aug 2014	26 Sep 2014
Cormorant	**0**	**2 (0)**	**6 (0)**	**3 (1)**	**1(0)**	**0**	**3(0)**
Grey Heron	**0**	**2 (0)**	**2 (1)**	**2 (0)**	**1(0)**	**2(0)**	**6(3)**
Black-headed Gull	**0**	**0**	**17 (2)**	**2 (0)**	**14(0)**	**2(0)**	**15(0)**
Common Gull	**7 (0)**	**3 (0)**	**15 (1)**	**1 (0)**	**2(0)**	**28(4)**	**34(34)**
Common Tern	**0**	**0**	**23 (0)**	**0**	**0**	**0**	**0**
Sandwich Tern	**0**	**4 (0)**	**1 (0)**	**0**	**0**	**1(0)**	**23(18)**
Brent Goose	**6 (0)**	**25 (0)**	**0**	**0**	**0**	**0**	**0**
Teal	**1 (0)**	**0**	**0**	**0**	**0**	**0**	**2(0)**
Bar-tailed Godwit	**11 (0)**	**0**	**0**	**0**	**0**	**2(0)**	**2(0)**
Redshank	**1 (0)**	**0**	**0**	**0**	**5(0)**	**3(0)**	**3(1)**
Dunlin	**200 (0)**	**3 (0)**	**0**	**0**	**0**	**0**	**14(0)**
Curlew	**3 (0)**	**0**	**0**	**4 (4)**	**7(0)**	**2(0)**	**4(2)**
Turnstone	**1 (0)**	**1 (0)**	**0**	**0**	**0**	**5(0)**	**9(0)**
Ringed Plover	**0**	**1 (0)**	**0**	**0**	**0**	**0**	**0**
Shag	2 (0)	3 (0)	4 (1)	0	0	5(0)	0
Little Egret	2 (0)	1 (0)	0	1 (0)	0	2(0)	2(0)
Great Black-backed Gull	1 (0)	1 (0)	1 (1)	2 (0)	3(0)	16(0)	3(3)
Lesser Black-backed Gull	0	0	0	0	2(0)	2(0)	0
Herring Gull	0	2 (0)	5 (0)	6 (0)	3(0)	49(4)	21(13)
Mallard	1 (0)	0	4 (0)	0	0	6(0)	1(1)
Purple Sandpiper	0	1 (0)	0	0	0	0	0
Greenshank	1 (0)	2 (0)	0	0	0	1(0)	3(0)
Oystercatcher	5 (0)	9 (4)	5 (2)	7 (0)	1(0)	8(5)	14(13)
Whimbrel	0	0	1 (1)	0	0	1(0)	0
Sanderling	0	6 (0)	0	0	0	0	1(0)
Common Sandpiper	0	0	0	0	0	2(0)	0

Appendix RFI 3 - Birds

RFI 3.2 Species Profiles by Chris Peppiatt

Bird Species Profiles
By
Dr. Chris Peppiatt

A detailed desk study of national and international publications was undertaken for each of the species and is presented below. In addition, waterbird monitoring of the GHE count area has been carried out through monthly counts from March 2011 – March 2012 (as presented in the EIS and NIS) in addition to October 2012 – March 2013 and from March – September 2014. The full data set is presented in Appendix 2.7 and is presented as ***additional information*** to that which was included within the EIS and NIS. Therefore, the interpretations of the data and maximum counts differ from the information originally presented and the information below should be considered ***to supersede*** the information presented in the NIS and EIS. Each count involved an eight hour watch from a vantage point at the northern edge of the GHE development site. Maximum counts of all species were recorded for each 30 minute interval during these counts. Some counts also recorded bird numbers in the adjacent intertidal areas at Renmore Beach and the eastern end of Nimmo's Pier – South Park Shore. It is considered that the full data set is sufficient to characterise the birds at the site.

Species Profiles
These species profiles, prepared by Dr. Chris Peppiatt, with input from Dr. Tom Gittings, include general reviews of species ecology, Irish status and distribution, occurrence within Inner Galway Bay; detailed assessment of their occurrence within and adjacent to the development site; and a review of their sensitivities to potential impacts. The profiles cover 14 of the 20 SCI species: Light-bellied Brent Goose, Wigeon, Red-breasted Merganser, Great Northern Diver, Cormorant, Grey Heron, Bar-tailed Godwit, Curlew, Redshank, Turnstone, Black-headed Gull, Common Gull, Sandwich Tern and Common Tern.

The remaining six SCI species (Teal, Shoveler, Ringed Plover, Golden Plover, Lapwing, and Dunlin) have never, or only very rarely been recorded within the development site and it is considered that the habitat conditions are unsuitable for these species. Two of these species (Ringed Plover and Dunlin) have been recorded in adjacent areas, but only occurred irregularly and in very small numbers, so any potential disturbance impacts are not considered likely to be significant.

(i) Black-headed Gull (*Chroicocephalus ridibundus*)

Background Information

Species Habits and Preferences

This species forms nesting colonies on the margins of lakes, lagoons, slow-flowing rivers, deltas, estuaries and on tussocky marshes, but may also nest on the upper zones of saltmarshes, coastal dunes and offshore islands in more coastal areas. The species will also utilise artificial sites such as sewage ponds, gravel- and clay-pits, ponds, canals and floodlands and may nest on the dry ground of heather moors, sand-dunes and beaches. During the winter the species is most common in coastal habitats and tidal inshore waters, showing a preference for inlets or estuaries with sandy or muddy beaches, and generally avoiding rocky or exposed coastlines. It may also occur inland during this season, frequenting ploughed fields, moist grasslands, urban parks, sewage farms, refuse tips, reservoirs, lakes, turloughs, ponds and ornamental waters. Roosting often occurs on inland lakes and reservoirs. Black-headed Gulls roost communally at night and may commute long distances between foraging areas and their nocturnal roosts. Irish wintering distribution is widespread, both inland and at the coast. Black-headed Gull can forage in a variety of ways and is a member of the surface swimmer, water column diver (shallow; maximum depth one metre), intertidal walker (out of water), intertidal walker (in water) and terrestrial walker trophic guilds. A wide range of prey items are taken including insects (beetles, flies, dragonflies, grasshoppers and crickets, mayflies, stoneflies, caddisflies), oligochaete and polychaete (at coast) worms, slugs, marine and freshwater molluscs, small fish, amphibians, carrion and items from rubbish dumps. Generally breeding birds forage at maximum distances of 12-30 kilometres from the colony. Birds are fully mature after two years and the oldest recorded individual was 32 years ten months old.

The birds that breed in Ireland are part of the W Europe/W Europe W Mediterranean West Africa population that breeds in north and west Europe and south Greenland and winters in south and west Europe. The size of this breeding population is estimated at 3.7 to 4.8 million individuals. The population trend is currently stable and the European population has been assessed as secure. Birds are present in Ireland during the whole year, with resident birds being joined by numbers of wintering visitors from northern and eastern Europe. Black-headed Gull is red-listed in BoCCI 2014-2019 (Colhoun and Cummins, 2013) due to the severe decline in its breeding population, which was approximately 14,000 AON when surveyed for the Seabird 2000 project during the period 1998-2002 (Mitchell *et al*., 2004). There is no estimate available of the size of the Irish wintering population. Irish birds are generally resident, although dispersal has been noted to continental Europe. Worldwide, there are six flyway populations of Black-headed Gull, breeding in eastern Europe, Russia, Kamchatka, central Asia, China, North-east U.S.A. and South-east Canada. Wintering populations are also found in the Mediterranean, North and East Africa, Central, South and South-east Asia, Japan, Korea, China and North-east U.S.A.

Species Sensitivities

The species is susceptible to avian influenza and avian botulism so may be threatened by future outbreaks of these diseases. It may also be threatened by future coastal oil spills and has suffered local population declines in the past as a result of egg collecting. In some areas of its breeding range the species may also suffer from reduced reproductive successes due to contamination with chemical pollutants. In Ireland, it is thought that breeding declines may be due to predation at colonies by American Mink.

It has been predicted (Huntley *et al*., 2007) that, as a result of climate change, the overall European breeding range of Black-headed Gull will be reduced and shifted northwards by the late 21st century. Most of the southern half of the present breeding distribution (including the Republic of Ireland, Wales and much of southern England) is predicted to become unsuitable for the species, while only limited northward extension of suitable areas is predicted, to Northernmost Norway and Russia, Novaya Zemyla and Svalbard. It is difficult to predict what these changes might have on the Irish wintering population of Black-headed Gull were they to occur; due to the wide-ranging nature of this species it is probable that birds would still winter around the Irish coast, although the numbers doing so could decline.

Black-headed Gull is relatively tolerant of human disturbance. Furness *et al*. (2012) gave Black-headed Gull a low vulnerability score for disturbance by ship traffic and this species habitually occurs in close proximity to human activity. However, the species may be more sensitive to disturbance at its breeding colonies, and, in winter, at large nocturnal roosts.

Population size and distribution within Inner Galway Bay

During the period from winter 2001/02 to 2008/09 the peak I-WeBS count in the Inner Galway Bay SPA varied between 1,230 and 3,153, with a mean of 2,148 for the period from 2004-2008 (Boland and Crowe, 2012). The Inner Galway Bay wintering population has been assessed as being in favourable condition with an increase of 8% between 1994/5-2007/08 (NPWS, 2013).

Black-headed Gulls occur throughout Inner Galway Bay. In the BWS low tide counts, the main concentrations occurred along the northern shore of the bay, possibly reflecting the proximity to Galway Docks and other urban feeding habitats. The locations of the nocturnal roost sites are not known.

Black-headed Gulls can utilise a wide range of habitats for foraging and roosting. In the BWS low tide counts, the majority of birds occurred in intertidal habitats (mean of 62% of the total counts, and 79% of the counts of foraging birds, with smaller numbers in subtidal habitat (25%, 19%). The numbers recorded in supratidal/terrestrial habitat were low (13%, 2%), but this reflected the definition of the subsites and large numbers of the species feed in fields, etc. around Inner Galway Bay.

Site Specific Comments Re. Habits, Preferences and Sensitivities

Black-headed Gull has been regularly recorded in the development study area (as recorded in the NIS and EIS), with maxima of 69 birds using the site for foraging during the period from March 2011 to March 2012 (recorded on seven out of 18 watches; mean peak count of 5 birds, next largest count 12 birds and all other counts either zero or less than ten birds), 23 birds during the period from October 2012 to March 2013 (recorded on eleven out of twelve watches; mean peak count of 8 birds) and 22 birds during the period from April to June 2014 (recorded on two out of four watches, mean peak count of seven birds). The mean total counts within the GHE count area in the two winter seasons monitored were 7.3 (2011/12) and 8.4 (2012/13), compared to maximum counts of 69 (2011/12) and 24 (2012/13).

Whilst in the study area they have been observed to forage on the shoreline, to feed from the surface of the water and to rest briefly on the water. Birds regularly rest on buoys within the marine part of the study area. True roosting behaviour was not observed within the development site study area, either on the foreshore or on the water. Unlike the pattern observed in the BWS low tide counts, the majority of birds observed in the GHE counts were in the subtidal zone.

Black-headed Gull was also regularly recorded in adjacent areas. Large numbers can occur in Nimmo's Pier-South Park Shore (mean 132, range 0-300, across the 2011/12 and 2012/13 winters), while numbers in Renmore Beach are low (mean of 3, range 0-7, across the 2011/12 and 2012/13 winters).

(ii) Cormorant (*Phalacrocorax carbo*)

Background Information

Species Habits and Preferences

The species breeds in a wide variety of habitats in coastal and inland areas. Along the coast it may breed on cliff ledges from just above high water to 100 metres, although often undisturbed islands are used, where (as at Deer Island) the nests can be on flat ground. Breeding sites can also be inland on lake islands, where nesting may be on the ground or on trees (which are usually killed by the birds' guano after a few years, but can still be used until they become unstable). Breeding colonies may number a few hundred to over a thousand nests. Throughout the year birds may forage along the coast, close inland to water depths of 30-35 metres, in estuaries, lagoons and in shallow inland waters like lakes and ponds, rivers and reservoirs. Roosting is at the breeding colony during the breeding season. Outside the breeding season, Cormorants roost communally, often in large groups close to their foraging areas on rocks and sandbanks, at nocturnal roost sites on small islands, steep cliffs and in groups of trees surrounded by water, and may commute considerable distances to and from these roosts. During the day, they may roost in smaller groups on rocks and sandbanks close to their foraging areas.

Cormorant is a member of the water column diver (deeper) trophic guild. It is a specialist predator that feeds mostly by diving from the surface for prey. Cormorant often forage alone, but there are sometimes large feeding flocks of up to several hundred birds. Such flock-feeding is associated with schooling prey and (in some areas) with shallow, often turbid, water; the flock move slowly forwards with ranks of birds diving almost synchronously in successive waves, driving fish before them towards the surface. In clear waters they may use visual pursuit-diving after individual prey but in turbid waters probably forage by disturbing prey from the substrate or from hiding places which are grabbed at short range. Foraging occurs mainly during the day. Prey items are usually benthic fish over bare or vegetated substrates, although schooling fish like Sandeels are also taken and individuals shift flexibly between benthic and pelagic foraging. The maximum dive depth is 30-35 metres, although on average probably more usually around ten metres.

Cormorants generally prefer waters less than 10 m deep for foraging (Skov et al., 1995, quoted by Kober et al., 2010; Seabird Wikispace). Prey items comprise mainly fish of less than 20 centimetres in length, but fish up to 75 centimetres or 1.5 kilograms are occasionally taken. Marine prey includes: Sandeels, Sprat, Herring, Whiting, Cod, Saithe, Pollack, Dab, Plaice, Butterfish, blennies, Eel and crabs. Recorded foraging distances from the breeding colony are varied, with a maximum claimed of 50 kilometres, a mean of maximum foraging distances of approximately 30 kilometres and a mean of approximately 10 kilometres. In general it is safe to say that the majority of birds forage within 15 kilometres of the colony during the breeding season. Birds are fully mature after two to four years, typical lifespan is 15 years and the oldest recorded individual was 22 years old.

The birds that breed in Ireland are mainly sedentary, with dispersal of birds from breeding areas at other times of year. The Irish population is North-west European population of the subspecies *P. c. carbo*. The size of this breeding population is estimated at about 120,000 individuals. The population trend is currently increasing. The All-Ireland breeding population is approximately 5,180 AON (Seabird 2000). The all-Ireland wintering population is estimated at 11,920 birds (Crowe and Holt, 2013). Worldwide, there are also breeding populations in Iceland, Greenland, north-eastern North America, right across the mid latitudes of Russia to the Pacific, Japan, India, China, Australia, New Zealand, the north-western Atlantic coast of Africa, southern Africa and central Africa.

Species Sensitivities

Breeding birds are very loyal to traditional nest sites, even if they experience persecution there. Cormorant can be vulnerable to drowning after entanglement is fishing nets. This species is also often the target of the animosity of fishing and fishery management interests and they can then experience (illegal) persecution. Although hunted for food in the Middle East, this does not occur in the range of the Irish population. Pollution and changes to/depletion of fish stocks are also important threats.

It has been predicted (Huntley *et al*., 2007) that, as a result of climate change, the overall breeding range of Cormorant will remain similar to the situation at present, although there may be slight shift to the North, including in Ireland, Britain and continental Europe, with a predicted expansion in Iceland.

Cormorant feed by diving in the sea and often rest close to water. Thus they are vulnerable to oil spills, both in the sense of direct oiling of the birds and due to contamination of and/or shortage of suitable prey in the aftermath of a spill.

There appears to be little published evidence about the sensitivity of Cormorants to human disturbance. Furness *et al*. (2012) gave Cormorant a high vulnerability score for disturbance by ship traffic, referring to “moderate distance flush”. However, in Cork Harbour, Cormorants regularly feed within, and around, the shipping channel at the mouth of the harbour (Roches Point) and do not flush when ships pass (T. Gittings, personal observations). Cormorants regularly feed in the upper reaches of estuaries, close to harbours and docks, and in small waterbodies in close proximity to human activity. Inner Galway Bay is the sixth most important site in the Republic of Ireland for wintering Cormorants (Boland and Crowe, 2012).

Population size and distribution within Inner Galway Bay

During winter the SPA regularly supports 1% or more of the all-Ireland population of Cormorant. The mean peak number of this species within the SPA during the baseline period (1995/96 – 1999/00) was 266 individuals, compared to 263 individuals in recent years (2005/06-2008/09). The Inner Galway Bay wintering population has been assessed as being in favourable condition with an increase of 43% between 1994/5-2007/08, compared to a national increase of 32% over the same period (NPWS, 2013).

The site is also selected for its breeding population of Cormorant. There is a single colony, located at Deer Island in the south-western part of the SPA. In 2000, as part of the Seabird 2000 survey, 200 pairs of Cormorant (based on apparently occupied nests, AON) were estimated on Deer Island; exceeding the All-Ireland 1% threshold and making the site of national importance for this species. In 2010, 128 AON were recorded (Alyn Walsh, NPWS, pers. comm.).

The breeding colony at Deer Island may also be used as a nocturnal roost site during winter. The locations of other nocturnal roost sites in Inner Galway Bay are not known.

The distribution of foraging Cormorants in summer is not known. However, as the entire area of Inner Galway Bay is within the potential foraging range of the Deer Island colony, it may be reasonable to assume that birds are more or less uniformly distributed throughout suitable subtidal habitat (as in winter).

Site Specific Comments Re. Habits, Preferences and Sensitivities
Cormorant has been regularly recorded in the development study area (as recorded in the NIS and EIS), with maxima of 6 birds using the site for foraging during the period from March 2011 to March

2012 and 23 birds during the period from October 2012 to March 2013 and 5 birds during the period from April to June 2014. The mean total counts within the GHE count area in the two winter seasons monitored were 2.8 (2011/12) and 6.8 (2012/13).

Whilst in the study area they have been observed to dive for prey regularly. The whole of the marine area of the study area is foraging habitat for this species, therefore. Small numbers of birds (maxima 6, 2 and 3 for the periods mentioned above) use intertidal rocks and marine buoys within the study area as daytime resting/roosting places. However, these are mainly short term resting places and there is no nocturnal roost within the proposed development area.

The colony site on Deer Island is 8.5 kilometres from the site of the proposed development.

(iii) Common Gull (*Larus canus*)

Background Information

Species Habits and Preferences

This species nests on the ground in a wide variety of situations, including, islands, cliffs, shingle banks and bogs. Rooftop nesting is known from Scotland and continental Europe. In Ireland breeding is on the coast and inland on islands on large lakes in the west. Nesting is usually colonial, but there can be anything from a few to several hundred nests. Outside of the breeding season it occupies similar habitats to when breeding, but also occurs more frequently along the coast on estuaries with low salinities, sandy beaches and estuarine mudflats. Common Gulls roost communally at night and may commute long distances between foraging areas and their nocturnal roosts. Irish wintering distribution is widespread, both inland and at the coast. Common Gull can forage in a variety of ways and it is a member of the surface swimmer, water column diver (shallow; maximum depth one metre), intertidal walker (out of water), intertidal walker (in water) and terrestrial walker trophic guilds. Foraging can be intertidal on rocky and muddy shores, from marine and fresh water bodies, on wet grassland, by following the plough and at rubbish dumps. Scavenging discards from fishing boats has been recorded as an important food source. A wide range of prey items are taken including earthworms, insects (craneflies, moth adults and larvae), aquatic and terrestrial invertebrates (e.g. planktonic crustaceans, crayfish and molluscs), small fish, frogs, young birds and small mammals. During the spring the species will also take agricultural grain and often scavenges. There is little information available about the typical foraging ranges from breeding colonies, but one study reported a maximum range of 50 kilometres and a mean maximum range of 25 kilometres from the colony (Thaxter *et al*., 2012). Birds are fully mature after 2-3 years. The average lifespan is 18 years and the oldest recorded individual was 33 years six months old.

The birds that breed in Ireland are part of the Northwest and Central Europe/Atlantic coast and Mediterranean flyway population that breeds in Iceland, Ireland, Britain and continental Europe east to the White Sea and winters across Europe to north Africa. The size of this breeding population is estimated at 1.2 to 2.25 million individuals. The population trend is considered to be possibly declining/depleted. Birds are present in Ireland during the whole year, with resident birds being joined by numbers of wintering visitors from central and northern Scotland, Scandinavia and the Baltic. Common Gull is amber-listed in BoCCI 2014-2019 (Colhoun and Cummins, 2013) due to a moderate decline in its breeding population and the concentration of the breeding population in a small number of sites. The Irish breeding population is approximately 1,600 AON (Mitchell *et al*., 2004). Irish birds are generally resident, although dispersal has been noted to continental Europe. Worldwide, there are four flyway populations of four subspecies of Common Gull, which breed in Russia, Siberia, Alaska and Canada. Wintering populations are also found in the Black and Caspian seas, East and South-east Asia, Canada and U.S.A.

Species Sensitivities

In north and west Europe the species is threatened at breeding colonies by predation from introduced ground predators such as American Mink, and by disturbance from tourism, angling and research activities during the laying period. Inland populations breeding in colonies near rivers are also vulnerable to mass outbreaks of black flies (Simuliidae). The species is also threatened by the transformation and loss of its breeding habitats through land reclamation, drainage, afforestation (e.g. with conifers) and dam construction. In its wintering range the species is potentially threatened by the activities of fisheries (e.g. reductions in fishing effort, increases in net mesh sizes and exploitation of formerly non-commercial fish species) and their effects on competition for prey resources. Other threats to wintering sites include land reclamation and drainage. Egg collecting from colonies occurs in Germany, Scotland, the Russian Federation and Poland, and the species is shot in the Russian Federation.

It has been predicted (Huntley *et al*., 2007) that, as a result of climate change, the overall European breeding range of Common Gull will be reduced in extent by almost half and shifted northwards by the late 21st century. Most of the southern half of the present breeding range (including the Ireland, Wales, southern and central England and much of central continental Europe) is predicted to become unsuitable for the species, while only limited northward extension of suitable areas is predicted, to Northern Russia, Iceland, Novaya Zemyla and Svalbard. It is difficult to predict what these changes might have on the Irish wintering population of Common Gull (although it is obvious that 1,600 pairs of resident birds would be missing) were they to occur; due to the wide-ranging nature of this species it is probable that birds would still winter around the Irish coast, although the numbers doing so could decline.

Common Gull is relatively tolerant of human disturbance. Furness *et al*. (2012) gave Common Gull a low vulnerability score for disturbance by ship traffic and this species habitually occurs in close proximity to human activity. However, the species may be more sensitive to disturbance at its breeding colonies, and, in winter, at large nocturnal roosts.

Population size and distribution within Inner Galway Bay

During the period from winter 2001/02 to 2008/09 the peak I-WeBS count in the Inner Galway Bay SPA varied between 913 and 2,886, with a mean of 1,312 for the period from 2004-2008 (Boland and Crowe, 2012). The Inner Galway Bay wintering population has been assessed as being in favourable condition with an increase of 21% between 1994/5-2007/08 (NPWS, 2013).
In the BWS low tide counts, on average, over half the total count occurred on the southern shore of the bay between Aughinish Island and Kinvarra Bay. There was also a concentration along the northern shore of the bay, possibly reflecting the proximity to Galway Docks and other urban feeding habitats.

Common Gulls can utilise a wide range of habitats for foraging and roosting. In the BWS low tide counts, the majority of birds occurred in intertidal habitats (mean of 58% of the total counts, and 71% of the counts of foraging birds, with smaller numbers in subtidal habitat (20%, 17%). The numbers recorded in supratidal/terrestrial habitat were low (8%, 12%), but this reflected the definition of the subsites and large numbers of the species feed in fields, etc. around Inner Galway Bay.

Site Specific Comments Re. Habits, Preferences and Sensitivities

Common Gull has been regularly recorded in the development study area (as recorded in the NIS and EIS), with maxima of 7 birds using the site for foraging during the period from March 2011 to March 2012 (recorded on seven out of 18 watches; mean count of 1 bird), 19 birds during the period from October 2012 to March 2013 (recorded on nine out of twelve watches; mean count of 7 birds) and 4 birds during the period from April to June 2014 (recorded on one out of four watches, mean count of one bird). Whilst in the study area Common Gull have been observed to forage on the shoreline, to feed from the surface of the water and to rest briefly on the water. True roosting behaviour was not observed within the development site study area, either on the foreshore or on the water. Unlike the general pattern observed across Inner Galway Bay in the BWS counts (see above), the majority of birds in the GHE counts occurred in the subtidal zone.

Common Gull was also regularly recorded in adjacent areas. Large numbers can occur in Nimmo's Pier-South Park Shore (mean 13, range 0-30, across the 2011/12 and 2012/13 winters), while numbers in Renmore Beach are low (mean of 1, range 0-3, across the 2011/12 and 2012/13 winters).

During the period from winter 2001/02 to 2008/09 the peak I-WeBS count in the Inner Galway Bay SPA varied between 913 and 2,886, with a mean of 1,312 for the period from 2004-2008 (Boland and Crowe, 2012).

(iv) Common Tern (*Sterna hirundo*)

Background Information

Species Habits and Preferences

The species breeds in a wide variety of habitats in coastal and inland areas from sea-level to altitudes of 4,000 metres or more. Along the coast it shows a preference for nesting on flat rock surfaces on inshore islands, open shingle and sandy beaches, dunes and spits, vegetated inter-dune areas, sandy, rocky, shell-strewn or well-vegetated islands in estuaries and coastal lagoons, saltmarshes, mainland peninsulas and grassy plateaus on coastal cliff tops. Inland it may nest in similar habitats including sand or shingle lakes shores, shingle banks in rivers, sandy, rocky, shell-strewn or well-vegetated islands in lakes and rivers, sand- or gravel-pits, marshes and reservoirs. During winter it inhabits sheltered coastal waters, estuaries and large rivers, occupying harbours, jetties, piers, beaches and coastal wetlands (i.e. lagoons, rivers, lakes, swamps and saltworks, mangroves and saltmarshes). During winter roosting occurs on un-vegetated sandy beaches, shores of estuaries or lagoons, sandbars and rocky shores.

Birds are present in Ireland during passage periods (April-May and August-September-October) and the breeding season (April to July). Common Tern is a member of the water column diver (shallow) trophic guild. It is a specialist predator that feeds mostly by plunge diving for prey (often preceded by hovering), but also by 'contact-dipping', where the bill only is dipped into the water to catch prey from the surface. The maximum dive depth is 1-2 metres. Prey items comprise mainly small fish. Marine prey includes: Herring, Sandeels, Sprat, Anchovy, Whiting, Cod, Hake, Haddock, Saithe, Mackerel, Sea Lamprey. Freshwater prey can include: Perch, Bream, Rudd, Salmon, Trout and Eel. Also taken are shrimps, crabs, water beetle larvae, caddis flies, small squid and polychaete worms. Detection of active prey is visual and birds roost on rocks or islands (i.e. at the nesting colony during the breeding season) at night. Recorded foraging distances from the breeding colony are varied, with a maximum claimed of 37 kilometres, a mean (of maximum foraging distances) of approximately 15 kilometres and a mean (of mean foraging distances) of 8.67 km; in general it is safe to say that the majority of birds forage within 20 kilometres of the colony during the breeding season (seabird wikispace). Birds are fully mature after three-four years, average lifespan is 12 years and the oldest recorded individual was 33 years old.

The birds that breed in Ireland are part of the southern and western Europe breeding population that winters mainly off the western seaboard of Africa, with smaller numbers wintering off Portugal and Spain. The size of this breeding population is estimated at about 160,000 – 200,000 individuals. The

population trend is currently stable and the European population has been assessed as secure, although Common Tern is listed on Annex 1 of the Birds Directive (79/409/EEC). This population breeds in Ireland, Britain, France, Netherlands, Norway, Sweden, Denmark, Italy, Spain and Greece. Wintering is mainly off western and southern African coasts. The Irish breeding population is approximately 4,200 pairs (Seabird 2000). Worldwide, there are also breeding populations around the Baltic, across Russia from the west to the Pacific, down into China and across North America.
Species Sensitivities

Breeding birds are very sensitive to human disturbance at their nest sites, but can nest in urban environments. In Leith Docks (Edinburgh), Jennings et al. (2014) reported that “the birds are tolerant of routine human activities in the docks and that they have become well habituated to breeding in this urban environment” (Merne, 2004; Jennings et al., 2012a). Similarly, a Common Tern colony has been established for many years in Dublin Port (Merne, 2004), while, in Cork Harbour, Common Terns have nested on an island in a small golf course lake at Ringaskiddy.

Common Terns appear to be sensitive to disturbance within a zone of around 100-150 m around their breeding colonies. Carney and Sydeman (1999) quote two studies that reported flush distances of 142 m and 80 m for Common Tern colonies approached by humans. Burger (1998) studied the effects of motorboats and personal watercraft (jet skis, etc.) on a Common Tern colony. She found that the personal watercraft caused more disturbance than the motor boats, the factors that affected the terns were the distance from the colony, whether the boat was in an established channel, and the speed of the craft, and she recommended that personal watercraft should not be within 100 m of colonies.

Foraging Common Terns are more tolerant of human disturbance and Furness *et al*. (2012) gave Common Tern a low vulnerability score for disturbance by ship traffic, referencing “slight avoidance at short range”. In Irish coastal waters they often feed in very close proximity to human activity. For example in Galway Bay, they regularly feed in the mouth of the Corrib inside Nimmo’s Pier.

Common Terns are also sensitive to loss of breeding sites due to erosion, wind-blown sand or overgrowth of vegetation and to nest predation by predators. Common Terns wintering off West Africa are hunted by snaring. Pollution and changes to/depletion of fish stocks are also important threats.

It has been predicted (Huntley *et al*., 2007) that, as a result of climate change, the overall breeding range of Common Tern will remain similar to the situation at present, although it may become patchier in Ireland, Britain and eastern Europe, while it is predicted that Iceland may be colonised by breeding birds.

Common Tern feed by diving into the sea and often rest close to water. Thus they are vulnerable to oil spills, both in the sense of direct oiling of the birds and due to contamination of and/or shortage of suitable prey in the aftermath of a spill.

Population size and distribution within Inner Galway Bay

In 1995, as part of the All-Ireland Tern survey, 98 pairs (apparently occupied nests, AON) of Common Tern were recorded in Ballyvaghan Bay in Co. Clare. The colony site in Ballyvaghan Bay was described as Green Island but, according to Lysaght (2002), the Ballyvaughan colony was at Gall Island, and “it is likely that the 1995 survey misidentified the island”. The Seabird 2000 Survey recorded 46 pairs (AON) of Common Tern on Mutton Island in Co. Galway in 2001. Both counts exceed the All-Ireland 1% threshold for this species. The colony at Mutton Island was abandoned in 2003 and 2004. During the years 2005 to 2013 inclusive the Mutton island colony switched sites to nearby Rabbit Island, where it was estimated that there were 50 pairs being present in 2010 and 35-

50 pairs in 2011. The Rabbit Island colony continued to be occupied up to 2013. In the 2014 breeding season the Common Tern colony that had been using Rabbit Island returned to the original site on the north-east corner of Mutton Island and it is estimated that there were 50-75 pairs (i.e. still above the All-Ireland 1% threshold); according to staff at Mutton Island, some terns may have also been nesting on Mutton Island in 2013. The old colony site in Ballyvaghan Bay was not occupied in the 2014 breeding season, and there are no records indicating occupation of this colony since the 1990s. Small numbers of Common Tern share the Sandwich Tern and Black-headed Gull colony in Coranroo Bay; it is estimated that 10 pairs were present during the 2014 breeding season. The above pattern of local movement of colonies is typical for this species: Jennings et al. (2012b) described how numbers at individual colonies are strongly affected particularly by local influences of predation, whereas numbers in the region as a whole are more strongly influenced by food supply.

The distribution of foraging Common Terns within Inner Galway Bay is not known. The mean foraging range of Common Terns is 8.67 km, while the majority of birds forage within 20 kilometres of their breeding colony (seabird wikispace). The mean foraging range probably represents the core foraging area, while the area between the mean foraging range and the maximum foraging range can be thought of as a buffer zone, exploited by lower numbers of birds less intensively. Therefore, if these foraging range figures are representative of the Inner Galway Bay population, the core foraging range for the Common Terns from the Rabbit Island/Mutton Island colony is likely to be along the northern and eastern shores of the bay. The southern shore being exploited less intensively by these birds, but is likely to be the core foraging range for the Corranroo Bay colony. Within these areas, Common Terns can feed in all subtidal habitat (and have been observed feeding out in the middle of the bay) and in intertidal habitat at high tide. Based on the seabird wikispace foraging range data, it is around 70% of the core foraging ranges of the Mutton Island colony, and 90% of the core foraging ranges of the Rabbit Island and Corranroo Bay are contained within the Inner Galway Bay SPA.

Site Specific Comments Re. Habits, Preferences and Sensitivities

Common Tern has been regularly recorded in the development study area (as recorded in the NIS and EIS), with maxima of 4 birds using the site for foraging during summer 2011 and 14 birds during the period from April to June 2014. Whilst in the study area they have been observed to plunge dive for prey regularly. The whole of the marine area of the study area is foraging habitat for this species, therefore. One bird was observed resting briefly on rocks within the study area in May 2014 and birds regularly rest on buoys within the marine part of the study area during the summer months.

Common Tern probably regularly feed in the adjacent section of shoreline to the west of the GHE site, including in the mouth of the Corrib at Nimmo’s Pier and along the Nimmo's Pier-South Park Shore. On 28 June 2014, around 30-40 Common Terns were feeding in the latter area at low tide.

The colony site on Mutton Island is about one kilometre from the nearest part of the proposed development as built and approximately 300 metres from the proposed dredging zone of influence, and c. 300 m from the shipping channel. The colony site at Rabbit Island is approximately 1.9 kilometres from the site of the proposed development. The colony in Coranroo Bay is 12 kilometres from the site of the proposed development. The abandoned colony site in Ballyvaghan Bay is 15 kilometres from the site of the proposed development.

(v) Curlew (*Numenius arquata*)

Background Information

Species Habits and Preferences

This wader species breeds on coastal saltmarshes, inland wet grasslands with short swards (including cultivated meadows), grassy marshes, cutover bog, swampy heathlands and swampy moors. During the winter the distribution in Ireland is wide-ranging, including both coastal and inland sites on habitats that include rocky shores, muddy estuaries and inlets, sandbanks, saltmarshes, beaches, lagoons, lakes, turloughs and areas of wet grassland (including agricultural and amenity grasslands). Roosting is communal in areas like saltmarshes and sand banks. This species is a member of the intertidal walker (out of water) trophic guild. Foraging is mainly by pecking from the surface and by probing with the long, decurved bill into the substrate. Food items taken at the coast are chiefly polychaete worms, bivalves, crustaceans (amphipods, shrimps, crabs) and occasional small fish. Birds are mature after two years and the oldest known ringed individual was 31 years six months old.

The Europe/Europe North & West Africa population of Curlew breeds in western, central and northern Europe (including Ireland), east to the Ural mountains. The size of this population has been estimated at 700,000 – one million individuals and the trend is considered to be declining. This flyway population winters in western Europe (including Ireland), the Mediterranean, and North-west Africa, east to the Persian Gulf. The size of the Irish wintering population is estimated at 35,320 (Crowe and Holt, 2013); the resident population is swelled by wintering breeders from Scotland, northern England and Scandinavia. The Irish breeding population is widespread in distribution, but may have declined to as few as 200 pairs. Curlew has been red-listed in BoCCI 2014-2019 due to severe declines in its breeding and wintering populations (Colhoun and Cummins, 2013). Worldwide, there are five flyway populations of Curlew. In addition to the areas already mentioned, breeding occurs in south-eastern Europe, Siberia and Kazakhstan. Wintering populations are also found in South-west, southern and South-east Asia and eastern and southern Africa.

Species Sensitivities

The species is threatened by the loss and fragmentation of moorland habitats as a result of afforestation and of marginal grassland habitats as a result of agricultural intensification and improvement (e.g. drainage, inorganic fertilisation and reseeding). The species also suffers from high egg and chick mortalities (due to mechanical mowing) and higher predation rates if nesting on improved grasslands. Conversely populations in the central Asians steppes have declined following abandonment of farmland and subsequent increases in the height of vegetation, rendering large areas unsuitable for nesting. It has also suffered population declines as a result of hunting, and is susceptible to avian influenza so may be threatened by future outbreaks of the virus. Wintering populations are threatened by disturbance on intertidal mudflats (e.g. from construction work and foot-traffic), development on high-tide roosting sites, pollution and the flooding of estuarine mudflats and saltmarshes as a result of tidal barrage construction. The species is also threatened by the degradation of migration staging areas owing to land reclamation, pollution, human disturbance and reduced river flows. Local populations of this species have also declined owing to hunting pressures.

Curlew is relatively sensitive to human disturbance compared to other species. This reflects its large body size, as generally disturbance sensitivity increases with body size, and its status as a quarry species (Laursen et al., 2005). While it has been recently removed from the quarry species list in Ireland, it is likely that it will take a period of time for this to affect its disturbance sensitivity. Also, its continued status as a quarry species elsewhere along its migration route may affect its behaviour in Ireland as the higher disturbance sensitivity in quarry species may persist in migratory species even when they are in areas where they are not hunted (Burger and Gochfield, 1991, cited by Laursen et al., 2005). In various disturbance experiments in open tidal flats in North Sea coastal sites, Curlew showed escape distances (the distance at which they responded to disturbance) of 102-455 m (see Introductory Report). However, escape distances may be much lower in in enclosed coastal habitats and/or where background levels of human activity are higher and an escape distance of 38 m was reported for a rocky shore site in Northern Ireland (Fitzpatrick and Bouchez, 1998).

Wintering Curlew feed at the coastline, often on the waterline. They are vulnerable to oil spills that can (when they reach shore) coat the foraging habitat, oil birds and kill/contaminate prey.

It has been predicted (Huntley *et al*., 2007) that, as a result of climate change, the breeding range of European populations of Curlew will be reduced in extent by more than 40% and shifted north-eastwards by the latter part of the 21st century. It is predicted that Curlew will become extinct as a breeding bird in most of the Republic of Ireland, southern and central England and Wales. It is also predicted that areas in southern Scandinavia and western/central Europe will become unsuitable for the species' needs and that these losses will not be offset by the possible colonisation of Svalbard, Novaya Zemyla and Iceland. It is not possible to predict exactly what the effect of changing breeding distribution would be on the wintering distribution of the species, but it is quite possible that the Irish wintering population may be reduced in both numbers and the extent of its distribution.

Population size and distribution within Inner Galway Bay

During the period from winter 2001/02 to 2008/09 (Boland and Crowe, 2012) the peak count in the Inner Galway Bay SPA varied between 442 and 987 (mean of 674). The conservation condition Inner Galway Bay Curlew population has been assessed as favourable, with an increase of 10.6% over the period 1994/95-2008/09, compared to a national decrease of -25.7% over the same period (NPWS, 2013). Inner Galway Bay is the twelfth most important site in the Republic of Ireland for Curlew (Boland and Crowe, 2012).

Wintering Curlew in Ireland often utilise terrestrial habitats. However, the numbers of Curlew recorded in the supratidal/terrestrial zone during the BWS counts of Inner Galway Bay were very low (around 1% of the total count). These low percentages do not necessarily reflect the actual usage of these habitats around Galway Bay, but, instead, probably reflect the focus of the survey on recording waterbird distribution in the tidal zones.

Site Specific Comments Re. Habits, Preferences and Sensitivities

Curlew have been recorded in the development study area (as recorded in the NIS and EIS), but somewhat irregularly and in very low numbers. Whilst in the study area they have been observed to forage in the intertidal zone of the site of the proposed development. The whole of the intertidal area of the study area is foraging habitat for this species, therefore. Count maxima of 3 birds using the proposed development site for foraging during the period from March 2011 to March 2012 (mean 0.75, recorded on 5 out of 12 counts during the winter period), 3 birds during the period from October 2012 to March 2013 (mean 0.9, recorded on 6 out of 12 counts) and 3 birds during the period from April to June 2014 were recorded.

Curlew also occur in the adjacent intertidal area to the west (Nimmo's Pier-South Park Shore), again somewhat irregularly and in very low numbers (1-2 birds in five out of 13 counts during the 2011/12 and 2013/14 winters). Curlew were not recorded in the adjacent intertidal area to the east (Renmore Beach).

(vi) Grey Heron (*Ardea cinerea*)

Background Information

Species Habits and Preferences

Grey Heron nest colonially, usually in tall trees, but also in low trees and bushes and sometimes on the ground on marine or lake islands. Foraging takes place in a wide variety of freshwater and marine aquatic habitats, including ponds, lakes, reservoirs, canals, rivers, streams, ditches, estuaries, lagoons and any kind of open coastal shoreline. This species is often found both breeding and foraging at suitable sites in urban areas. Foraging birds feed on land or in shallow water, where they wade or stand still (either singly or in loosely associated groups). Prey items are caught by grabbing or stabbing with the bill and they are usually killed before swallowing. Foraging takes place mostly during daylight. This species is a member of the intertidal walker (in water) trophic guild. Food items are chiefly fish, amphibians, small mammals, insects and reptiles, also occasionally crustaceans, molluscs, worms and birds. Birds are mature after one year. The average expected lifespan is five years, but the oldest recorded ringed bird was 25 years and four months old.

Although birds in Ireland and Britain are mainly sedentary, rather than migratory, the northern and western European population of Grey Heron is estimated at 263,000 – 286,000 individuals and is considered to be increasing. The All-Ireland wintering population is estimated at 2,500 birds (Crowe and Holt, 2013) distributed across the whole island. The Irish and British populations of Grey Heron are the sole non-migratory populations. There is dispersal up to 150 kilometres from natal heronries. However, there is some recorded movement between Britain and Ireland and the Irish population is increased during winter by migrants from Norway.

Worldwide, Grey Heron are distributed right across Europe (as far north as Norway and Sweden, but not in Iceland; they are much more thinly distributed around the Mediterranean), across central Asia and down into India, China and South-east Asia, Japan, southern and eastern Africa and Madagascar.

Species Sensitivities

In Europe the species was heavily persecuted in the nineteenth century due to its consumption of fish, which resulted in competition with fishermen and fish farmers Timber harvesting is a threat throughout much of the species range by removing trees used by nesting colonies and/or disturbing nearby colonies. The species is also susceptible to avian influenza and avian botulism, so may be threatened by future outbreaks of these diseases. Individual site populations may be threatened by loss of or damage to foraging habitat or roosting sites.

Grey Heron are generally relatively tolerant of human disturbance. They feed in a wide range of habitats, including small ponds and watercourses, often in close proximity to human activity.
It has been predicted (Huntley *et al*., 2007) that, as a result of climate change, the breeding range of the Grey Heron in Europe will shift northwards by the latter part of the 21st century. These authors predict that breeding will increase in Fenno-Scandinavia and that Iceland will be colonised, while declines are predicted in the south of the current breeding range in the Mediterranean. Although there may be some small-scale reduction in breeding distribution, the situation in Ireland and Britain was predicted to remain very much the same as it is at present. If the Irish and British breeding populations continue to be sedentary (as at present), it may be that the distribution and numbers recorded will also remain similar to as at present.

Grey Heron feed along the coastline, including in shallow water. They are thus very vulnerable to oil spills that can oil the birds and kill/contaminate prey.

Population size and distribution within Inner Galway Bay

According to the Conservation Objectives Supporting Document (NPWS, 2013) the SPA regularly site regularly supports 1% or more of the all-Ireland population of Grey Heron during winter. The mean peak number of this species within the SPA during the baseline period (1995/96 – 1999/00) was 102 individuals. During the period from winter 2001/02 to 2008/09 the peak count in the Inner Galway Bay SPA varied between 87 and 174 (mean of 130). The conservation condition of the Inner Galway Bay Grey Heron population has been assessed as favourable, with an increase of 52.4% over the period 1994/95-2008/09, compared to a national increase of 29.2% over the same period (NPWS, 2013). Inner Galway Bay is the most important site in the Republic of Ireland for Grey Heron (Boland and Crowe, 2012).

Grey Heron can utilise a wide range of habitats for foraging and roosting. In the BWS low tide counts, the majority of birds occurred in intertidal habitats (mean of 64% of the total counts, and 70% of the counts of foraging birds, with smaller numbers in subtidal habitat (24%, 28%). The numbers recorded in supratidal/terrestrial habitat were low (12%, 2%), but this reflected the definition of the subsites and it is likely that larger numbers of the species feed in small non-tidal wetlands, ditches, etc. around Inner Galway Bay.

The subtidal habitat suitable for foraging by Grey Heron will be limited to shallow subtidal waters in which the birds can wade. The tidal zone between the mean low tide and the lowest astronomical tide can be considered to be a reasonable approximation of the distribution at low tide of suitable Grey Heron subtidal foraging habitat. The distribution of heronries around Inner Galway Bay is presented in Figure NIS(A) 2.4 below.

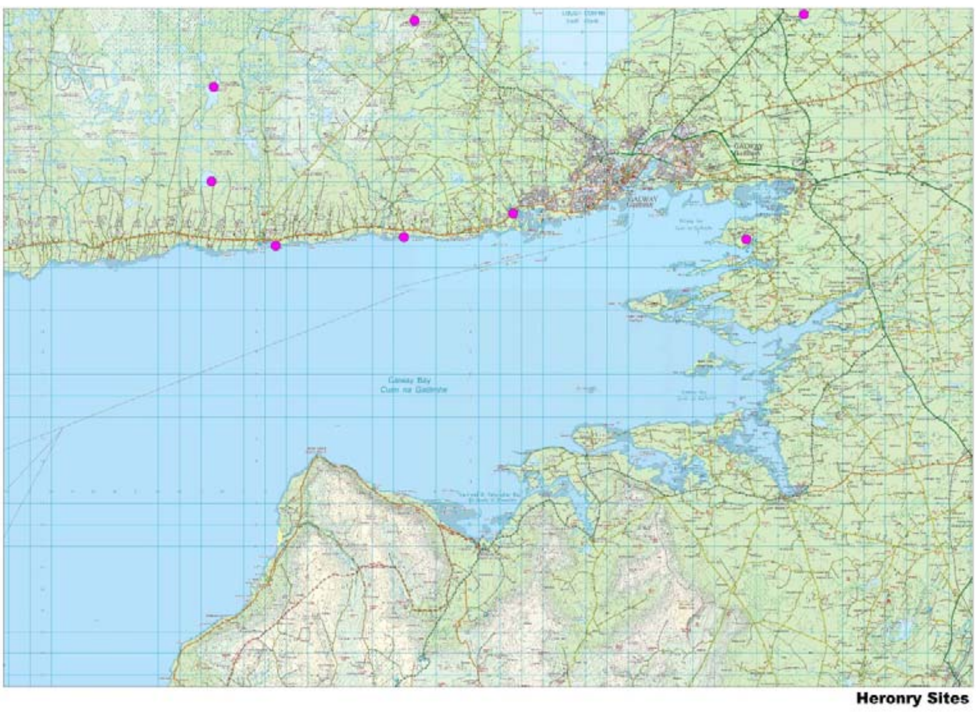


Figure NIS(A) Error! No text of specified style in document.**.1 Heronries around Inner Galway Bay**

Site Specific Comments Re. Habits, Preferences and Sensitivities

Grey Heron have been regularly recorded in the development study area (as recorded in the NIS and EIS). Whilst in the study area they have been observed to forage along the shoreline and in shallow water in the intertidal zone (i.e. walking/wading in water). The whole of the intertidal marine area of the study area is foraging habitat for this species, therefore. Roosting behaviour has not been observed at the development site study area. Count maxima of 2 birds using the proposed development site for foraging during the period from March 2011 to March 2012 (mean 0.8, recorded on 8 out of 12 counts during the winter period), 2 birds during the period from October 2012 to March 2013 (mean 1.1, recorded on 9 out of 13 counts during the winter period) and 2 birds during the period from April to June 2014 were recorded. It should be noted that Grey Heron was recorded at the development site study area on 23 out of 34 long watches that have currently been carried out at the site. This species does not occur at the site of the proposed development at or close to high tide, when there is no exposed foreshore on which it can forage.
Grey also occur in the adjacent intertidal area to the west (Nimmo's Pier-South Park Shore), but irregularly and in very low numbers (1-3 birds in two out of 13 counts during the 2011/12 and 2013/14 winters). Grey Heron were recorded on a single count in the adjacent intertidal area to the east (Renmore Beach).

(vii) Great Northern Diver (*Gavia immer*)

Background Information

Species Habits and Preferences

This species breeds on freshwater lakes, but is mainly found in coastal marine areas during winter (i.e. when it is present in Ireland). It is a specialist predator that swims on the surface of the water and (as the common name suggests) dives beneath it to capture prey, being a member of the water column diver (deeper) trophic guild. When searching for prey, the bird regularly dips its bill and forehead below the water surface before diving silently from there. Diving depths of up to 70 metres have been reported, although it is thought that the majority of dives are to within ten metres of the surface. The average dive time has been quoted as 42 seconds. Fish up to 28 cm in length (including species found in Galway Bay like Haddock, Whiting, Herring, Sprat, Sandeel and Sea Trout) are the main food, although crustaceans (including crabs and shrimp) and molluscs are also commonly taken. Detection of active prey is visual and birds roost on the water at night. Birds are mature after two years and the oldest recorded individual (ringing recovery) was 7 years and 10 months old.

The best wintering habitat types for this species would be shallow marine waters with an ample supply of small/medium-sized fish, crustaceans and molluscs. Off the south-eastern United States, Haney (1990) found Great Northern Divers to prefer the 0-19 m depth zone, but to be frequent in the 20-39 m depth zone (28% of observations) and occurred up to 100 km offshore (to the edge of continental shelf). Warden (2010) reported that 33% of the bycatch occurred at depths of 15-35 m (compared to 52% of the landings). From data in Wilson et al. (2006), Lewis et al (2008) and Lewis et al (2009) a mean of 29% (s.d. 32%, n = 10) of observations of Great Northern Divers were below the 20 m depth contour in aerial transects of c. 10-50 km length around the Scottish coast. Therefore, published data indicates that Great Northern Divers prefer depths of less than 20 m, but can regularly occur in depths of up to around 30-40 m.

The birds that winter in Irish waters are part of the European breeding population that comes from Iceland and Greenland. The wintering population is mainly present from September to May (with October to March being the important peak months), although a few birds are present in the SPA during May-June and the first birds of the autumn are usually seen in August. This species spends the majority of time on the water, but it is able to fly strongly (usually low over water, to a height of about ten metres, but higher over land) at speeds up to 110-120 km/h. It is thought that migration of the European breeding population may involve multiple flights with breaks spent on the sea. The size of the European breeding population is estimated at about 5,000 individuals, or 700-2,300 pairs. This estimate has remained the same through all five editions of Wetlands International's Waterbird Population Estimates (made in the years 1994, 1997, 2002, 2006 and 2012), so (as far as can be told) the flyway population is stable. The European wintering distribution is around the coasts of Ireland and Britain, the Norwegian coast and continental Atlantic coasts from the North Sea to the Bay of Biscay and as far as Atlantic Iberia (with some staying to winter around Iceland).

The Irish wintering distribution is effectively around the entire coastline, although the larger population size apparent on the west coast is to be expected, given that this side of the country is closer to Iceland and Greenland. The All-Ireland wintering population has been estimated as 1,340 birds (Crowe and Holt, 2013), but the authors note that this is a conservative estimate. The three sites in Ireland at which internationally important concentrations (50 or more individuals) have been recorded are Inner Galway Bay, Donegal Bay and Blacksod & Tullaghan Bays, Co. Mayo (Boland and Crowe, 2012). The record count is of 385 on the 25th of January 2009 in Inner Galway Bay. Although bays/estuaries are undoubtedly good sites for divers, they also offer more viewing opportunities for survey (c.f. open coastline) and are more sheltered, thus giving better sea conditions for detecting the birds. Sea state is very important for counting divers, with birds being difficult to count in conditions with significant waves, a factor which has been noted during I-WeBS counts in Inner Galway Bay and that has been commented on in literature (Suddaby, 2010). Since non-estuarine stretches of coastlines are only surveyed formally every nine years (the BWI NEWS survey) and birds can be foraging up to ten kilometres offshore, it is likely that Crowe and Holt were correct in treating the Irish wintering population estimate as conservative. In the third edition (Colhoun and Cummins, 2013) of the Birds of Conservation Concern in Ireland (BoCCI), Great Northern Diver was moved from the green list (low conservation concern) to the amber list (medium conservation concern) on the strength of the international importance (> 20% of flyway population) of the non-breeding population, although it seems that this change does not actually indicate a worsening of the conservation status of the Irish wintering population.

Species Sensitivities

Breeding birds are very sensitive to human disturbance at their nest sites (i.e. outside of Ireland). Nests are also commonly lost to predators and to flooding following water level fluctuations at breeding lakes. At North American breeding lake sites, birds have been negatively impacted by pollution (acid rain effects, mercury pollution), lead poisoning from lead fishing weights and type E botulism. It does not appear that this species is regularly hunted, although it has been noted that they may be occasionally so by the Inuit.

It has been predicted (Huntley *et al*., 2007) that, as a result of climate change, the breeding range of the Great Northern Diver in Iceland will be decreased and shifted north-eastwards, but that islands to the North (Jan Mayen, Bjørnøya and parts of Svalbard) may become suitable for breeding by the latter part of the 21st century. It is not clear what effect this northward shift of the breeding population would have on the wintering distribution of the species; it could be that the wintering distribution will also move further northwards (with unpredictable impacts on the Irish wintering population), but the birds are reputed to avoid ice, so this could limit northward shifting of wintering sites.

As birds that spend the vast majority of their time on or in the water, divers are highly vulnerable to oil spills.

There is evidence that divers can be disturbed by boats/shipping, both recreational and commercial. The potential negative impacts of such disturbance are as follows:

(1) Birds may avoid areas where ships are regularly present (e.g. shipping lanes), resulting in secondary habitat loss.
(2) Individual birds that are regularly disturbed (i.e. which lose foraging time and experience energy loss while fleeing ships) may experience fitness consequences, which at an extreme level could lead to mortality.

Borgmann (2010) reviewed human disturbance impacts on waterbirds and listed a case where Great Northern Diver exhibited an average flush distance (presumably to flight, rather than by swimming or diving) of 51 metres when disturbed by non-motorised boats whilst wintering off the U.S. coast.

Furness *et al*. (2012) mention that "*divers are especially sensitive to approaching boats more than 1 km*", quoting Schwemmer *et al*. (2011) as the authority for this statement. However, this statement does not appear in the paper by Schwemmer *et al*. (2011) that has been referenced in Furness *et al*. (2012). In the tabulated data supplementary to Furness *et al*. (2012) (which are available for online download), it is stated that Great Northern Diver are "apparently less sensitive than other diver species" (i.e. c.f. Red-throated and Black-throated divers, which are stated to have "*a very great flush distance*") to ship traffic disturbance, without a clear authority being given. In the same supplementary data, Topping and Petersen (2011) are quoted as stating that Great Northern Diver "fly from boats more than 1000m away". Forrester *et al*. (2007) is also listed as a reference in the supplementary data to Furness *et al*. (2012). Research has indicated that they are likely to be referring to a statement in Forrester *et al*. (2007) that Great Northern Diver "*rarely fly in winter*". A total of 14 Great Northern Divers were recorded during five studies at four offshore wind farm sites in the U.K.: Argyll Array, Humber Gateway, Gwynt Y Mor and Burbo Bank (Cook *et al*., 2012). Of these, none recorded Great Northern Divers flying within the generic collision risk zone, while Red-throated and Black-throated divers where regularly recorded flying, although it should be noted that 14 sightings is a small sample. Topping and Petersen (2011) actually state that "*Red-throated Divers are susceptible to human disturbances while in the marine environment. From ship-based bird surveys it is known that birds often flush at distances of about 1 km from an approaching ship*". Schwemmer *et al*. (2011) detail research that they carried out in the German North Sea in which they determined that Red-throated Diver (*Gavia stellata*) and Black-throated Diver (*Gavia arctica*) avoid active shipping lanes. In this study these two species were lumped together due to an inability to differentiate them during aerial surveys. They go on to suggest that, due to the recorded avoidance of shipping lanes, these two species are unlikely to habituate to shipping traffic. While Great Northern Diver can certainly be flushed to flight by approaching ships, it seems that there is a certain amount of confusion in the literature that is currently available. There is the suggestion that Great Northern Diver may be less sensitive to ship traffic disturbance than the other two species, but it appears that no authoritative studies have been carried out. Red-throated Diver appears to have been the subject of most survey work, due to concerns that have been raised about marine renewable energy projects (wind and wave) in the North Sea, where this species is by far the commonest diver.

Distribution within Inner Galway Bay

According to the supporting information document for the Inner Galway Bay SPA conservation objective (NPWS, 2013) the population change for Great Northern Diver (based on two five-year means, 1995/96 – 1999/00 and 2005/06 – 2009/10) was + 93%. The site conservation condition for this species was classified as favourable. There is no comparable all-Ireland trend with which the site trend can be compared.

For the I-WeBS period from 2007/08 to 2011/12, Great Northern Diver was recorded in 23 of the 25 I-WeBS subsites (the exceptions being Lough Atalia and a turlough site that lies near to the shoreline of the bay). During the 2009-2010 low tide baseline waterbird surveys, Great Northern Diver was recorded from 17 of the 31 sub-sites that were defined for the study. Foraging was recorded at all 17 sub-sites and roosting was also recorded in nine of these. In the area of the Inner Galway Bay SPA as a whole, I-WeBS counts have indicated that divers are more numerous around the southern coast than the northern coast.

Site Specific Comments Re. Habits, Preferences and Sensitivities

Great Northern Divers have been regularly recorded in the development study area (as recorded in the NIS and EIS). Whilst in the study area they have been observed to dive regularly and on some occasions have been observed to eat prey at the surface. The whole of the marine area of the study area is foraging habitat for this species, therefore. Great Northern Diver have been observed swimming within a few metres of the tide line, so the whole marine area up to the high water mark is potential habitat for this species. Birds have also been observed loafing/resting on the surface within the study area, so the whole marine area is also resting habitat. It is to be expected that birds also roost within the study area at night. There appear to be no available data on the effects of lighting on this species, i.e. as to the possibility that lighting may increase the available foraging period, or if lighting from shore may limit roosting in nearshore areas.

During two winters of observations at the proposed port extension study area (during which attention was paid during the passage of ships into and out of the port) Great Northern Diver was never observed to take flight because of boat/ship passage. Observed diver/ship interactions were comparatively few, probably not more than ten in total. Individuals were occasionally observed to swim away from approaching boats or to dive. Similarly, in Cork Harbour, Great Northern Divers regularly feed within, and around, the shipping channel at the mouth of the harbour (Roches Point) and do not flush when ships pass (T. Gittings, personal observations). In contrast, a Great Northern Diver has been observed to take flight (on a single occasion) at the rapid approach of a RIB within the study area for the proposed compensation/SPA extension site (west of Silver Strand beach, up to and just to the west of Bearna Pier). Furthermore, such flushing behaviour was noted on a number of times when the observer was travelling across the bay from the harbour in a fast RIB whilst on the way to count hauled-out seals at low tide. In any case, Great Northern Divers within the study area categorically do not flush when vessels approach to within a distance of one kilometre or more. Even given the statement by Schwemmer *et al*. (2011) that they consider Red-throated and Black-throated Divers are unlikely to become habituated to fast or intense shipping activity, it seems that this may be the case for Great Northern Diver in the Galway harbour area if their average flushing distance is in any way close to that stated for the other two species.

The key to the severity of shipping disturbance to divers may be due to the speed at which the vessels are travelling. Ships entering or leaving the harbour along the harbour channel are always travelling slowly, as are traditional fishing vessels and yachts. RIBs travel more quickly along the channel, but even in this case not as fast as they do when crossing open stretches of water where no channel discipline is required. Observations made by Schwemmer *et al*. (2011) were for Red-throated and Black-throated divers (congeners, but different species from the Great Northern) that may have differing sensitivities to shipping. Their observations (i.e. that divers avoid shipping lanes) were made in the German North Sea in area where shipping was described as ‘intense’ and ‘channelled’. There were no details of the average speed and size of these ships, but it might be that their speed is the key factor in causing the avoidance of the shipping lanes by divers.

(viii) Light-bellied Brent Goose (*Branta bernicla hrota*)

Background Information

Species Habits and Preferences

This migratory wildfowl species nests in small, loose colonies on tundra with pools. In winter (i.e. when they are present in Ireland) they are found in estuaries and large sheltered coastal bays. Foraging takes the form of grazing on saltmarshes, foreshores and (in some places) on improved and amenity grasslands. Brent geese will feed in shallow water and upend to reach food. This species is a member of both the surface swimmer and intertidal walker (out of water) trophic guilds. In winter the birds can be in small flocks (10-30 birds), or in larger flocks of hundreds or even a few thousand. Roosting in winter is communal and can be on land in open areas, or on islands or sand bars. This species is vegetarian and the main food types are Eelgrasses (in autumn and early winter), saltmarsh grasses, marine green algae like *Ulva* and *Enteromorpha,* saltmarsh plants like Sea Aster, Arrowgrass and Glassworts and other grass species on sown agricultural and amenity grassland close to the coast. Birds are mature after two to three years. Wild birds can live until their twenties.

The flyway population of the *hrota* subspecies of Brent Goose that breeds in the east Canadian high Arctic winters mostly in Ireland. Wintering birds are present mainly from September to April (peak period October to March), arriving at Strangford Lough in autumn before spreading across Ireland. The size of this flyway population is estimated at 40,000 individuals; it has continued to show an increase since the early 1990s.

The All-Ireland wintering population comprises the vast majority of the 40,000 flyway population, with an estimated number of 36,380 (Crowe and Holt, 2013). Light-bellied Brent Goose is amber-listed in BoCCI 2014-2019 (Colhoun and Cummins, 2013) due to the concentration of the wintering population in a small number of sites and its international importance. Worldwide, there are seven populations of Brent Goose of three or four recognised subspecies. Breeding is circumpolar, occurring Greenland, high Arctic Canada, Alaska, central to Pacific high Arctic Russia, Svalbard and Franz Josef Land. Wintering birds from these populations are found on the Pacific and Atlantic coasts of North America, Britain, France, Netherlands, Denmark, Japan and Korea.

Species Sensitivities

This species is lightly hunted in Canada and Greenland. It is thought that they may be occasionally subject to illegal hunting in Ireland during the winter. However, hunting pressure on this species is not considered to be heavy. Brent Geese are relatively tolerant of human disturbance (e.g. walkers) in comparison to other species. In its winter range the species may be persecuted by farmers, as in recent years it has increasingly taken to grazing on cultivated grasslands and winter cereal fields near the coast. The species may also be threatened in the future by reductions in food supplies following the return of a disease of Eelgrass (*Zostera marina*), an important food in autumn and early winter. The nesting success of breeding pairs in Svalbard is greatly reduced as a result of Arctic Fox predation. The species is susceptible to avian influenza so may be threatened by future outbreaks of the virus. Individual site populations may be threatened by loss of or damage to foraging habitat or roosting sites.

It has been predicted (Huntley *et al*., 2007) that, as a result of climate change, the breeding range of the Brent Goose in Europe will diminish by the latter part of the 21st century. These authors predict that breeding, which currently occurs in Svalbard and Franz Josef Land, will be restricted to the latter archipelago. A northward shift in the east Canadian Arctic breeding population (which winters in

Ireland) is predicted by other sources. It is not clear what effects this shift of the breeding population would have on the wintering distribution of the species.

Brent Geese feed along the coastline, including in shallow water. They are thus very vulnerable to oil spills that can oil the birds and kill/contaminate plant food.

Population size and distribution within Inner Galway Bay

According to the Conservation Objectives Supporting Document (NPWS, 2013) the SPA regularly supports 1% or more of the biogeographical population of Light-bellied Brent Goose. The mean peak number of this species within the SPA during the baseline period (1995/96 – 1999/00) was 676 individuals. During the period from winter 2001/02 to 2008/09 the peak count in the Inner Galway Bay SPA varied between 729 and 1,457 (mean of 1,110). The conservation condition Inner Galway Bay Curlew population has been assessed as favourable, with an increase of 135% over the period 1994/95-2008/09, compared to a national increase of 58% over the same period (NPWS, 2013). Inner Galway Bay is the eighth most important site in the Republic of Ireland for Curlew (Boland and Crowe, 2012).

The subsite distribution of Light-bellied Brent Goose in Inner Galway Bay does not show any strong patterns of association with the distribution of suitable tidal zones or biotopes. Light-bellied Brent Goose tend to feed on concentrated food resources, often in the supratidal or terrestrial zone and the large-scale distribution of these birds may have been affected by the proximity of suitable supratidal/terrestrial foraging habitat.

Light-bellied Brent Goose can utilise a wide range of habitats for foraging and roosting. In the BWS low tide counts, the majority of birds occurred in subtidal habitats (mean of 59% of the total counts, and 59% of the counts of foraging birds, with substantial numbers in intertidal habitat (30%, 29%). The numbers recorded in supratidal/terrestrial habitat were low (11%, 12%), but this may have reflected the focus of the count subsites on tidal habitats. Although this species is well-known for using agricultural or amenity grasslands (sometimes not immediately adjacent to the sea), they are generally coastal in Galway Bay. They do use amenity grasslands close to the sea at South Park and the Galway Golf Club at Salthill; other supratidal habitats used in Galway Bay (e.g. saltmarsh in Oranmore Bay, in the Tawin area and close to Lough Muree) are covered by I-WeBS/BWS.

The subtidal habitat suitable for foraging by Light-bellied Brent Goose will be limited to shallow subtidal waters as Light-bellied Brent Goose generally do not feed in waters of greater than 0.5 m depth. The tidal zone between the mean low tide and the lowest astronomical tide can be considered to be a reasonable approximation of the distribution at low tide of suitable Light-bellied Brent Goose subtidal foraging habitat.

Site Specific Comments Re. Habits, Preferences and Sensitivities

Brent Geese have been recorded, somewhat irregularly, in the development study area (as recorded in the NIS and EIS). Whilst in the study area they have been observed to forage along the shoreline and in shallow water in the intertidal zone (i.e. walking/wading in water and swimming at up-ending depths). The whole of the intertidal marine area of the study area is foraging habitat for this species, therefore. Although Brent Geese will rest on deeper water, they have not been observed to do so at the development site study area and roosting behaviour has not been observed. Count maxima of 16 birds using the proposed development site for foraging during the period from March 2011 to March 2012 (mean 2.2, recorded on 3 out of 12 counts during the winter period), 17 birds during the period from October 2012 to March 2013 (mean 3.6, recorded on 4 out of 12 counts during the winter period) and 2 birds during the period from April to June 2014 were recorded.

Brent Geese also occur in the adjacent intertidal areas, again somewhat irregularly. In the area to the west (Nimmo's Pier-South Park Shore) 1-41 birds were recorded in four out of 13 winter counts. In the area to the east (Renmore Beach), 2 birds were recorded one one out of 10 winter counts.

(ix) Bar-tailed Godwit (*Limosa lapponica*)

Background Information

Species Habits and Preferences

This wading bird species nests on the ground in areas of tundra and bog in the continental low Arctic and into high Arctic regions. Outside the breeding season Bar-tailed Godwit are almost entirely coastal in distribution, showing a pronounced preference for sheltered bays or estuaries, or shores free of rock, gravel or shingle and providing plenty of tidal movement over fine sand or muddy sand. This species is a member of the intertidal walker (out of water) trophic guild and feeds mainly in flocks at the tide edge or by water margins and in water up to 15 centimetres deep. Roosting and resting occurs on beaches, except at high spring tides, where it may occur in slightly more elevated areas, including grassland close to the sea. Much of the foraging is by probing while walking, inserting the long bill to moderate depths or full length with the head rotating slightly. Also uses shallow probes, a rapid ‘stitching’ action (consisting of a rapid series of shallow probes close together) and will also pick food from the surface. The major food groups taken at the coast are lugworms, ragworms, small crustaceans, small molluscs and occasionally small fish like Sandeels.

The Northern and Western European wintering population of Bar-tailed Godwit breeds in high Arctic Scandinavia, North Russia, the White Sea and Kanin. Worldwide, there are five flyway populations of the various recognised subspecies of Bar-tailed Godwit. In addition to the breeding sites already mentioned, breeding occurs across high Arctic Siberia to the Pacific and into West Alaska. Birds are mature after two years. While the average lifespan is only 5 years, the oldest known individual was over 24 years old.

The size of the Northern and Western European wintering population has been estimated at 120,000 individuals and the trend is increasing. The European wintering distribution includes Ireland, Britain, continental Europe from France to Germany, Atlantic Iberia, in scattered parts of the western Mediterranean and North-west Africa. Worldwide, wintering populations are also found in West, West-central and South-west Africa, Madagascar, the Red Sea and Middle East, India, South-east Asia and Australasia. Bird shave been tracked migrating from New Zealand to the Yellow Sea in China; at over 10,000 kilometres this is the longest known non-stop flight made by any bird species.

Species Sensitivities

The species is threatened by the degradation of foraging sites due to land reclamation, pollution, human disturbance, reduced river flows and in some areas the invasion of mudflats and coastal saltmarshes by mangroves (owing to sea-level rise and increased sedimentation and nutrient loads at the coast from uncontrolled development and soil erosion in upstream catchment areas). In Ireland it is also possible that the invasion of estuarine mud by colonising *Spartina* grass (not present in Galway Bay) may be the cause of habitat degradation. The species is also susceptible to avian influenza so may be threatened by future outbreaks of the virus. There is also evidence of subsistence hunting of Bar-tailed Godwit in Alaska and China.

Bar-tailed Godwit feed at the coastline, often on the waterline. They are vulnerable to oil spills that can (when they reach shore) coat the foraging habitat, oil birds and kill/contaminate prey.

It has been predicted (Huntley *et al*., 2007) that, as a result of climate change, the breeding range of the flyway population of Bar-tailed Godwit will be reduced by 75% and shifted north-eastwards (to southern Novaya Zemyla and extreme North-east European Russia) by the latter part of the 21st century. Thus, it is predicted that the breeding range of the Irish wintering population will be drastically reduced and will be further from Ireland (although birds from other flyway populations currently migrate much further distances than that between Ireland and the predicted new breeding range of the wintering population). It is not possible to predict exactly what the effect of this would be on the wintering distribution of the species, but it seems quite possible both that the size of the flyway population may be reduced and that birds may not migrate as far as Ireland to winter, so it is quite possible that the Irish wintering population will be reduced in both size and distribution.

Site Specific Comments Re. Habits, Preferences and Sensitivities

During surveys at the proposed development site Bar-tailed Godwit was not recorded within the study area at the proposed development site. These on-site surveys have so far comprised long watches on 34 different dates (18 watches between March 2011 and March 2012; 12 watches between October 2012 and March 2013; four watches between March 2014 and June 2014), giving a total of 212 hours of watches. This total included 25 watches (170 hours) over the October to March winter season when Bar-tailed Godwit would have been most to likely to be in the area, but also included cover over the breeding season and during passage.

According to the Conservation Objectives Supporting Document (NPWS, 2013) the SPA regularly supports 1% or more of the all-Ireland population of Bar-tailed Godwit during winter. The mean peak number of this Annex I species within the SPA during the baseline period (1995/96 – 1999/00) was 447 individuals. During the period from winter 2001/02 to 2008/09 (Boland and Crowe, 2012) the peak count in the Inner Galway Bay SPA varied between 207 and 796 (mean of 447).

(x) Redshank (*Tringa totanus*)

Background Information

Species Habits and Preferences

The wader species breeds on coastal saltmarshes, inland wet grasslands with short swards (including cultivated meadows), grassy marshes, cutover bog, swampy heathlands and swampy moors. On passage the species may frequent inland flooded grasslands and the silty shores of rivers and lakes, but during the winter it is largely coastal, occupying rocky, muddy and sandy beaches, saltmarshes, tidal mudflats, saline and freshwater coastal lagoons and tidal estuaries. In Ireland the breeding distribution is mostly limited to Connemara, the Shannon Estuary, Mullet Peninsula, Donegal and birds in the Midlands nesting on cutover bog. The Irish winter distribution is mainly coastal, with smaller numbers on inland lakes and turloughs. This species is a member of the intertidal walker (out of water) trophic guild. Foraging during daylight is mainly by pecking from the surface and probing into the substrate, with prey or the burrows of prey located by sight. Foraging at night, in turbid shallow water or when birds are forced together into high densities is by touch and can involve the open bill being moved rapidly from side to side in mud until prey is located. Food items taken at the coast are chiefly polychaete worms, gastropod snails, bivalves and crustaceans (amphipods, shrimps, crabs). Birds are mature after one year and the oldest known ringed individual was 17 years old.

The Iceland & Faroes/Western Europe population of Redshank breeds in Iceland and the Faroe Islands. The size of this population has been estimated at 150,000 - 400,000 individuals and the trend is considered to be possibly increasing. This flyway population winters in Ireland, Britain, other North Sea coasts and North-west France. The size of the Irish wintering population is estimated at

29,520 (Crowe and Holt, 2013). The small Irish breeding population is part of the Britain & Ireland/Britain-Ireland-France population of Redshank, which also breeds in Britain and winters Ireland, Britain and North-west France. The size of this population is estimated at 95,000 – 135,000 birds and the trend is declining. Redshank is red-listed in BoCCI 2014-2019 (Colhoun and Cummins, 2013) due to the severe decline of the Irish breeding population and the wintering population also qualifies for amber-listing. During passage periods migrating individuals from other flyway populations may also be present in Ireland. Worldwide, there are nine flyway populations of Redshank. In addition to the areas already mentioned, breeding occurs in Fenno-Scandinavia, the Baltic, most of central Europe, Russia, Siberia, Mongolia, China, India and Tibet. Wintering populations are also found in the Mediterranean, Asia Minor, South-east Asia, India, Sri Lanka, East Africa and the Middle East.

Species Sensitivities

The species is threatened by the loss of breeding and wintering habitats through agricultural intensification, wetland drainage, flood control, afforestation, land reclamation, industrial development, encroachment of *Spartina* spp. on mudflats, improvement of marginal grasslands (e.g. by drainage, inorganic fertilising and re-seeding), coastal barrage construction, and heavy grazing (e.g. of saltmarshes). The species is also threatened by disturbance on intertidal mudflats from construction work (UK) and foot-traffic on footpaths. It is vulnerable to severe cold periods on its Western European wintering grounds and suffers from nest predation by introduced predators (e.g. European Hedgehog) on some islands. The species is also susceptible to avian influenza so may be threatened by future outbreaks of the virus.

Redshank generally show moderate sensitivity to human disturbance. In various disturbance experiments in open tidal flats in North Sea coastal sites, Redshank showed escape distances (the distance at which they responded to disturbance) of 82-137 m (see Introductory Report). However, escape distances may be much lower in in enclosed coastal habitats and/or where background levels of human activity are higher and an escape distance of 37 m was reported for a rocky shore site in Northern Ireland (Fitzpatrick and Boucher, 1998).

Wintering Redshank feed at the coastline, often on the waterline. They are vulnerable to oil spills that can (when they reach shore) coat the foraging habitat, oil birds and kill/contaminate prey.

It has been predicted (Huntley *et al*., 2007) that, as a result of climate change, the breeding range of European populations of Dunlin will be reduced in extent and shifted north-eastwards by the latter part of the 21st century. It is predicted that Redshank will become extinct as breeding bird in the Republic of Ireland, southern and central England and Wales. It is also predicted that areas in southern Scandinavia and central Europe will become unsuitable for the species' needs and that these losses will not be offset by increases in Svalbard, Novaya Zemyla and North-west Russia. However, it is also predicted that Iceland and the Faeroe Islands (where the bulk of the birds that winter in Ireland breed) will remain suitable for the species' needs. It is not possible to predict exactly what the effect of changing breeding distribution would be on the wintering distribution of the species, but it is quite possible that the Irish wintering population will remain stable (unless, which seems unlikely, the winter climate of Iceland warms to the extent that breeding birds are able to winter there also).

Population size and distribution within Inner Galway Bay

During the period from winter 2001/02 to 2008/09 (Boland and Crowe, 2012) the peak count in the Inner Galway Bay SPA varied between 671 and 1,091 (mean of 910). The conservation condition Inner Galway Bay Curlew population has been assessed as favourable, with an increase of 81% over the period 1994/95-2008/09, compared to a national increase of 22.7% over the same period

(NPWS, 2013). Inner Galway Bay is the ninth most important site in the Republic of Ireland for Redshank (Boland and Crowe, 2012).

Site Specific Comments Re. Habits, Preferences and Sensitivities

Redshank have been regularly recorded in the development study area (as recorded in the NIS and EIS). Whilst in the study area they have been observed to forage in the intertidal zone of the site of the proposed development. The whole of the intertidal area of the study area is foraging habitat for this species, therefore. Count maxima of 1 bird using the proposed development site for foraging during the period from March 2011 to March 2012 (mean 0.5, recorded on 6 out of 12 counts during the winter period), 1 bird during the period from October 2012 to March 2013 (mean 0.5, recorded on 6 out of 12 counts) and 1 bird during the period from April to June 2014 were recorded.

Redshank also occur in the adjacent intertidal area to the west (Nimmo's Pier-South Park Shore), somewhat irregularly and in very low numbers (1-3 birds in seven out of 13 counts during the 2011/12 and 2013/14 winters). Redshank were not recorded in the adjacent intertidal area to the east (Renmore Beach).

(xi) Red-breasted Merganser (*Mergus serrator*)

Background Information

Species Habits and Preferences

This duck species nests on sheltered lakes and large rivers, also along the coast, on islands and sea-loughs. In winter they are found exclusively in brackish and marine waters, particularly in shallow protected estuaries, bays, lagoons and also offshore. Red-breasted Merganser is a member of the water column diver (shallow) trophic guild. Foraging occurs during the daytime and is by diving from the water surface; birds forage with head and eyes immersed to search for food and subsequently dive to capture it. This species prefers shallow waters to about 5 metres in depth and most dives are within 3-5 metres of the surface. Foraging can be by single birds, pairs, or by larger flocks, sometimes cooperatively. Marine food items taken include: Cod, Herring, Butterfish, sandeels, Sprat, blennies, sticklebacks, Hake, crustaceans (prawns, shrimps and crab) and molluscs. In winter the birds are generally found in small flocks. Birds are mature after two to three years. The oldest recorded individual (ringing recovery) was 9 years and four months old.

Breeding in Ireland occurs mainly in the North and West, in Northern Ireland, Donegal, Mayo, Galway, Kerry and west Cork. Wintering occurs around the majority of the Irish coast. The Irish wintering population includes local breeding birds that move to the coast, but also birds from Icelandic breeding population and probably some from East Greenland also. This wintering population is part of the North-west and central European flyway population, which breeds in North and North-west Europe, Iceland and East Greenland. Wintering birds in Ireland are mainly present from September to May (with October to March being the important peak months). The size of this flyway population is estimated at about 170,000 individuals. This flyway population is considered to be currently secure.

The Irish wintering distribution is effectively around the entire coastline. The All-Ireland wintering population has been estimated at 2,130 (Crowe and Holt, 2013). Worldwide, there are also breeding populations in North-east Europe, Siberia, China, West and South-east Greenland, Alaska, Canada and adjoining areas in the U.S.A. Wintering birds from these populations are found off the Atlantic and Pacific coasts of North America, the Gulf of Mexico, East Mediterranean, Black Sea, South-east, South-west and Central Asia and the South-west coast of Greenland.

Species Sensitivities

The species is subject to persecution and may be shot by anglers and fish-farmers who consider that it threatens fish stocks. It is also threatened by accidental entanglement and drowning in fishing nets. Alterations to its breeding habitats by dam construction and deforestation, and habitat degradation from water pollution are other major threats to the species. It is also considered vulnerable to nest predation by ground predators (e.g. American Mink) and would (like any marine coastal species) be vulnerable to the effects of oil pollution.

It has been predicted (Huntley *et al*., 2007) that, as a result of climate change, the breeding range of the Red-breasted Merganser in Europe is predicted to be shifted northwards by the latter part of the 21st century. These authors predict the extinction of this species as a breeding bird in Ireland, a shift northwards in Britain to the extreme north of Scotland only, a reduction of breeding range in North-west Russia, Finland and Scandinavia, but a colonisation of Svalbard and Novaya Zemlya. It is not clear what effects this shift of the breeding population would have on the wintering distribution of the species; it could be that the wintering distribution will also move further northwards (with unpredictable impacts on the Irish wintering population).

Red-breasted Merganser frequently occur in enclosed estuarine waters in relatively close proximity to moderate levels of human activity: e.g., in Cork Harbour their main area of occurrence is in the North Channel, where they occur in the middle of the channel 200-300 m from a road (used as an informal amenity walking route) running along the southern shore. However, there appears to be little specific research evidence about their response to human disturbance. Avocet Research Associates (2007) report the results of research carried out in San Francisco Bay where Red-breasted Merganser were experimentally disturbed by kayaks. The mean response distance was 28 m, and they recommended a buffer distance of 219 m (to include the upper end of the 95% confidence limit plus an extra 40 m) to avoid disturbance. Knapton et al. (2000) reported flight distances[1] of 746-939 m, and flight times of 33-51 seconds, for diving ducks (including Red-breasted Merganser) in response to disturbance by boats on an Ontario lake.

Red-breasted Merganser feed by diving beneath the water for prey. They are thus very vulnerable to oil spills that can oil the birds and kill/contaminate prey.

Population size and distribution within Inner Galway Bay

According to the Conservation Objectives Supporting Document (NPWS, 2013) the SPA regularly supports 1% or more of the all-Ireland population of Red-breasted Merganser during winter. The mean peak number of this species within the SPA during the baseline period (1995/96 – 1999/00) was 249 individuals. During the period from winter 2001/02 to 2008/09 the peak count in the Inner Galway Bay SPA varied between 156 and 335 (mean of 215). The conservation condition of the Inner Galway Bay Red-breasted Merganser population has been assessed as intermediate (unfavourable), with a decrease of 4.1% over the period 1994/95-2008/09, compared to a national decrease of 11% over the same period (NPWS, 2013). Inner Galway Bay is the most important site in the Republic of Ireland for Red-breasted Merganser (Boland and Crowe, 2012).

Site Specific Comments Re. Habits, Preferences and Sensitivities

Red-breasted Merganser have been recorded, somewhat irregularly, in the development study area (as recorded in the NIS and EIS). Whilst in the study area they have been observed to forage by diving within the marine area of the site of the proposed development. However, the other section of the GHE count area (including the proposed entrance channel to the commercial port) is deep

[1] The distance flown in response to disturbance

subtidal habitat (greater than 5 m depth) and is, therefore, unlikely to be very suitable foraging habitat for this species. Red-breasted Merganser were not observed within the intertidal portion of the development area. Count maxima of 3 birds using the proposed development site for foraging during the period from March 2011 to March 2012 (mean 0.5, recorded on 3 out of 12 counts during the winter period), 5 birds during the period from October 2012 to March 2013 using the proposed development site for foraging during the period from March 2011 to March 2012 (mean 2, recorded on 10 out of 12 counts during the winter period) and 11 birds during the period from April to June 2014 were recorded.

(xii) Sandwich Tern (*Sterna sandvicensis*)

Background Information

Species Habits and Preferences

This species breeds in colonies mainly on marine inshore islands, sand spits, shingle beaches and (occasionally in Ireland) on islands in freshwater lakes. During winter it is mainly found in coastal marine areas during winter. Birds are present in Ireland during passage periods and the breeding season, mainly between March and September-October. In recent years a small number (maximum number recorded has been eight) of individuals have also wintered in Galway Bay. Sandwich Tern is a member of the water column diver (shallow) trophic guild. It is a specialist predator that feeds mostly by plunge diving for prey, but will also snatch prey in flight from just below the water surface or skims low over the waves to catch small fish emerging from the water. The maximum dive depth is 1.5-2 metres. Prey items comprise mainly marine fish about 10 cm in length; in the Atlantic these are mainly Sandeels, but Herring, Sardines, Anchovies, Sprat, Whiting, sticklebacks and Cod are also taken, as are shrimps, squid and ragworms. Detection of active prey is visual and birds roost on rocks or islands (i.e. at the nesting colony during the breeding season) at night. Recorded foraging distances from the breeding colony are varied, with a maximum claimed of 70 kilometres and a mean of approximately 15 kilometres; in general it is safe to say that the majority of birds forage within 20 kilometres of the colony during the breeding season. Birds are fully mature after three-four years and the oldest recorded individual (ringing recovery) was 27 years and 3 months old.

The birds that breed in Ireland are part of the Western Europe breeding population that winters mainly off West African coasts and in the Mediterranean. The size of the European breeding population is estimated at about 166,000 – 171, 000 individuals. The population trend is currently stable, although the European population has been assessed as depleted, due to a moderate historical decline, and Sandwich Tern is listed on Annex 1 of the Birds Directive (79/409/EEC). This population breeds on Atlantic coasts (Ireland, Britain, France, Netherlands, Germany, Sweden, Denmark and the Baltic), in the Mediterranean (France, Spain and Italy) and in the Black and Caspian seas. Wintering is mainly off West African coasts (Mauretania, Ghana, Senegal, Sierra Leone, Liberia, Côte D'Ivoire), but occurs down as far as South Africa. The Irish breeding population is approximately 3,700 AON (apparently occupied nests, or pairs). Worldwide, there are also breeding populations in southern U.S.A., Caribbean islands, Gulf of Mexico and Caribbean Mexico and South America).

Species Sensitivities

Breeding birds are very sensitive to human disturbance at their nest sites. Foraging Sandwich Terns are more tolerant of human disturbance and Furness *et al*. (2012) gave Sandwich Tern a low vulnerability score for disturbance by ship traffic, referencing "slight avoidance at short range". In Irish coastal waters they often feed in very close proximity to human activity.

Sandwich Terns are also to loss of breeding sites due to erosion, wind-blown sand or overgrowth of vegetation and to nest predation by predators. Sandwich Terns wintering off West Africa are hunted.

It has been predicted (Huntley *et al*., 2007) that, as a result of climate change, the breeding range of Sandwich Tern in Ireland and Britain will remain similar to as at present. Overall, a slight breeding distribution shift to the north is predicted, with the possibility that breeding may start to occur in Iceland, but that there will be a decline on continental Atlantic coasts from France to Germany and in the Black Sea.

Sandwich Tern feed by diving into the sea and often rest close to water. Thus they are vulnerable to oil spills, both in the sense of direct oiling of the birds and due to contamination of and/or shortage of suitable prey in the aftermath of a spill.

Population size and distribution within Inner Galway Bay

In 1995, as part of the All-Ireland Tern survey, the breeding population of Sandwich Tern in Inner Galway Bay was surveyed and 81 pairs (based on apparently occupied nests) were recorded. This exceeds the All-Ireland 1% threshold for this Annex I species. In 2014 the breeding colony on an island in Coranroo Bay was still extant and the size of the breeding population was estimated at 50 to 75 pairs, still exceeding the all-Ireland 1% threshold.

The distribution of foraging Sandwich Terns within Inner Galway Bay is not known. The mean foraging range of Common Terns is 14.7 km, while the majority of birds forage within 20 kilometres of their breeding colony (seabird wikispace). The mean foraging range probably represents the core foraging area, while the area between the mean foraging range and the maximum foraging range can be thought of as a buffer zone, exploited by lower numbers of birds less intensively. Therefore, if these foraging range figures are representative of the Inner Galway Bay population, the core foraging range for the Sandwich Tern colony includes the entire SPA, and extends outside the SPA to near Black Head on the southern shore. Within these areas, Sandwich Terns can feed in all subtidal habitat (and have been observed feeding out in the middle of the bay) and in intertidal habitat at high tide. Based on the seabird wikispace foraging range data, around 60% of the core foraging ranges is contained within the Inner Galway Bay SPA.

Site Specific Comments Re. Habits, Preferences and Sensitivities

The Sandwich Tern breeding colony is approximately 12 kilometres from the site of the proposed development and is not close to any of the shipping routes, areas likely to be used by recreational boating, etc.

Sandwich Tern has been regularly recorded in the development study area (as recorded in the NIS and EIS), with maxima of 13 birds using the site for foraging during summer 2011 and 6 birds during the period from April to June 2014. Whilst in the study area they have been observed to plunge dive for prey regularly. The whole of the marine area of the study area is foraging habitat for this species, therefore. This species has not been observed resting within the study area, although they do regularly rest on exposed muddy sand near to Nimmo's Pier and on rocks between Nimmo's Pier and the Mutton Island causeway.

(xiii) Turnstone (*Arenaria interpres*)

Background Information

Species Habits and Preferences

This wading bird species nests on the ground in open sites, usually on a slight ridge or hummock, or in a rock fissure, usually close to the coast, but sometimes a few kilometres inland. In winter (i.e. when present in Ireland) the distribution is around the shoreline of the coast, with shores that are stony, rocky, or covered with seaweed preferred, as well as sea-walls, breakwaters, harbours and jetties. Turnstone is a member of the intertidal walker (out of water) trophic guild. The commonest feeding technique (which gives the bird its common name) is to overturn objects (e.g. stones, seaweed) with the bill and forehead while searching for prey. Other feeding techniques include rolling up mats of seaweed, searching in cracks between rocks and probing into sediment with the bill. Food items taken include flies, wasps, ants, butterflies and moths, beetles, spiders, crustaceans (amphipods, barnacles, crabs and isopods), molluscs (winkles, mussels and limpets), worms, brittlestars, urchins, small fish (sticklebacks) and plant seeds. Will scavenge dead animals washed up on the shoreline (seals, whales, man, sheep and wolf have been recorded), eat discarded human foodstuffs (e.g. spilt grain, bread, chips) and also steal the contents of unguarded birds' eggs. In winter the birds are generally found in small loose flocks (of less than ten to 20-30 individuals), although larger groups may be found at particularly attractive feeding areas, or at roosts. Flocks will typically forage energetically and actively in one area before flying of together to another feeding site along the shoreline. Birds are mature after two years and the average lifespan is nine years. The oldest recorded individual (ringing recovery) was 19 years and eight months old.

The birds that winter in Ireland breed in North-eastern Canada and North and east Greenland. The wintering population is mainly present from September to May (with October to March being the important peak months). The size of this population is estimated at about 100,000 to 200,000 individuals. The current trend is tentatively considered to be increasing after declines in previous years. The wintering distribution is around the coasts western Europe and North-west Africa.

The Irish wintering distribution is effectively around the entire coastline. The All-Ireland wintering population has been estimated at 9,630 (Crowe and Holt, 2013). Since non-estuarine stretches of coastlines are only surveyed formally every nine years (the BWI NEWS survey) and rocky coastlines are a preferred habitat for this species, estimates of populations size and population trends based on I-W*e*BS data (this survey covers only a very small proportion of non-estuarine wetlands) should be treated with caution. Worldwide, there are also breeding populations in Fenno-Scandinavia, Northwest Russia, the high Russian Arctic, west and central Siberia, low Arctic Canada and Alaska. Wintering birds from these populations are found in South and Central America, southern U.S.A., Africa, Madagascar, the Middle East, India, South-east Asia, Australia and New Zealand.

Species Sensitivities

Breeding birds are vulnerable to nest predation (i.e. outside of Ireland). Other threats include habitat loss and pollution.

It has been predicted (Huntley *et al*., 2007) that, as a result of climate change, the breeding range of the Turnstone in Scandinavia and North-west Russia will be reduced and shifted slightly northwards by the latter part of the 21st century. Presumably, this northward shift will also occur in Canada and Greenland. It is not clear what effects this shift of the breeding population would have on the wintering distribution of the species; it could be that the wintering distribution will also move further northwards (with unpredictable impacts on the Irish wintering population).

Turnstone feed at the coastline, often on the waterline. They are vulnerable to oil spills that can (when they reach shore) coat the foraging habitat, oiling the birds and kill/contaminate prey.

Population size and distribution within Inner Galway Bay

According to the Conservation Objectives Supporting Document (NPWS, 2013) the SPA regularly supports 1% or more of the all-Ireland population of Turnstone during winter. The mean peak number of this species within the SPA during the baseline period (1995/96 – 1999/00) was 182 individuals. During the period from winter 2001/02 to 2008/09 the peak count in the Inner Galway Bay SPA varied between 217 and 372. However, due to the difficulties of counting Turnstone, the I-WeBS counts are likely to be significant underestimates of the true population size within Inner Galway Bay. The conservation condition of the Inner Galway Bay Turnstone population has been assessed as favourable, with an increase of 105% over the period 1994/95-2008/09, compared to a national trend of 16% over the same period (NPWS, 2013). Inner Galway Bay is the third most important site in Ireland for Turnstone (Boland and Crowe, 2012).

Over the twelve I-WeBS seasons (37 counts) from 2002/03 to 2013/14, Turnstone was recorded in 24 of the 25 I-WeBS sub-sites used (the exception being the Ahapouleen wetland, a freshwater turlough site that lies near to the shoreline of the bay). During the 2009-2010 low tide baseline waterbird surveys, Turnstone was recorded from 26 of the 31 sub-sites that were defined for the study. Foraging was recorded at all 26 sub-sites and roosting was also recorded in 14 of these. For the five monthly counts from October 2009 to February 2010, the average SPA count was 287, with a maximum count of 466 in December 2009. In the area of the Inner Galway Bay SPA as a whole, I-WeBS counts and low tide baseline data have indicated that Turnstone are most numerous around the southern coast of the inner bay between Kinvara and Aughinish and in the centre of the bay in the Tawin Island area.

As Turnstone typically feed on rocky shores, their distribution within Inner Galway Bay might be expected to be correlated with the distribution of the fucoid-dominated community complex biotope. However, no such relationship was found in our analyses of subsite distribution. It may be that, in areas with large amounts of this biotope, the difficulties of detecting Turnstone in counts from fixed vantage points causes systematic undercounting, compared to areas with small amounts of the biotope.

Site Specific Comments Re. Habits, Preferences and Sensitivities

Turnstones have been regularly recorded in the development study area (as recorded in the NIS and EIS). Whilst in the study area they have been observed to forage actively on the shoreline. No high tide roosts have been observed within the development site study area. In most cases the birds observed foraged for a short period before flying off, either to the west or to the east. Turnstone do not regularly occur in the areas of intertidal habitat adjacent to the GHE site (Nimmo's Pier-South Park Shore and Renmore Beach).

The intertidal habitat within the study area is classified as the fucoid-dominated biotope and is suitable foraging habitat for the species. However, it has been fragmented due to the loss of the upper shore by the development of the GHEP and now exists as small patches of habitat, isolated from other areas of suitable habitat. This fragmented nature of the habitat is reflected in the behaviour of the birds only staying within the site for short periods of time as described above.

(xiv) Wigeon (*Anas penelope*)

Background Information

Species Habits and Preferences

This dabbling duck species nests on shallow freshwater marshes, on lake islands, or under tussocks adjacent to lakes and lagoons. In winter they occur on coastal marshes, freshwater and brackish lagoons, estuaries and bays. Many also winter on inland wetlands, lakes, rivers and turloughs. Wigeon is a member of the both the surface swimmer and intertidal walker (out of water) trophic guilds. This species is almost entirely vegetarian, foraging is by grazing on land while walking, on water, from the surface and under water by immersion of the head and neck. Wintering birds are gregarious and can feed during the day or night, depending on tidal state and disturbance. Food items taken include: *Zostera*, *Ruppia*, *Salicornia*, algae (e.g. *Enteromorpha*, *Ulva*) and grasses from the supratidal zone, as well as duckweeds, clover, horsetails and Fool's Watercress. Occasionally, some animal materials (i.e. cockles, other molluscs, crustaceans, amphibians and fish spawn) are taken. Birds are mature after one year. Although average life expectancy is only 1.6 years, the oldest recorded individual (ringing recovery) was 18 years and three months old.

The Irish breeding population is small at best; during the last breeding atlas survey pairs were present during the breeding season in nine 10-kilometre squares scattered across inland lowland wetlands, but breeding was not confirmed at any of these sites. The Irish wintering population is widespread and can be found at lowland wetlands both at the coast and inland. This wintering population includes birds from the Icelandic, Fenno-Scandinavian and Russian breeding populations and can fluctuate widely in number due to the severity of weather conditions both in continental Europe and in Ireland. Wintering birds are part of the Western Siberia & NE Europe/NW Europe flyway population, which breeds in western Siberia and northern Europe (including Iceland and very thinly in Ireland and Britain). Wintering birds in Ireland are mainly present from September to April (with October to March being the important peak months). The size of this flyway population is estimated at about 1.5 million individuals and the population trend is considered to be currently stable/secure. The All-Ireland wintering population has been estimated at 62,980 (Crowe and Holt, 2013) and Wigeon is red-listed in BoCCI 2014-2019 (Colhoun and Cummins, 2013) due to a severe decline in the wintering population. Worldwide, there are five flyway populations of Wigeon breeding across Siberia, into Mongolia and North-east China. Wintering birds from these populations are found in southern and central Asia, North-east Africa, the Black Sea and the Mediterranean.

Species Sensitivities

This species is susceptible to disturbance from freshwater recreational activities (e.g. walkers), pollution (including thallium contamination, petroleum pollution, wetland drainage, peat-extraction (e.g. in the Kaliningrad region of Russia), changing wetland management practices (decreased grazing and mowing in meadows leading to scrub over-growth) and the burning and mowing of reeds. Avian influenza virus (strain H5N1) is also a potential threat, as is poisoning from the ingestion of lead shot pellets. This species is hunted for sport (e.g. in Ireland and Britain), and although population numbers in an area decrease significantly after a period of shooting, there is no current evidence that such utilisation poses and immediate threat to the species, although hunting may increase the species sensitivity to disturbance impacts (see below). The eggs of this species used to be (and possibly still are) harvested in Iceland. This species is also hunted for commercial and recreational purposes in Gilan Province, northern Iran.

Wigeon generally show moderate-high sensitivity to human disturbance. In various disturbance experiments in open tidal flats in North Sea coastal sites, Wigeon showed escape distances (the distance at which they responded to disturbance) of 128-269 m (see Introductory Report). In controlled disturbance experiments in a restored freshwater wetland complex in Denmark (Bregnballe et al., 2009), escape distances were 190-205 m when views were unobstructed and 117 m (but note small sample size) when views were obstructed. Mathers et al (2000) reported observations of unplanned disturbances on Wigeon feeding on *Zostera* beds in Stangford Lough, Ireland. As the *Zostera* beds are spatially discrete and widely separated, the displacement costs are likely to be high. The EDs were reported in distance bands of 0-100 m, 100-250 m and > 250 m, and for flock sizes of 0-100 and > 100 birds. The median ED was in the 100-250 m band, but there were significant numbers of observations of birds showing both small EDs (< 100 m) and large EDs (> 250 m). It should be noted that, as this was not a controlled study, the distribution of potential disturbances was not necessarily equal across the distance bands.

It has been predicted (Huntley *et al*., 2007) that, as a result of climate change, the breeding range of the Wigeon in Europe is predicted to be shifted northwards by the latter part of the 21st century. These authors predict the extinction of this species as a breeding bird in Ireland, England and Wales, a reduction of the breeding range in Iceland (slight), southern Scandinavia and Russia, but a colonisation of Svalbard and Novaya Zemlya. It is not clear what effects this shift of the breeding population would have on the wintering distribution of the species; it could be that the wintering distribution will also move further northwards (with unpredictable impacts on the Irish wintering population), but winter visitors from Iceland (swelled by birds from the east during bad weather on the continent) would still be expected.

Population size and distribution within Inner Galway Bay

During the period from winter 2001/02 to 2008/09 the peak count in the Inner Galway Bay SPA varied between 1,138 and 2,185, with a mean of 1,828 (Boland and Crowe, 2012). The conservation condition Inner Galway Bay Curlew population has been assessed as favourable, with an increase of 17.6% over the period 1994/95-2008/09, compared to a national decrease of -20.2% over the same period (NPWS, 2013). Inner Galway Bay is the tenth most important site in the Republic of Ireland for Wigeon (Boland and Crowe, 2012).

The subsite distribution of Wigeon in Inner Galway Bay does not show any strong patterns of association with the distribution of suitable tidal zones or biotopes. Wigeon tend to feed on concentrated food resources, often in the supratidal or terrestrial zone and the large-scale distribution of these birds may have been affected by the proximity of suitable supratidal/terrestrial foraging habitat.

Wigeon can utilise a wide range of habitats for foraging and roosting. In the BWS low tide counts, the majority of birds occurred in subtidal habitats (mean of 56% of the total counts, and 59% of the counts of foraging birds, with substantial numbers in intertidal habitat (40%, 38%). The numbers recorded in supratidal/terrestrial habitat were low (4%, 3%), but this may have reflected the focus of the count subsites on tidal habitats. As with Brent Goose, most of the supratidal habitats used by this species in Inner Galway Bay are covered by I-WeBS/BWS.

The subtidal habitat suitable for foraging by Wigeon will be limited to shallow subtidal waters as Wigeon generally do not feed in waters of greater than 0.5 m depth (Kirby et al., 2000). The tidal zone between the mean low tide and the lowest astronomical tide can be considered to be a reasonable approximation of the distribution at low tide of suitable Wigeon subtidal foraging habitat.

Site Specific Comments Re. Habits, Preferences and Sensitivities

Wigeon have been recorded, somewhat irregularly, in the development study area (as recorded in the NIS and EIS). Within the study area they have been observed to forage on the foreshore (almost certainly on marine algae) and in the shallow water immediately adjacent to it. The foraging habitat for this species in the proposed development site are the intertidal and shallow subtidal zones, therefore. Count maxima of 12 birds using the proposed development site for foraging during the period from March 2011 to March 2012 (mean 1.8, recorded on 3 out of 12 counts during the winter period), 4 birds during the period from October 2012 to March 2013 (mean 0.8, recorded on 4 out of 12 counts during the winter period) and 3 birds during the period from April to June 2014 were recorded. The pattern of usage of the site appears to be seasonal, with all the records in later winter/spring. Roosting behaviour was not recorded at the site of the proposed development.

Wigeon also occur in the adjacent intertidal areas, again somewhat irregularly and in very low numbers. In the area to the west (Nimmo's Pier-South Park Shore) 1-10 birds were recorded in five out of 13 counts during the 2011/12 and 2013/14 winters. In the area to the east, 1-2 birds were recorded in two out of 10 counts during the 2011/12 and 2013/14 winters.

Appendix RFI 3 - Birds

RFI 3.3 Bird Species Assessments by Dr. Tom Gittings

GALWAY HARBOUR EXTENSION:
SPECIAL CONSERVATION INTERESTS
SPECIES ASSESSMENTS

Tom Gittings BSc, PhD, MIEEM
Ecological Consultant
3 Coastguard Cottages
Roches Point
Whitegate
CO. CORK
www.gittings.ie

REPORT NUMBER: 14-14
STATUS OF REPORT: Revision 5
DATE OF REPORT: 15 October 2014

CONTENTS

1. INTRODUCTION

The species assessments contained in this report provide site and species-specific assessments of the potential impacts of the Galway Harbour Extension project on the Special Conservation Interest (SCI) species of the Inner Galway Bay SPA.

These species assessments cover 14 of the 20 SCI species: Light-bellied Brent Goose, Wigeon, Red-breasted Merganser, Great Northern Diver, Cormorant, Grey Heron, Bar-tailed Godwit, Curlew, Redshank, Turnstone, Black-headed Gull, Common Gull, Sandwich Tern and Common Tern. However, Bar-tailed Godwit was never recorded within the development site, but occurred regularly in adjacent areas, and is, therefore, only considered in relation to potential disturbance impacts.

The remaining six SCI species (Teal, Shoveler, Ringed Plover, Golden Plover, Lapwing, and Dunlin) have never, or only very rarely been recorded within the development site and it is considered that the habitat conditions are unsuitable for these species. Two of these species (Ringed Plover and Dunlin) have been recorded in adjacent areas, but only occurred irregularly and in very small numbers, so any potential disturbance impacts will not be significant.

The SCI species of Lough Corrib have been assessed separately in a document prepared by Chris Peppiatt.

The main impact assessments (of habitat loss/degradation and disturbance) are presented separately for the non-breeding and breeding SCI populations. This reflects differences in the data available for the assessments, which dictated the methodology of the assessments, and in some of the issues potentially affecting the populations.

These species assessments are informed by the species profiles, prepared mainly by Chris Peppiatt, which include: general reviews of their ecology, Irish status and distribution, occurrence within Inner Galway Bay; detailed assessment of their occurrence within and adjacent to the development site; and review of their sensitivities to potential impacts.

2. BACKGROUND INFORMATION

2.1. AREAS REFERRED TO IN THIS REPORT

The various areas referred to this report are defined in Table 1 and are shown in Figure 1 (which is included at the end of the report). Note that although Figure 1 indicates that the GHE count area includes part of the intertidal habitat at Renmore Beach, in practice the only intertidal area counted as part of the GHE count area was within the GHE development site. Also, the NPWS biotope map (NPWS, 2013b; part of which is reproduced in Figure 1) does not map the full extent of the intertidal habitat within the GHE development site[1].

Table 1. Areas referred to in this report

Area	Definition
GHE development site	The area subject to permanent development work
GHE site	The GHE development site and the area subject to maintenance dreging
GHE count area	The area covered by the waterbird monitoring counts
Nimmo's Pier-South Park Shore	The intertidal and shallow subtidal habitat between Nimmo's Pier and the Mutton Island causeway
Renmore Beach	The intertidal and shallow subtidal habitat between the GHE development site and the small headland approximately 250 m to the east.

[1] The extent of intertidal habitat within the GHE development site has been quantified for this report (see Section 2.2.3).

2.2. HABITAT DEFINITIONS AND AREAS

2.2.1. Habitat definitions

The definition of intertidal and subtidal habitat used in this report follows that used in the SPA Conservation Objectives (see Section 2.2.3 below).

For some assessments, a tidal zone described as shallow subtidal habitat is referred to. We have defined this as the zone between the mean low water mark and the lowest astronomical tide. This tidal zone provides an approximation to the subtidal habitat available to foraging Light-bellied Brent Goose, Wigeon and Grey Heron at low tide.

2.2.2. Habitat within the SPA

The total areas of intertidal and subtidal habitat within the SPA are taken from NPWS (2013a) as follows:

- Intertidal habitat (between the mean high water mark and the mean low watermark) - 2,111 ha
- Subtidal habitat (below the mean low water mark and predominantly covered by marine water) - 10,352 ha
- The total area of intertidal and subtidal habitat is, therefore, 12,463 ha.

The total area of shallow subtidal habitat within the SPA has been estimated as 1930 ha. This was calculated by digitising the area between the mean low water mark (as defined in the shapefiles for intertidal biotopes obtained from NPWS) and the lowest astronomical tide (as defined on the Admiralty Chart).

2.2.3. Habitat loss

All figures for permanent habitat loss used in this report are based on Table 3.13 of the NIS. However, the intertidal/subtidal boundary used for the derivation of these figures appears to be based upon the extent of the intertidal zone shown in the Admiralty Chart, with a few modifications. This uses the lowest astronomical tide to define the intertidal zone (i.e., the 0 m contour). This extent of intertidal habitat is only very rarely exposed. Based on UK Admiralty tidal predictions for Galway Harbour between September 2013 and March 2014, the mean low tide in Galway Bay is around 1.2 m and only 10% of low tides have heights of 0.5 m or less. Therefore, figures of intertidal habitat loss based on the lowest astronomical tide will substantially exaggerate the likely reduction in potential foraging habitat available to intertidally feeding species over the course of the winter. Similarly, figures of subtidal habitat loss based on the lowest astronomical tide will substantially underestimate the likely reduction in permanently flooded foraging habitat available to subtidally feeding species over the course of the winter. Furthermore, these figures will not be comparable with the intertidal and subtidal zones defined by NPWS.

Therefore, for use in this report, the figures for habitat loss from Table 3.13 of the NIS have been adjusted to correspond to the intertidal and subtidal zones defined by NPWS. This was done by subtracting the area between the mean low water mark (as defined on the Ordnance Survey Discovery Series map) and the lowest astronomical tide (as defined in 3.6 of the NIS) from the figure for intertidal habitat loss given in Table 3.13 of the NIS, and adding this area to the figure for subtidal habitat loss given in Table 3.13 of the NIS (see Table 2). It should be noted that this adjustment does not alter the overall figure for habitat loss, just the division of this figure between the intertidal and subtidal zones.

Therefore, the figures used for permanent habitat loss are:

- intertidal habitat = 2.1 ha (0.1% of the intertidal habitat within the SPA);
- subtidal habitat = 24.8 ha (0.2% of the subtidal habitat within the SPA; and
- intertidal and subtidal habitat = 26.9 ha (0.2% of the intertidal and subtidal habitat within the SPA).

All the marine habitat potentially affected by temporary construction/dredging disturbance is below the mean low water mark and is, therefore, classified as subtidal habitat (as defined by NPWS). Therefore, the figures for additional temporary habitat loss in this report are:

- intertidal habitat = 0 ha;
- subtidal habitat = 51.8 ha (0.5% of the subtidal habitat within the SPA; and
- intertidal and subtidal habitat = 51.8 ha (0.4% of the intertidal and subtidal habitat within the SPA).

There is also an additional 220 ha of subtidal habitat within the GHE count area but outside the GHE site.

Table 2. Permanent habitat loss in relation to tidal zones used in the NIS and by NPWS

<table>
<tr><th rowspan="2">Tidal zone</th><th rowspan="2">Area (ha)</th><th colspan="2">NIS</th><th colspan="2">NPWS</th></tr>
<tr><th>Zone</th><th>Area (ha)</th><th>Zone</th><th>Area (ha)</th></tr>
<tr><td>Above MLWM</td><td>2.1</td><td rowspan="2">intertidal</td><td rowspan="2">5.9</td><td>intertidal</td><td>2.1</td></tr>
<tr><td>MLWM-LAT</td><td>3.8</td><td rowspan="2">subtidal</td><td rowspan="2">24.8</td></tr>
<tr><td>Below LAT</td><td>21.0</td><td>subtidal</td><td>21.0</td></tr>
<tr><td>All</td><td>26.9</td><td>All</td><td>26.9</td><td>All</td><td>26.9</td></tr>
</table>

2.3. WATERBIRD OCCURRENCE IN THE DEVELOPMENT AREA

Waterbird monitoring of the GHE count area has been carried out through monthly counts from March 2011-March 2012, October 2012-March 2013 and from March-September 2014. Each count involved an eight hour watch from a vantage point within at the northern edge of the GHE development site. Maximum counts of all species were recorded for each 30 minute interval during these counts. Some counts also recorded bird numbers in the adjacent intertidal areas at Renmore Beach and the eastern end of Nimmo's Pier-South Park Shore.

For this assessment, the occurrence of the non-breeding SCI populations within the GHE count area has been analysed using the count data from September 2011-March 2012 and October 2012-March 2013. These periods correspond to the seasonal period normally used for assessing non-breeding waterbird populations (September-March), and can be compared with I-WeBS data for the same winters. The counts from March 2011 and 2014 have not been included, as comparisons between counts from a single month and I-WeBS data for a whole winter would not be representative.

The occurrence of the breeding SCI populations within the GHE count area has been analysed using the count data from April-July 2011 and 2014 (Cormorant) and May-July 2011 and 2014 (Sandwich Tern and Common Tern).

The occurrence of the non-breeding SCI populations in the adjacent areas of intertidal habitat has been analysed using all available counts from the September-March period, due to the lower number of counts in the individual winters.

For species associated with intertidal/shallow subtidal habitat, only the counts that included the low tide period were included in the analysis.

2.4. WATERBIRD POPULATION SIZES IN THE INNER GALWAY BAY SPA

The information in this report on waterbird population sizes in the Inner Galway Bay SPA are based on Irish Wetland Bird Survey (I-WeBS) count data for Inner Galway Bay. However, in interpreting the I-WeBS count data it is important to note that the I-WeBS subsites do not cover the entire SPA (Figure 2). Note that the same overall area was also used for the National Parks and Wildlife Survey Baseline Waterbird Survey (BWS) counts, although some of the I-WeBS subsites were subdivided for these counts.

Overall, the subsites cover 88% of the intertidal habitat within the SPA. In practice, however, it is likely that counts in intertidal and shallow subtidal habitat extend outside the mapped subsites in certain areas (e.g., Corranroo Bay), while the selection of the subsites has reflected local knowledge about the important intertidal areas in Inner Galway Bay. Therefore, the counts of the intertidal and shallow subtidal zones are likely to represent reasonable approximations of the populations using the habitats within the SPA (unless significant numbers occur in the uncounted areas around Island Eddy).

The subsites only cover around 54% of the subtidal habitat within the SPA. In practice, birds in subtidal habitat beyond a subsite boundary are likely to be counted as part of the subsite if they are visible. However, the subsite boundaries generally extend 1-1.5 km offshore, so significant numbers of birds in subtidal habitat outside the subsite boundaries are only likely to be counted during exceptionally calm weather conditions. Therefore, I-WeBS and NPWS BWS monitoring data on birds that use subtidal habitat (Great Northern Diver, Red-breasted Merganser and Cormorant) will substantially underestimate the true SPA population and are also likely to display a substantial amount of variation related to weather conditions during the counts.

Because of the potential under-representation of the SPA population by I-WeBS/BWS counts, we use the following terms to distinguish between the population counted and the overall population:

- the **SPA count** refers to the total numbers counted by I-WeBS/BWS within the SPA; while
- the **SPA population** refers to the total numbers actually occurring within the SPA, including within the areas not covered by the I-WeBS/BWS subsites.

2.5. WATERBIRD DISTRIBUTION IN THE INNER GALWAY BAY SPA

The impact assessments in this report are informed by a review of waterbird distribution patterns within the Inner Galway Bay SPA. This review was based on analyses of BWS and I-WeBS data (Appendix 1), as well as the descriptions in the species profiles that were informed by the local knowledge of the author (Chris Peppiatt).

3. IMPACT ASSESSMENT METHODOLOGY

3.1. HABITAT LOSS AND DEGRADATION (NON-BREEDING POPULATIONS)

3.1.1. General approach

The potential impact of habitat loss on SCI species listed for their non-breeding populations has been assessed by calculating the displacement impact in terms of the number of birds displaced as a percentage of the Inner Galway Bay SPA population.

The displacement impacts calculated this way are often expressed as decimal fractions (e.g., 0.3 birds). Clearly, only whole birds can be physically displaced. However, the displacement impact from a site reflects both the numbers occurring within the site and the amount of time they use the site. Therefore, a displacement impact of 0.3 can be interpreted as the displacement of one bird that uses the site for 30% of the time, or two birds that used the site 15% of the time, etc.

3.1.2. Calculations from GHE count data

The potential displacement impacts were assessed in the NIS by expressing the maximum count in the GHE development site as a percentage of the maximum I-WeBS count during the same period of time. This will provide an estimate of the maximum potential displacement impact and can be seen as a very conservative assessment. The importance of attribute 2 of the conservation objectives, and the requirement for assessment of displacement impacts that arise from it, relates to the need to maintain sufficient areas of habitat to support the species population. As birds are mobile animals, occasional large aggregations may occur that are much larger than the typical numbers that usually occur. The mean, or median, numbers of birds using an area will provide a better indication of its importance in supporting the site population than the maximum count. The only exception will be in situations where it is difficult to obtain accurate counts, and the maximum count may represent the only day when conditions allowed an accurate count. However, given the small size of the GHE site, and the survey methods, this exception will not have applied to the monitoring counts carried out for the GHE assessment.

The numbers present in the GHE site show considerable variation between counts. A large part of this variation will be due to the fact that these are mobile species and the GHE site is a small area, with extensive areas of similar habitat available nearby, so there will be a high degree of stochastic variation in the number of birds using the site. However, there will also be annual, seasonal, and, possibly, short-term variation in the total number of birds in Inner Galway Bay, so the size of the pool of birds available to use the GHE site will vary. Therefore, in order to precisely quantify the potential displacement impact using the mean count data, it would be necessary to express each count in the GHE site as a proportion of the overall Inner Galway Bay population on that date. Data for the overall Inner Galway Bay population is not available at that level of resolution. It would be possible to use I-WeBS counts for the closest available month, but it is likely that a substantial part of the variation between I-WeBS counts within a winter represents random counting error, rather than true variation in the population. Instead the potential displacement impact has been calculated using the mean GHE development site count divided by the mean I-WeBS counts for the relevant two winters. By using the mean I-WeBS counts across two winters, the sample size is increased and the effects of anomalous high or low counts should be reduced.

The displacement impacts have been calculated using data from the GHE counts between September and March only, as this corresponds to the period typically used for assessing non-breeding waterbird populations. Where appropriate, the period has been further restricted: e.g., excluding September counts for Light-bellied Brent Goose and Wigeon. For species utilising intertidal and shallow subtidal habitat, only data from GHE counts that included the low tide period have been included.

3.1.3. Calculation from subsite data

For selected species we also used the BWS/I-WeBS subsite data to provide alternative assessments of potential displacement impacts. These assessments, while using inferential estimates of numbers within the GHE count area, allow the potential displacement impact to be calculated using data from the same source for both the numerator and the denominator.

As a simple assessment measure, we used the mean proportion of the SPA count (see Section 2.5 above) occurring within the subsites adjacent to the GHE count area (subsites 0G497 and 499). It is reasonable to conclude, given the nature of the GHE count area, and the characteristics of these subsites, that the GHE count area would not hold significantly higher densities of birds than the overall densities within those two subsites.

For species where there is a significant relationship between the subsite distribution and a relevant habitat parameter (see Section 2.5 above), we used the regression equations derived from the relationship to predict the numbers expected within the GHE development site, GHE site and GHE count area, based on habitat area. The regressions were derived using arcsine-transformed data and checked for normal distribution of residuals and homogeneity of variation in residuals when plotted against predicted values. The predicted numbers from the regression were then back-transformed.

3.1.4. Habitat degradation

Given the nature of the project, habitat degradation impacts are only considered likely to affect subtidal habitat. The main area likely to be affected are the areas subject to maintenance dredging, etc., which can be defined as the area of the GHE site outside the GHE development site. This area is mainly within the 0-10 m depth contours as shown on the Admiralty Chart.

There are also two areas of shallow subtidal habitat:

- There is one small area at the lower end of the shore below the GHE development site (Figure 1). The assessment of displacement impacts from habitat loss assumed complete displacement of all birds associated with shallow subtidal habitat, as indicated by the GHE count data. This would have included any birds using this area. Therefore, this area is not included in the assessment of impacts from habitat degradation.

- There is another small area at the lower end of the shore below the GHE development site, and in the lower part of Nimmo's Pier-South Park Shore (Figure 1). Due to the very low numbers of shallow subtidal species that use the whole of the Nimmo's Pier-South Park Shore intertidal/shallow subtidal zone (Table 10), it can be concluded that displacement of birds from this small area would not significantly increase the overall displacement impacts.

There are potential habitat degradation impacts that could extend outside the GHE site, and the section of the GHE count area outside the GHE development site can be considered to be the maximum extent of subtidal habitat potentially vulnerable to habitat degradation impacts. However, the impacts will be minor in character and would not cause complete displacement of birds. It is reasonable to conclude that the overestimation of the displacement impacts calculated for the subtidal species (due to the coverage of only 54% of the subtidal habitat by the I-WeBS counts) will be larger than any additional displacement that occurs due to such minor habitat degradation. Therefore, the calculation of habitat degradation impacts uses complete displacement from the maintenance dredging area (i.e., the section of the GHE site outside the GHE development site) as the worst-case scenario.

3.1.5. Assessment of significance

A number of site- and species-specific criteria have been used to assess the significance of the predicted displacement impacts. These are described below, with full details of the rationale behind the development of these criteria provided in Appendix 2.

All the predicted displacement impacts involve very small numbers of birds, and very small percentages of the overall Inner Galway Bay population. Therefore, these displacement impacts will only have consequences at the site population-level, if the population is at, or near, the effective carrying capacity of the site[2]. SCI populations which show strongly positive population trends, continuing over an extended period, and up to the present day, cannot be at their effective carrying capacity. So for these species, minor displacement impacts can be predicted to have no population-level consequences. SCI populations which show negative population trends, in contrast to stable or increasing national or regional trends, are likely to be being affected by a site-specific factor and may well, therefore, be at their effective carrying capacity. So for these species, even minor displacement impacts may have population-level consequences. However, the population trends of the majority of SCI populations will fall between these extremes. For these species, additional criteria need to be examined.

Where analysis of the BWS/I-WeBS data shows an approximately linear relationship between subsite area of suitable habitat and the proportion of the SPA count within the subsite, it is reasonable to conclude that the SCI population occurs at fairly uniform density across suitable habitat within the SPA. In these circumstances, the increase in density due to the predicted displacement can be calculated quite simply. Where this increase in density is extremely small, it is reasonable to conclude that the predicted displacement will have no population-level consequences. Furthermore, for some species there is information available about the typical densities at which density-dependent processes start to become important.

Some SCI populations do not show the above linear relationships, indicating that their distribution within the site is determined by additional, and unknown, factors. Therefore, for these populations, it is not possible to calculate densities. Instead, their potential sensitivity to displacement impacts can be assessed more generally, using the following criteria:

- Site fidelity - individuals from populations with high site fidelity may find it more difficult to adapt to a new site after being displaced due to lack of familiarity with the location of food resources in the new site.

[2] Based on Goss-Custard (2014), effective carrying capacity is defined in this report as the population level above which density-dependent mortality/emigration and/or loss of body condition occurs. This is referred to as effective carrying capacity to distinguish this term from other, quite different, uses of the term carrying capacity.

- Sensitivity to interference effects - populations that are sensitive to interference effects will not be able to utilise all the available food resources within the site due to density-dependent reductions in food intake at high bird densities.
- Habitat flexibility - species with a high degree of habitat flexibility may be able to utilise alternative, currently under-utilised, terrestrial habitats, if displaced from the tidal habitats in Inner Galway Bay.

3.2. HABITAT LOSS AND DEGRADATION (BREEDING POPULATIONS)

As is the case with SCI breeding populations in many coastal SPAs, there is very limited data available on the distribution and habitat usage of the SCI breeding populations within Inner Galway Bay. This reflects the absence of regular national monitoring for the species involved. Therefore, it was not possible to carry out detailed quantitative assessments for these populations. The potential displacement impacts to these populations were assessed qualitatively based on general information on their foraging range and behaviour.

3.3. DISTURBANCE IMPACTS

3.3.1. Areas affected

The areas potentially affected by disturbance impacts are:

- The subtidal habitat surrounding the GHE site. For the purposes of this assessment, the section of the GHE count area outside the GHE site is considered to present the subtidal habitat potentially vulnerable to disturbance impacts. This area extends over 500 m to the east of the GHE site, apart from in the vicinity of Hare Island. To the west, this area extends, more or less, up to the natural boundary formed by Mutton Island and the intertidal zone of the Nimmo's Pier-South Park Shore.
- The intertidal/shallow subtidal habitat along the Nimmo's Pier-South Park Shore, which extends around 750 m west of the GHE site.
- The intertidal/shallow subtidal habitat of Renmore Beach. The small headland at the eastern side of Renmore Beach forms a natural boundary to this area, and the next significant area of intertidal habitat, in the bay to the east of this headland, is over 700 m from the GHE site.
- Subtidal habitat elsewhere in Inner Galway Bay, along the shipping lane, and in areas used by recreational boat traffic.

3.3.2. Impact assessment

Disturbance impacts during the construction and operational phases of the development, and from increased shipping and boat traffic generated by the development, are assessed separately.

The first stage of the assessment examined the occurrence of the SCI species in the areas potentially affected by disturbance impacts. Only species that occur regularly in these areas have any potential to be affected by disturbance impacts with sufficient frequency to cause population-level consequences. For these species, a literature review was carried out of their sensitivity to disturbance impacts of the general types likely to occur and this helped to inform the final assessment.

The disturbance sensitivity of subtidal species to shipping and boat traffic is reviewed in the relevant species profiles. In particular, the review in the species profile for Great Northern Diver demonstrates that the figure that has been quoted in the submission by the Department of Arts, Heritage and the Gaeltacht of this species being disturbed by shipping traffic at distances of more than 1 km does not have any firm basis in the literature and is not relevant to the situation in Inner Galway Bay.

There is an extensive literature on the impacts of human disturbance on waterbird populations and relevant studies are referred to in this report to inform the assessment of potential disturbance impacts. One particular approach to the study of disturbance impacts is the use of Escape Distances (EDs), and this approach is introduced in Appendix 3 to provide a general context for the specific discussion of EDs in this report.

3.4. IN-COMBINATION EFFECTS

3.4.1. Galway Harbour Flights Operation

Permission to apply for Planning Permission to operate Flights within the Galway Harbour Company jurisdiction was granted to the Flights Company, Harbour Air Ireland Ltd. (HAI) by Galway Harbour Company subject to the granting of a Foreshore License by the relevant Government Department. Planning Permission was granted for the operation of Harbour Flights by An Bord Pleanala on 25/11/2010. A Foreshore License Application was lodged for the Flights and a request for Further Information was issued to the applicant in June 2012. To date the applicant has failed to provide the Further Information requested. An operational licence, under harbour management requirements, has not been approved or signed by GHC for HAI. GHC will not grant such a licence unless HAI can prove no cumulative impact will arise. Hence this R.F.I. has not included for air flight impacts in the assessment of cumulative impacts.

3.4.2. Galway Harbour Enterprise Park

There is potential for cumulative impacts of the GHE development in combination with historical habitat loss from the development of the Galway Harbour Enterprise Park (GHEP). The figures for the latter are taken from the NIS. The mean proportion of the SPA count occurring within the subsites adjacent to the GHE count area (subsites 0G497 and 499) has been used to provide an indication of the likely usage of the intertidal habitat in the GHEP site. However, where relevant, we have also considered the potential additional fragmentation impact of the GHEP development.

3.4.3. Aquaculture

A draft Appropriate Assessment of aquaculture and fisheries in the Inner Galway Bay SPA has recently been completed (Gittings and O'Donoghue, 2013). The only potential near-significant impacts identified in the assessment were impacts from mussel bottom culture to fish-eating birds (it should be noted that this AA has not yet been published, and so could be subject to change). Therefore, potential cumulative impacts from the GHE development in-combination with the impacts of bottom mussel culture are considered in the relevant species profiles.

4. IMPACT ASSESSMENT

4.1. HABITAT LOSS AND DEGRADATION (NON-BREEDING POPULATIONS)

4.1.1. Impact magnitude

The predicted displacement due to habitat loss assessed on its own is shown in Table 3, while the predicted displacement due to habitat loss combined with a worst-case scenario of habitat degradation within the remaining subtidal area of the GHE site is shown in Table 4. Alternative displacement estimates for the three species dependent on subtidal habitat are presented in Table 5. These are similar to the estimates from the count data, indicating that the correction factors used for the latter did not significantly distort the estimates. It is also notable that the occurrence predicted for the GHE count area by the regression equations are greater than those actually recorded in the GHE count data, indicating that the GHE count area is below average quality for these species.

The percentage displacement figures for Red-breasted Merganser, Great Northern Diver and Cormorant, and, to a lesser extent, Black-headed Gull and Common Gull, will be significant over-estimates due to the very incomplete coverage of subtidal habitat by I-WeBS counts (see Section 2.3). In addition, as discussed in the species profiles, the much more intensive survey effort involved in the GHE counts will have over-recorded certain species compared to the I-WeBS counts. This will be particularly the case for species that occur offshore (Red-breasted Merganser, Great Northern Diver and Cormorant) and for cryptic species (Turnstone).

Table 3. Predicted displacement due to habitat loss

Species	GHE count mean	GHE count SD	Correction factor	Birds displaced	Mean I-WeBS	% displaced
Wigeon	1.6	3.4	1.00	1.6	1478	0.1%
Light-bellied Brent Goose	3.0	6.2	1.00	3.0	1212	0.2%
Red-breasted Merganser	1.3	1.5	0.08	0.1	175	0.1%
Great Northern Diver	4.1	2.9	0.08	0.3	102	0.3%
Cormorant	4.8	6.5	0.08	0.4	162	0.2%
Grey Heron	1.0	0.8	1.00	1.0	83	1.2%
Curlew	1.0	1.1	1.00	1.0	430	0.2%
Redshank	0.6	0.5	1.00	0.6	498	0.1%
Turnstone	5.9	5.3	1.00	5.9	279	2.1%
Black-headed Gull	5.2	5.1	0.09	0.5	1546	< 0.1%
Common Gull	4.1	5.5	0.09	0.4	907	< 0.1%

GHE count data are from the 2011/12 and 2012/13 seasons and, in each season, cover the September-March period. Light-bellied Brent Goose, Wigeon, Grey Heron, Curlew, Redshank, Turnstone, Black-headed Gull and Common Gull figures only include data from GHE counts that included the low tide period (n= 20), and Light-bellied Brent Goose and Wigeon exclude GHE count data from the one September count (which was a low tide count); n = 24 for the other species.
Correction factors are based on the percentage of the GHE count area occupied by the GHE development site (8%), adjusted, for Black-headed and Common Gulls, by the percentage of birds that occurred in subtidal habitat (90%).
Mean I-WeBS counts are the means of the 2011/12 and 2012/13 counts, which were carried out if November, January and March in each season.

Table 4. Predicted displacement due to habitat loss and habitat degradation (worst-case scenario)

Species	GHE count mean	GHE count SD	Correction factor	Birds displaced	Mean I-WeBS	% displaced
Red-breasted Merganser	1.3	1.5	0.25	0.3	175	0.2%
Great Northern Diver	4.1	2.9	0.25	1.0	102	1.0%
Cormorant	4.8	6.5	0.25	1.2	162	0.7%
Black-headed Gull	5.2	5.1	0.28	1.4	1546	0.1%
Common Gull	4.1	5.5	0.28	1.1	907	0.1%

Correction factors are based on the percentage of the GHE count area occupied by the GHE site (25%), adjusted, for Black-headed and Common Gulls, by the percentage of birds that occurred in subtidal habitat (90%).

Table 5. Alternative displacement predictions for the main subtidal species

Species	Method	Predicted occurrence: GHE count area	Predicted occurrence: GHE site	Predicted occurrence: GHE development site
Red-breasted Merganser	subsites	1.1-2.7%	0.3-0.7%	0.1-0.2%
	regression			
Great Northern Diver	subsites	1.7-5.7%	0.4-1.4%	0.1-0.5%
	regression	6%	1.6%	0.5%
Cormorant	subsites	7.3-8.7%	1.8-2.2%	0.6-0.7%
	regression	6%	1.3%	0.4%

The subsites method is based on the percentage occurrences of the species in the adjacent subsites (0G497 and 499). The regression method uses the equations derived from the regressions of species percentage occurrences against habitat areas. See Section 3.1.3 for further details.

4.1.2. Species sensitivities

Population trends

The population trend data is summarised in Table 6. While many of the species show large long-term increases in Inner Galway Bay, only Light-bellied Brent Goose and Turnstone show large increases in the short-term site trends.

In the case of Light-bellied Brent Goose, recent I-WeBS data indicates a continued increasing trend since 2007/08. The all-Ireland Brent Goose population has also shown long term (1995/96-2007/08) and short-term (2005/06-2009/10) increasing trends, but in both cases these are much weaker than the corresponding site trend. Therefore, the population trend data for Brent Goose provides a strong indication that the Inner Galway Bay Light-bellied Brent Goose population has not yet reached the effective carrying capacity of the site.

In the case of Turnstone, recent I-WeBS data indicates that the population trend may have levelled off since 2007/08, although detailed trend analysis would be required to confirm this. However, the evidence at present does not rule out the possibility that the Inner Galway Bay Turnstone population has reached the effective carrying capacity of the site.

Wigeon, Red-breasted Merganser, Cormorant, Grey Heron, Curlew and Redshank have negative, or stable recent site trends. Therefore, the evidence does not rule out the possibility that the Inner Galway Bay population of these species have reached the effective carrying capacity of the site.

Red-breasted Merganser is the only species where the recent all-Ireland trend is positive. The site population trend graph (NPWS, 2013A, p. 15) shows an increase up to 2001/02, followed by a decrease back to similar levels as the mid-1990s. The recent I-WeBS data does not indicate any further decrease, and possibly some recovery, in recent winters. Therefore, the negative site trend for 2002/03-2007/08 reflects the particular winters chosen as the start and end points for the analysis, rather than a sustained decrease and does not provide strong evidence that the Inner Galway Bay population of this species has reached the effective carrying capacity of the site.

There is no all-Ireland trend data available for Great Northern Diver, Black-headed Gull and Common Gull, while site trends are based on changes in the mean annual maxima (which is a less sensitive parameter than the GAM analyses used for the other species). Therefore, the trend data for these species is not sufficiently detailed to make any assessment as to whether the Inner Galway Bay population of this species has reached the effective carrying capacity of the site.

Table 6. Population trend data for the Inner Galway Bay SCI species included in this assessment

Species	Long-term trend		Short-term trend	
	All-Ireland 1995/96-2007/08	Site 1995/96-2007/08	All-Ireland 2005/06-2009/10	Site 2002/03-2007/08
Light-bellied Brent Goose	58	135	13.2	32.5
Wigeon	-20.2	17.6	-4.8	-10.5
Red-breasted Merganser	-11	-4.1	5.9	-17.6
Great Northern Diver		93		
Cormorant	31.5	42.8	-30.7	-14.1
Grey Heron	29.2	52.4	-4.3	-6.6
Bar-tailed Godwit	1.4	26.4	35.4	-14.4
Curlew	-25.7	10.6	-23.5	-14.5
Redshank	22.7	81	-13.6	1.4
Turnstone	16.1	104.6	-15.8	30
Black-headed Gull		8		
Common Gull		21		

Long-term trends and site short-term trends source: (NPWS, 2013A).
All-Ireland short-term trends source: Crowe et al. (2012).
Note: Bar-tailed Godwit is included in this table, as it is considered under the assessment of displacement impacts.

Population densities

Six species (Red-breasted Merganser, Great Northern Diver, Cormorant, Grey Heron, Curlew and Redshank) show approximately linear relationships between habitat area and the proportion of the SPA count in each subsite (Appendix 1). This indicates that these species occur at relatively uniform densities across Inner Galway Bay and, therefore, any displaced birds would be evenly distributed across the remaining habitat, rather than concentrated in one area.

The potential increase in densities for these species is shown in Table 7. The current densities were calculated by dividing the mean I-WeBS counts for 2011/12 and 2012/13 by the area of the relevant habitat in the I-WeBS subsites. The latter was defined conservatively: for the subtidal species, the intertidal zone was not included, even though it will be available to the species over the high tide period; for Grey Heron, the intertidal zone was not included, although this will be used to a certain extent; and for Curlew and Redshank, the shallow subtidal zone was not included, though it will be available to the species on spring low tides. Also, in practise the counts of the subtidal species will have included some birds outside the I-WeBS subsites, on at least some counts (as all visible birds would be counted).

For each species, the displacement is predicted to cause an increase in overall density of less than 0.1 bird per 100 ha, or, in percentage terms, an increase in overall density of around 1% or less.

Table 7. Predicted increase in overall densities of selected SCI species due to displacement

Species	I-WeBS mean	Tidal zone	Area (ha)	Density (birds/100 ha)	Birds displaced	Increase in density	
Red-breasted Merganser	175	subtidal < 5 m deep	3164	5.5	0.3	0.01	0.2%
Great Northern Diver	102	subtidal	4322	2.4	1.0	0.02	1.0%
Cormorant	162	subtidal < 10 m deep	4322	3.7	1.2	0.03	0.7%
Grey Heron	83	shallow subtidal	1199	6.9	1.0	0.08	1.2%
Curlew	430	intertidal	1352	31.8	1.0	0.07	0.2%
Redshank	498	intertidal	1352	36.8	0.6	0.04	0.1%

Displacement figures are from Table 4 (Grey Heron, Curlew and Redshank) and Table 5 (Red-breasted Merganser, Great Northern Diver and Cormorant).

Sensitivity to displacement impacts

The available information on the potential sensitivity of the SCI species to displacement impacts is summarised in Table 8.

Table 8. Factors affecting sensitivity to displacement impacts

Species	Site fidelity		Interference sensitivity	Habitat flexibility
	NPWS (2013a)	Wright et al (2014)		
Wigeon	weak	low	none	low
Red-breasted Merganser	unknown	-	unknown	negligible
Great Northern Diver	unknown	-	unknown	negligible
Cormorant	moderate	high	unknown	low
Grey Heron	unknown	-	unknown	high
Bar-tailed Godwit	moderate	-	moderate	negligible
Curlew	high	high	high	moderate
Redshank	high	high	high	low
Turnstone	high	high	high	moderate
Black-headed Gull	moderate	-	weak?	high
Common Gull	moderate	-	weak?	high

Habitat flexibility refers to the potential for the species to find alternative, under-utilised, habitat in the vicinity of Inner Galway Bay (see text).
Note: Bar-tailed Godwit is included in this table, as it is considered under the assessment of displacement impacts

Site fidelity

The classification of species site fidelity in NPWS (2013a) is described as being "based on published information". The classification of species site fidelity in Wright et al. (2014) is based on the 'WeBS Alerts Biological Filter', which uses a scoring system to assess the natural fluctuations in species' numbers between winters.

Interference competition

A lot of work on interference competition has been carried out with wader species. Interference competition has been demonstrated experimentally in Redshank (Yates et al., 2000) and Turnstone (Vahl, 2006), while Curlew have been described as being known to being sensitive to interference effects (Folmer et al., 2010). However, this may depend upon prey type: Turnstone feeding on spilt grain and fishmeal in a port did not appear to be affected by interference competition (Smart and Gill, 2003), while interference will not occur in waders feeding on small, surface-dwelling and immobile prey (e.g., *Hydrobia*) (Goss-Custard, 2014). Nevertheless, interference competition is considered to be the key mechanism that determines the density-dependent processes that regulate the populations of most waders during the non-breeding season. Functions that simulate the effects of interference competition are a key component of the individual-based models (IBMs) that have been developed to model mortality rates in non-breeding shorebird populations. The density at which interference competition starts to cause density-dependent reductions in intake rate have been experimentally determined in some species, and modelled for other species. In the WaderMorph program (West et al., 2011), the threshold density, above which interference effects are modelled, is 100 birds/ha for most shorebird species-prey combinations (including all such combinations for Curlew and Redshank; Turnstone is not included in the model). However, this includes an aggregation factor of 10, reflecting the tendency of individuals to be clustered together. Therefore, the actual density at which interference effects are assumed to become important in this model is 10 birds/ha.

Herbivorous species are generally considered to have low sensitivity to interference effects. This has allowed Wigeon population dynamics to be successfully simulated by spatial depletion models (which do not incorporate interference effects; Sutherland and Allport, 1994; Percival et al., 1998).

Gulls often show intra- and inter-specific interference behaviours (such as kleptoparasitism). However, the sensitivity of gull populations to interference effects is likely to vary considerably, reflecting their very broad diet and habitat associations. In one study (Moreira, 1995), Black-headed Gulls feeding in intertidal habitats, showed reduced feeding rates on their main prey (*Scrobicularia*) with increasing bird numbers, but overall intake rates were not affected. In line with this study, it is reasonable to suppose that the high degree of dietary and habitat flexibility displayed by this species will reduce its susceptibility to interference effects.

There is little information available about for the remaining species. Kleptoparasitic behaviour has been reported from a Red-breasted Merganser population in a Canadian estuary (Kahlert et al., 1998), while Grey Herons in northern Italy showed a low rate of aggressive interactions (Fasola, 1986). Otherwise, there does not appear to be any information available on the sensitivity of these species to interference effects.

Habitat/dietary flexibility

Wigeon show habitat flexibility, with lakes and turloughs supporting important wintering populations, as well as coastal habitats. In addition, Wigeon wintering in estuarine habitat often feed on adjacent fields. However, given the importance of water as a disturbance refuge for Wigeon (Jacobsen and Ugelvik, 1994; Mayhew and Houston, 1989), they may only be able to utilise fields where there is access to permanent standing water nearby.

Red-breasted Merganser and Great Northern Diver are restricted to subtidal habitat (in winter). For both species, the Inner Galway Bay SPA probably does not form a discrete subsite and the birds in Inner Galway Bay are likely to be parts of larger populations that occur across the wider Galway Bay area. However, if the Inner Galway Bay component is at, or near, carrying capacity, then it would be reasonable to conclude that the wider Galway Bay area is also at, or near, carrying capacity. Therefore, in these circumstances, these species are unlikely to have significant capacity to utilise alternative nearby habitat, and their habitat flexibility has been classified as negligible.

Cormorant wintering populations show habitat flexibility occurring on rivers and lakes, as well as in marine waters. As with the previous species, the Inner Galway Bay SPA probably does not form a discrete subsite and the birds in Inner Galway Bay are likely to be parts of larger populations that occur across the wider Galway Bay area, and, in this case, also in the lower part of Lough Corrib. The same argument as above would, therefore, apply to these areas. However, small numbers of Cormorant may also use small lakes and rivers, so their habitat flexibility has been classified as low.

Grey Heron wintering populations show a high degree of habitat flexibility occurring in a wide range of inland waters and wetlands (including small ponds and ditches), as well as in coastal habitats. Therefore, any birds displaced from Inner Galway Bay are likely to have a high degree of ability to find suitable alternative terrestrial habitats.

Irish Curlew wintering populations do show some habitat flexibility, with birds visiting fields around estuarine sites for feeding. Therefore, any birds displaced from Inner Galway Bay are likely to have some ability to compensate for such impacts by feeding on fields. However, the intake rate of Curlew feeding on fields is likely to be lower than that of birds feeding on high quality intertidal habitat.

Irish Redshank wintering populations show little habitat flexibility, with birds rarely visiting fields around estuarine sites for feeding (apart from flooded fields/wetlands). Therefore, there may be little suitable alternative terrestrial habitat for any birds displaced from Inner Galway Bay.

Turnstone wintering populations can show some habitat flexibility, with birds feeding on coastal structures such as piers, harbours and jetties. Therefore, it is possible, but not certain, that any Turnstone displaced from the intertidal zone within the GHE development site may be able to utilise new structures within the completed development.

Black-headed and Common Gulls show a high degree of habitat flexibility, using a wide range of inland wetland and terrestrial habitats, including ploughed fields, moist grasslands, urban parks, sewage farms, refuse tips, reservoirs, lakes, turloughs, ponds and ornamental waters. In fact coastal habitats may be of relatively minor importance as foraging habitat for these species. For example, at least 10,000-20,000 Black-headed Gulls roost at night in Cork Harbour, but the counts during the day do not record more than a few thousand birds utilising the intertidal and subtidal habitats. Therefore, any birds displaced from Inner Galway Bay are highly likely to find suitable alternative terrestrial habitat nearby.

4.1.3. Impact significance

Light-bellied Brent Goose

The predicted displacement impact is 3.0 birds, or 0.2% of the Inner Galway Bay population. The continuing strongly increasing trend of this species indicates that the Inner Galway Bay population is not at, or close to, carrying capacity. Therefore, it is reasonable to conclude that sufficient area and diversity of habitats will be maintained for this species, and that this very minor displacement impact will not cause any population-level consequences, and the conservation status of this species within the SPA will not be adversely affected by the proposed development.

Wigeon

The predicted displacement impact is 1.6 birds, or 0.1% of the Inner Galway Bay population. Wigeon have low site fidelity, are not sensitive to interference effects, and have some potential ability to use alternative terrestrial habitats in the vicinity of Inner Galway Bay. Therefore, it is reasonable to conclude that sufficient area and diversity of habitats will be maintained for this species, and that this very minor displacement impact will not cause any population-level consequences, and the conservation status of this species within the SPA will not be adversely affected by the proposed development.

Red-breasted Merganser

The predicted displacement impact from habitat loss is 0.1 bird, or 0.1% of the Inner Galway Bay population, and, from combined habitat loss and a worst-case habitat degradation scenario, is still only 0.2% of the Inner Galway Bay population. This would cause an increase in density of less than 0.1 bird per 100 ha. Therefore, it is reasonable to conclude that sufficient area and diversity of habitats will be maintained for this species, and that this very minor displacement impact will not cause any population-level consequences, and the conservation status of this species within the SPA will not be adversely affected by the proposed development.

Great Northern Diver

The predicted displacement impact from habitat loss is 0.3 birds, or 0.3% of the Inner Galway Bay population, and, from combined habitat loss and a worst-case habitat degradation scenario, 1.0 birds or 1.0% of the Inner Galway Bay population. This would cause an increase in density of less than 0.1 bird per 100 ha. Therefore, it is reasonable to conclude that sufficient area and diversity of habitats will be maintained for this species, and that this very minor displacement impact will not cause any population-level consequences, and the conservation status of this species within the SPA will not be adversely affected by the proposed development.

Cormorant

The predicted displacement impact from habitat loss is 0.4 birds, or 0.2% of the Inner Galway Bay population, and, from combined habitat loss and a worst-case habitat degradation scenario, 1.2 birds, or 0.7% of the Inner Galway Bay population. This would cause an increase in density of less than 0.1 bird per 100 ha. Therefore, it is reasonable to conclude that sufficient area and diversity of habitats will be maintained for this species, and that this very minor displacement impact will not cause any population-level consequences, and the conservation status of this species within the SPA will not be adversely affected by the proposed development.

Grey Heron

The predicted displacement impact from habitat loss is 1.0 birds, or 1.2% of the Inner Galway Bay population. This would cause an increase in density of less than 0.1 bird per 100 ha. In addition, any displaced birds would have a high potential ability to use alternative terrestrial habitats in the vicinity of Inner Galway Bay. Therefore, it is reasonable to conclude that sufficient area and diversity of habitats will be maintained for this species, and that this very minor displacement impact will not cause any population-level consequences, and the conservation status of this species within the SPA will not be adversely affected by the proposed development.

Curlew

The predicted displacement impact from habitat loss is 1.0 birds, or around 0.2% of the Inner Galway Bay population. This would cause an increase in density of less than 0.1 bird per 100 ha. While Curlew have high site fidelity and high potential sensitivity to interference effects, the current density (0.3 birds/ha) is over an order of magnitude below the level (10 birds/ha) where interference effects are likely to start becoming important. In addition, any displaced birds would have some potential ability to use alternative terrestrial habitats in the vicinity of Inner Galway Bay. Therefore, it is reasonable to conclude that sufficient area and diversity of habitats will be maintained for this species, and that this very minor displacement impact will not cause any population-level consequences, and the conservation status of this species within the SPA will not be adversely affected by the proposed development.

Redshank

The predicted displacement impact from habitat loss is 0.6 birds, or around 0.1% of the Inner Galway Bay population. This would cause an increase in density of less than 0.1 bird per 100 ha. While Redshank have high site fidelity and high potential sensitivity to interference effects, the current density (0.4 birds/ha) is over an order of magnitude below the level (10 birds/ha) where interference effects are likely to start becoming important. In addition, any displaced birds may have some potential ability to use alternative terrestrial habitats in the vicinity of Inner Galway Bay. Therefore, it is reasonable to conclude that sufficient area and diversity of habitats will be maintained for this species, and that this very minor displacement impact will not cause any population-level consequences, and the conservation status of this species within the SPA will not be adversely affected by the proposed development.

Turnstone

The predicted displacement impact from habitat loss is 5.9 birds, or around 2.1% of the Inner Galway Bay population. Turnstone has a high potential sensitivity to displacement impacts, due to its high site fidelity, its sensitivity to interference effects and the limited potential for displaced birds to use alternative habitats. However, the predicted displacement impact is likely to be a substantial overestimate of the true displacement impact due to differences in the survey intensity between the GHE and I-WeBS counts (see Section 4.1.1), while it is also possible that Turnstone will be able to use structures within the completed development[3]. Therefore, the actual displacement impact is likely to be very minor. It is reasonable to conclude that sufficient area and diversity of habitats will be maintained for this species, and that this very minor displacement impact will not cause any population-level consequences, and the conservation status of this species within the SPA will not be adversely affected by the proposed development.

Black-headed Gull

The predicted displacement impact from habitat loss is 0.5 birds, or less than 0.1% of the Inner Galway Bay population, and, from combined habitat loss and a worst-case habitat degradation scenario, 1.4 birds or 0.1% of the Inner Galway Bay population. Any displaced birds would have a very high potential ability to use alternative terrestrial habitats in the vicinity of Inner Galway Bay. Therefore, it is reasonable to conclude that sufficient area and diversity of habitats will be maintained for this species, and that this very minor displacement impact will not cause any population-level consequences, and the conservation status of this species within the SPA will not be adversely affected by the proposed development.

Common Gull

The predicted displacement impact from habitat loss is 0.4 birds, or less than 0.1% of the Inner Galway Bay population, and, from combined habitat loss and a worst-case habitat degradation scenario, 1.1 birds or 0.1% of the Inner Galway Bay population. Any displaced birds would have a very high potential ability to use alternative terrestrial habitats in the vicinity of Inner Galway Bay. Therefore, it is reasonable to conclude that sufficient area and diversity of habitats will be maintained for this species, and that this very minor displacement impact will not cause any population-level consequences, and the conservation status of this species within the SPA will not be adversely affected by the proposed development.

4.2. HABITAT LOSS AND DEGRADATION (BREEDING POPULATIONS)

4.2.1. Cormorant

The Cormorant breeding colony is located at Deer Island around 8.5 km from the GHE site. The mean Cormorant count in the GHE count area across all counts carried out during the April-July period was 2.5 (s.d = 1.8, n = 7). The Cormorant breeding population has been recently estimated as 128 AON (Alyn Walsh, NPWS, unpublished data), implying an adult population of around 250 birds, although there are also likely to be additional non-breeding birds present. Therefore, the mean summer GHE count is around 1% of the adult breeding population. This would equate to a potential displacement impact of less than 0.1%, due to habitat loss, and 0.25%, from combined habitat loss and a worst-case habitat degradation scenario. However, this will overestimate the potential displacement impact due to the presence of non-breeding birds. In any case, following the argument above (see Section 4.1.3), it is reasonable to conclude that this very minor displacement impact will not cause any population-level consequences, and the conservation status of this species within the SPA will not be adversely affected by the proposed development.

[3] The use of textured construction material has been proposed, which will enhance settlement by algae and invertebrates, potentially creating suitable foraging habitat for Turnstone.

4.2.2. Sandwich Tern

The Sandwich Tern breeding colony is located at Illaunnaguroge in Corranroo Bay around 12 km from the GHE site. The mean count of Sandwich Tern within the GHE count area during the breeding season (May-July) is 2.4. However, this is based on only five counts across two summers (2011 and 2014). The distribution of foraging birds may change over the course of the breeding season, between the incubation and chick provisioning stages. Therefore, the data is not sufficient to make any quantitative assessment of the likely displacement impacts. Furthermore, foraging terns are mobile and generally do not stay in any one area for extended periods of time. This means that the numbers of birds recorded in an area is not necessarily a good indication of its importance: for example, an area with a low maximum count may still be important if there is a high turnover of individuals. However, the distance of the GHE development site from the Sandwich Tern colony suggests that it is unlikely that the site provides important foraging resources for the colony. Therefore, loss and degradation of habitat within the GHE site is unlikely to cause any population-level consequences, and the conservation status of this species within the SPA will not be adversely affected by the proposed development.

4.2.3. Common Tern

Breeding colonies

Breeding Common Terns have been recorded at a number of different sites in Inner Galway Bay (Table 9). In recent years, the main Common Tern colony has been at Rabbit Island. However, in 2014, this site was abandoned and the main Common Tern colony had moved back to Mutton Island (some terns may have also been nesting on Mutton Island in 2013; Mutton Island WWTP site staff, per comm). In Corranroo Bay, a small number of Common Terns nest with the Sandwich Tern colony at Illaunnaguroge. A Common Tern colony of up to 100 nests occurred at Gall Island colony, in Ballyvaughan Bay, in the 1990s. This colony was not occupied in 2014, and there are no records indicating occupation of this colony since the 1990s. Therefore, the available data suggests that there has been a single main colony in Inner Galway Bay, which was located at Gall Island in the 1990s, moved to Mutton Island around the turn of the century, then to Rabbit Island, and has recently moved back to Mutton Island.

Table 9. Common Tern colonies in Inner Galway Bay

Colony	1984	1994	1995	2001	2013	2014
Gall Island		100	98			not present
Corranroo Bay	17		4			present
Mutton Island				46	present ?	present
Rabbit Island					50-100	not present

Numbers are pairs or nests.
Sources: Lysaght (2002); NPWS (2013c); SPA site synopsis; Tobin Consulting Engineers (2013); T. Gittings (unpublished data).

Foraging range

The mean foraging range of Common Terns, across all studies, is 8.67 km, while the majority of birds forage within 20 kilometres of their breeding colony (seabird wikispace). The mean foraging range probably represents the core foraging area, while the area between the mean foraging range and the maximum foraging range can be thought of as a buffer zone, exploited by lower numbers of birds less intensively (Lascelles, 2008).

Using the above mean value, the GHE site is within the core foraging range of the Mutton Island colony. It is outside the likely core foraging range, but within the likely maximum foraging range of the Corranroo Bay colony. The marine habitat within the GHE development site amounts to 0.2% of the likely core foraging range, and 0.1% of the likely maximum foraging range, of the Mutton Island colony, and 0.1% of the likely maximum foraging range of the Corranroo Bay colony.

However, it is quite likely that, if resources are available, the majority of the terns will feed much closer to the colony sites than implied by these foraging range figures. If this is the case, the

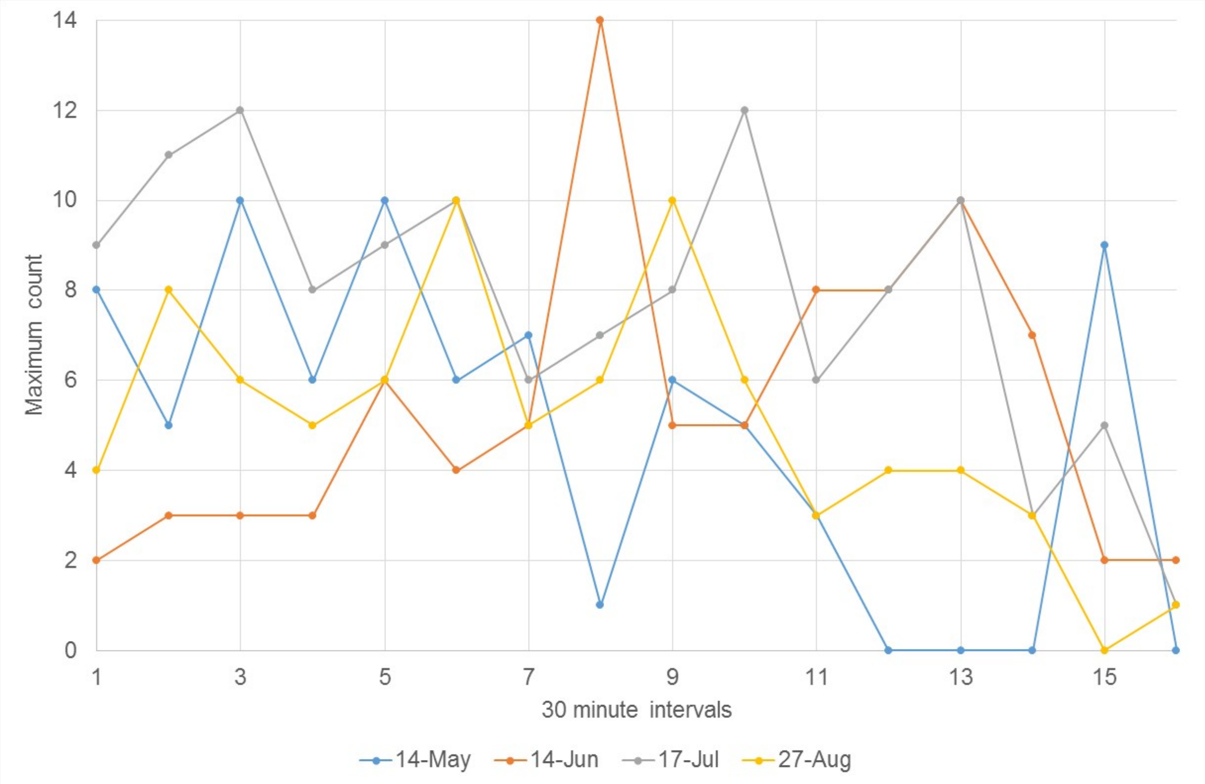
GHE development site may be more important as foraging habitat for the Mutton Island colony than indicated by the above percentages. Indeed, the mean foraging range reported by the individual studies reviewed in the seabird wikispace varies widely, with a minimum reported from a North American study of 2.4 km. Applying this foraging range, as a worst-case scenario, there is around 1400 ha of marine habitat within 2.4 km of the Mutton Island colony. The permanent habitat loss within the GHE development would correspond to around 2% of this foraging range, while the total area affected by permanent habitat loss and habitat degradation in the areas subject to maintenance dredging would correspond to around 6% of this foraging range.

As suitable colony sites are limited, the variation in the mean foraging range between studies is likely to reflect the proximity of suitable colony sites to food resources. Common Tern frequently move colony locations, as has been the case in Inner Galway Bay. Jennings et al. (2012) found that the breeding numbers at individual Common Tern colonies within the Firth of Forth varied much more widely than the overall breeding numbers across the whole of the area, They found strong negative correlations between individual colonies and suggested that these indicated a redistribution of the Firth of Forth breeding population between colonies, due to difference in recruitment or movement of adults between sites. In this context the movement of the main Common Tern colony around Inner Galway Bay is more likely to reflect changes in the suitability of the colony site (e.g., disturbance or rat predation), rather than close spatial tracking of food resources. Similarly, examination of the biotopes and depth zones within the minimum foraging ranges around the three locations used by the main Common Tern colony in Inner Galway Bay (Figure 3 and Figure 4) does not suggest that the Common Tern colony location is constrained by close proximity to particular habitats. The main prey of Common Terns in marine waters are small pelagic fish, such as sprat and sandeels, which are generally distributed independently of the benthic habitat, and occur widely throughout Inner Galway Bay. There is no reason to suppose that the GHE site contains particularly high densities of suitable fish prey for Common Terns. Indeed, the depressed salinities in the area due to the plume of the Corrib may cause reduced abundances of juvenile pelagic fish in this area (Brendan O'Connor, pers. comm.).

Occurrence within the GHE count area

The mean count of Common Tern within the GHE count area during the breeding season (May-July) is 6.6. This is based on five counts across two summers (2011 and 2014), and the location of the colony changed between these two summers. The distribution of foraging birds may change over the course of the breeding season, between the incubation and chick provisioning stages. However, an assessment can be made using knowledge of the ecology of the species and the distribution of food resources within Inner Galway Bay.

Foraging terns are mobile and generally do not stay in any one area for extended periods of time. This means that the, in theory, the numbers of birds recorded in an area is not necessarily a good indication of its importance. For example, an area with a high turnover of individuals, could have a low maximum count, if the foraging time within the area was small relative to the travel time to and from the colony, and provisioning time at the colony. However, the GHE count area extends right up to the Mutton Island colony site, so the travel time is effectively zero. There were probably 100-200 adults at this colony during the 2014 breeding season. Therefore, if a large proportion of the adult terns were regularly feeding within the GHE count area and returning to the colony to provision chicks, it would be reasonable to expect large maximum counts to occur with some frequency. On each count day in the summer of 2014, counts were carried out over a period of eight hours with the maximum count in each 30 minute interval recorded (Text Figure 1). With this level of survey effort, much larger daily maximums would be expected if a large proportion of the adult terns were regularly feeding within the GHE count area. Therefore, it is reasonable to conclude that the GHE count area does not provide crucial food resources for a large proportion of the Mutton Island colony.



Text Figure 1. Half-hourly maximum counts of Common Terns in the GHE count area, May-August 2014

4.2.4. Impact assessment

As discussed above, the proximity of the Mutton Island colony to the GHE count area does not mean that the latter is necessarily a particularly important foraging area, and the count data indicates that the GHE count area does not provide crucial food resources for a large proportion of the Mutton Island colony. Furthermore, the mobile nature of the prey, and their lack of dependence on benthic habitats, mean that habitat loss and degradation of a very small amount of the marine habitat within Inner Galway Bay will not significantly affect the prey resources for Common Terns. Therefore, it can be reasonably concluded that there will be no population-level impacts on Common Terns in Inner Galway Bay.

4.3. DISTURBANCE (NON-BREEDING POPULATIONS)

4.3.1. Bird numbers in the potential disturbance zones

The potential disturbance zones are the GHE site, for the subtidal species, and Nimmo's Pier-South Park Shore (eastern end) and Renmore Beach, for the intertidal/shallow subtidal species (see Section 3.3.1). In addition there is potential for disturbance to high tide roosts on Mutton Island, Hare Island and the rocks on the eastern side of the landward end of the Mutton island causeway.

The occurrence of the subtidal species in the GHE site is analysed in Section 4.1.1.

The occurrence of the intertidal/shallow subtidal species in Nimmo's Pier-South Park Shore and Renmore Beach is summarised in Table 10. The only species that regularly occurred (i.e., on 50% or more of the counts) in Nimmo's Pier-South Park Shore and/or Renmore Beach are Bar-tailed Godwit, Redshank (Nimmo's Pier-South Park Shore only), Black-headed Gull and Common Gull. The only species that occurred in numbers that were above around 1% of the mean I-WeBS count were Bar-tailed Godwit and Black-headed Gull.

Table 10. Count data for intertidal/shallow subtidal species in Nimmo's Pier-South Park Shore and Renmore Beach

Species	Nimmo's Pier-South Park Shore mean	SD	non-zero counts	% of I-WeBS	Renmore Beach mean	SD	non-zero counts	% of I-WeBS
Light-bellied Brent Goose	7.9	15.7	21%	0.7%	0.2	0.6	10%	0.0%
Wigeon	1.8	3.1	36%	0.1%	0.3	0.7	20%	0.0%
Bar-tailed Godwit	24	48.6	71%	6.2%	2.7	2.2	70%	0.7%
Curlew	0.5	0.8	36%	0.1%	0.0	0.0	0%	0.0%
Redshank	1.2	1.5	50%	0.2%	0.0	0.0	0%	0.0%
Turnstone	0.5	1.4	14%	0.2%	0.0	0.0	0%	0.0%
Black-headed Gull	113.1	112.4	93%	7.3%	3.4	2.2	90%	0.2%
Common Gull	9.8	9.1	71%	1.1%	0.8	1.0	50%	0.1%

Nimmo's Pier-South Park Shore: Count data from November-March in 2011/12 and 2012/13 and March 2013 (n =13) and only includes birds at the eastern end of the shore.
Renmore Beach: Count data from December-March in 2011/12, November-March in 2012/13, and March 2014 (n = 10).
% of I-WeBS: mean Nimmo's Pier-South Park Shore, or Renmore Beach, count as a percentage of the mean I-WeBS count for 2011/12 and 2012/13.

4.3.2. Potential impacts of disturbance

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

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

4.3.3. Construction disturbance

Characteristics of impacts

The construction period will be eight years, of which only 42 months (3.5 years) will involve works in the water. Therefore, any direct displacement, and/or energetic impacts will be limited to this period, and major disturbance impacts are likely to be limited to the 42 months involving works in the water.

Figures 10.4.1-10.4.4 in the noise chapter in the EIS shows that no noise impact in excess of 84 dB(A) is predicted for any of the construction activities, while noise impacts greater than 70 dB(A) will be limited to a small area around the immediate vicinity of the construction work. Noise impacts greater than 55 dB(A) will affect significant areas within the subtidal zone of the GHE count area during pile driving and dredging. Noise impacts greater than 55 dB(A) will affect Renmore Beach and most of the Nimmo's Pier-South Park Shore during the backhoe dredging and pile driving. These impacts could also affect high tide roosts on Mutton Island and Hare Island.

Potential impacts

The effects of the construction of the Mutton Island WWTP on a high tide wader roost on this island have been reported by Nairn (2005). This study found no negative effects of construction disturbance. The development of the WWTP introduced access controls to the island and the numbers of bird using the roost actually increased due to reduced pedestrian disturbance. This study provides some evidence about the response of waterbirds to construction disturbance in Inner Galway Bay. However, this study did not assess impacts to birds using intertidal habitat at low tide.

Burton et al. (2002) studied the effects of disturbance from construction work associated with major development work on waterbirds in Cardiff Bay. Construction work caused significant impacts to birds on adjacent areas of mudflats with reductions in densities of five species (Teal, Oystercatcher, Dunlin, Curlew and Redshank) and in the feeding activity of three of these species (Oystercatcher, Dunlin and Redshank, and possibly also Curlew). The only species (of those studied) that was not affected by construction work was Mallard. The study was based on observations of bird numbers and behaviour in a number of count sectors and the results (as presented) do not indicate the distance over which the disturbance effects operated. However, the count sectors that were assessed as being disturbed by construction activities extended over distances of up to 500 m from the relevant construction site. Therefore, it is reasonable to assume that the disturbance effects extended over distances of a few hundred metres, as if they were confined to a narrow zone adjacent to the construction site it is unlikely that they would have been able to produce effects that were detectable at the scale of the analyses of whole count sectors. However, the study does not report the effect size (the magnitude of the reductions in density). Furthermore, Cardiff Bay is not a very good analogy with the GHE development: the Cardiff Bay development involved multiple major development projects (including the Cardiff Bay barrage, road/bridge construction, land reclamation, hotel and housing development) at a number of locations around the bay, several of which involved work directly adjacent to, or even extending on to, the mudflats. By contrast, the GHE development involves a single construction location that is spatially separated from the main area of adjacent intertidal habitat (Nimmo's Pier-South Park Shore) by a deep tidal channel.

In contrast to Burton et al. (2002), other studies have reported reduced, or less clear-cut, impacts from major construction work. Dwyer (2010) studied the effect of construction of major road bridge in the Firth of Forth (Scotland). Two species (Cormorant and Redshank) showed significant reductions in numbers in count sectors adjacent to the bridge, with a reduction of around 30% in Redshank numbers. Other species showed mixed patterns, depending on tidal state, showing increased numbers in count sectors adjacent to the bridge at certain tidal stages. The reductions in Cormorant and Redshank numbers were considered to reflect disturbance to their roost sites (low tide roost in the case of the Cormorant and high tide roost in the case of Redshank), which, for Redshank, may also affect their use of habitat at low tide as they tend to feed close to their roost sites. However, given that the study did not find consistent patterns across a number of species indicating displacement due to construction disturbance, it may not be appropriate to interpret the effects on Cormorant and Redshank as being proof of displacement impacts caused by construction disturbance.

Cutts and Allen (1999) and Cutts et al. (2009) report on the responses of waterbirds to flood defence works in the Humber Estuary (England). They found that disturbance impacts were related to the presence of people and the visibility of the works: piling activity behind a seawall had no apparent impact, while once the work extended onto the seaward slope, some impacts were noted. However, even then the impact was minor with birds continuing to feed around 200 m from the piling operations. Similarly, in another study in the Tees (England), percussive piling had no apparent effect on waterbirds in a mudflat 270 m from the piling location (quoted in PD Teesport and Royal Haskoning, 2007). Based on their research, and research on disturbance by military activities summarised by Smit and Visser (1993), Cutts and Allen (1999) suggest that noise levels in excess of 84 dB(A) cause flight responses in waterbirds, while below 55 dB(A) there is no effect, with a “grey area” in between. This assessment was refined by Cutts et al. (2009), who classified noise levels of below 50 (dBA) as having no effect, 50-70 dB(A) as having a moderate effect (“head turning, scanning behaviour, reduced feeding, movement to other areas”), 70-85 dB(A) as having a moderate-high effect, and above 85 dB(A) as having a high effect (”maximum responses, preparing to fly away and flying away, may leave area altogether”). They recommended that “ambient construction noise levels should be restricted to below 70 dB(A), birds will habituate to regular noise below this level”, while “sudden irregular noise above 50dB(A) should be avoided as this causes maximum disturbance to birds”.

Wright et al. (2010) investigated the response of waterbirds to experimental impulsive noise. They reported the following ranges of responses to various noise levels:

- No observable behavioural response: 54.9-71.5 dB(A) (with a high proportion of extreme outliers).
- Non-flight response: 62.4-79.1 dB(A).
- Flight with return: 62.4-73.9 dB(A).
- Flight with all birds abandoning the site: 67.9-81.1 dB(A).

It should be noted that both Cutts et al. (2009) and Wright et al. (2010) acknowledge limitations to the general applicability of the thresholds they specify. But these do provide some useful indication of the range of noise levels where impacts may occur, and 55 dB(A) has been used as a threshold noise level for assessing potential impacts in various assessments of potential impacts to waterbirds from development projects (e.g., the York Field Development Project; Rose, 2011).

Therefore, while the Cardiff Bay study indicates that disturbance impacts from multiple major construction projects could cause statistically significant displacement impacts (but of unknown magnitude) over a distance of several hundred metres from the development site, studies of single construction projects do not provide strong evidence of large displacement impacts, while the limited site-specific data indicates that waterbirds in this area of Inner Galway Bay may not be very sensitive to construction disturbance (as might be expected due to the high background levels of routine disturbance). In addition, the noise levels that will be generated in receptor areas during construction will generally not exceed the level where flight responses are likely and, in the intertidal areas, will only just exceed the levels where any behavioural responses are likely.

Impact assessment

Displacement

As discussed previously, population-level consequences from displacement impacts will arise if the density-dependent reductions in food intake rate, causing increased mortality rates, arise as a result of increased densities in the areas to which the birds are displaced. With a permanent impact, such as habitat loss, even small increases in mortality rates can cause significant population reductions if they operate over many years. However, with a temporary impact, such as construction disturbance, any increases in mortality rates will only operate for a short period. Therefore, significant population reductions would require relatively large increases in mortality rates.

The species using subtidal habitat might be expected to be potentially the most affected by construction disturbance, as they will occur in the closest proximity to the works. In the case of Red-breasted Merganser, Great Northern Diver and Cormorant, under the worst-case scenario of complete displacement from the entire GHE count area, the increase in density in the remaining habitat would be 0.04-0.11 birds/100 ha (Table 11). Therefore, it is reasonable to conclude that such very minor displacement impacts (which are an overestimate of the actual likely impact) will not cause any population-level consequences. While similar density calculations cannot be made for Black-headed Gull and Common Gull, given the very low percentage displacements for these species (from subtidal habitat), it is also reasonable to conclude that such very minor displacement impacts will not cause any population-level consequences.

Most SCI species occurred in very low numbers in, or were absent from, the areas of intertidal habitat counted at Renmore Beach and most of the Nimmo's Pier-South Park Shore. While the counted areas do not include the entire potential disturbance zone (as indicated by the noise modelling), overall numbers of these species within these zones were unlikely to be very high, given these very low counts. Moreover, the counted areas will be the areas subject to the highest potential displacement. Given that the evidence reviewed above, indicates that construction disturbance does not cause complete displacement, and the actual disturbance zone is likely to be quite limited, it is reasonable to conclude that any displacement impacts that occur will be very minor, and these very minor displacement impacts will not cause any population-level consequences.

Bar-tailed Godwit and Black-headed Gull occurred in relatively high numbers in the area counted at the eastern end of the Nimmo's Pier-South Park Shore.

The recent Bar-tailed Godwit population trends (strong negative site decrease contrasting to positive national increase; Table 6) indicate that the population may have reached the effective carrying capacity of the site, although the recent I-WeBS data indicate some recovery in numbers. The attributes of the species (Table 8) indicate a moderate/high sensitivity to displacement impacts. Therefore, it is theoretically possible that complete displacement due to construction disturbance could cause a non-negligible short-term increase in mortality rates. However, as discussed above, there is no evidence for construction disturbance causing complete displacement. Furthermore, Nimmo's Pier-South Park Shore already experiences a high level of disturbance, so birds using the area must habituated to a certain level of disturbance, and the noise levels generated by the construction work will only just exceed the levels where any behavioural responses are likely. While disturbance from a major construction project is likely to cause greater disturbance impacts than the level to which the birds are habituated, the evidence from the waterbird monitoring carried during the construction of the Mutton Island WWTP indicates that Bar-tailed Godwits in this area of Inner Galway Bay have a low sensitivity to construction disturbance (Nairn, 2005). During that project, Bar-tailed Godwit numbers using the Mutton Island roost increased, with a mean annual peak count across the construction period of 324 birds, compared to 451 for the whole of Inner Galway Bay. In addition, low tide counts carried out within 1 km of Mutton Island recorded a mean of 141 birds. The construction of the Mutton Island WWTP (construction of the causeway) involved works taking place in the main intertidal zone used by Bar-tailed Godwit. The GHE development will be spatially separated from the Nimmo's Pier-South Park Shore by a deep tidal channel, which will reduce the perceived disturbance impact to birds using the intertidal habitat in the latter area. Therefore, given all the available evidence, it is reasonable to conclude that construction disturbance from the GHE development will not cause significant displacement impacts.

The Black-headed Gull has a low potential sensitivity to displacement impacts, due to its very high potential ability to use alternative terrestrial habitats in the vicinity of Inner Galway Bay (Section 4.1.2), and is also relatively tolerant of disturbance (Section 4.3.4). Therefore, it is unlikely that displacement due to construction disturbance could cause a non-negligible increase in mortality rates.

Table 11. Predicted increase in overall densities of subtidal SCI species due to worst-case scenario of displacement by construction disturbance

Species	I-WeBS mean	Tidal zone	Area (ha)	Density (birds/100 ha)	Birds displaced	Increase in density	
Red-breasted Merganser	175	subtidal < 5 m deep	3164	5.5	1.3	0.04	0.7%
Great Northern Diver	102	subtidal	4322	2.4	4.1	0.09	3.9%
Cormorant	162	subtidal < 10 m deep	4322	3.7	4.8	0.11	3.0%

Displacement figures are the mean count in the GHE count area.

Energetic impacts

Disturbance pressures from major construction works can be expected to be generally rather constant, as activities will not change over short periods of time. Therefore, the pattern of disturbance is likely to involve a low frequency of displacement events with birds moving out of the area affected and avoiding it while the disturbance pressure continues. Therefore, the energetic impacts of responding to disturbance (loss of foraging time and energy expended in evasive behaviour) will generally be low.

Disturbance to high tide roosts

The high tide roosts on Mutton Island is within the predicted 55-60 dB(A) noise contour from the Backhoe Dredging Noise Model (Figure 10.4.3 in the EIS), while the high tide roost at Hare Island is within the predicted 55-60 dB(A) noise contour from the Pile Driving Noise Model (Figure 10.4.4 in the EIS). The high tide roost on the rocks on the eastern side of the landward end of the Mutton island causeway is outside the predicted 55-60 dB(A) for any of the construction activities (Figure 10.4.1-10.4.4 in the EIS).

As discussed above, there is some evidence to suggest that noise levels above 55 dB(A) are within a “grey area” where some level of impact to waterbirds may occur. However, the construction of the Mutton Island WWTP, which obviously involved major construction works in much closer proximity to the Mutton Island roost than will occur in the GHE development, did not cause any detectable adverse impacts to the Mutton Island high tide roost. Therefore, it is reasonable to conclude that the GHE development will not cause significant disturbance to the Mutton Island and Hare Island high tide roosts.

4.3.4. Operational disturbance

Characteristics of impacts

Disturbance during the operational phase will be generated by shipping activity to/from the commercial port, recreational boating activity associated with the marina, and pedestrian and vehicular activity within the harbour area.

The additional shipping traffic generated by the GHE development is estimated to be 120-160 vessels per year. It is considered likely that around 60% of the traffic would be in winter (October-March) and 40% in summer (April-Sept). On average, this would result in less than one additional ship movement per day, although in reality, shipping traffic will not be evenly distributed and there will be some days with significantly higher levels and some days with no shipping traffic.

Shipping and boating activity will generally only affect birds using subtidal habitat. Activity within the harbour could potentially affect birds within adjacent areas of intertidal and shallow subtidal habitat. This may apply particularly to Renmore Beach which is contiguous to the harbour area. However, the intertidal and shallow subtidal habitat in the Nimmo's Pier-South Park Shore is separated by a deep channel from the harbour area and it is likely that this separation will reduce the sensitivity of birds on the Nimmo's Pier-South Park Shore to disturbance impacts from the harbour area. As discussed above, the Nimmo's Pier-South Park Shore is already subject to high levels of disturbance, so birds using this area are also likely to be habituated to disturbance impacts to some degree.

Potential impacts

The disturbance pressures to adjacent subtidal habitat will not be of sufficient intensity to cause complete displacement. Within the subtidal habitat, ship and boat traffic will not be continuous and will follow fixed routes. Any birds disturbed will be able to move short distances into adjacent areas of undisturbed habitat, and return to the area, when the disturbance pressure has passed. Similarly, as disturbance impacts are likely to be of low frequency, and birds will not have to move far, birds will not incur significant energetic expenditure avoiding the impacts.

At Nimmo's Pier-South Park Shore, depending upon the sensitivity of the species, and the nature of the activity in the harbour site, it is possible that disturbance could cause displacement impacts to a section of the eastern end of the intertidal and shallow subtidal habitat (but see comments above). At Renmore Beach, depending upon the nature of the activity in the harbour site, disturbance could cause displacement impacts to the entire site. At both sites, birds will be able to move short distances to avoid the disturbance impacts and will, therefore, not incur significant energetic expenditure avoiding the impacts, unless the impacts occur at very high frequency.

Therefore, operational disturbance will not cause permanent displacement, or high energetic costs, to any SCI species in subtidal waters. There is a theoretical potential for permanent displacement, or high energetic costs, to SCI species at the eastern end of Nimmo's Pier-South Park Shore and/or Renmore Beach, which is evaluated below.

Nimmo's Pier-South Park Shore

Disturbance from activity within the GHE site will only affect the eastern end of the Nimmo's Pier-South Park Shore, where the intertidal zone is at its narrowest (Figure 1). The only species that occurred in significant numbers in this area were Bar-tailed Godwit and Black-headed Gull.

Bar-tailed Godwit occurred on 71% of the counts on Nimmo's Pier-South Park Shore, with numbers ranging from 5-34 birds, apart from an exceptional count of 183 birds on 04 March 2013. Wader species are generally regarded as being potentially sensitive to human disturbance. Escape distances (EDs) of 84-219 m have been reported for Bar-tailed Godwit in disturbance experiments carried out on extensive tidal flats in the North Sea (Appendix 3). However, there is some evidence of escape distances decreasing with potential habituation to disturbance in one of these studies, while studies elsewhere have reported much lower escape distances (22-60 m) have been reported for this species (Appendix 3).

Black-headed Gull occurred on 93% of the counts on Nimmo's Pier-South Park Shore, with numbers ranging from 10-300 birds, and with five counts exceeding 100. Gulls are generally regarded as being very tolerant of human disturbance, often exploiting highly disturbed habitats and feeding in large numbers in very close proximity to human activity. However, flocks of gulls on intertidal habitats will flush in response to disturbance. Laursen et al (2005) reported escape distances (EDs) for Black-headed Gulls in the Danish Wadden Sea of 116 m (95% C.I.: 98-137 m), which were comparable to the EDs shown by some of the wader species in this study, but this study was carried out in an area with a very low level of human activity, and with ample undisturbed habitat for birds to move to, so the birds would not have been habituated to disturbance, and the costs of moving would have been low. Burger et al. (2007) found that Laughing Gulls on a New Jersey beach recovered very quickly after disturbance events, with birds returning within 30 seconds, and numbers reaching the pre-disturbance levels within five minutes, in contrast to the wader species, whose numbers still had not reached the pre-disturbance levels after ten minutes.

The GHE development site, at its nearest point, is around 160 m from the eastern end of Nimmo's Pier-South Park Shore. This is within the range of EDs reported for Bar-tailed Godwit in the North Sea disturbance experiments, but outside the 95% confidence interval of the ED reported for Black-headed Gulls in undisturbed habitat in the Danish Wadden Sea. In reality, both species will have much smaller EDs at the eastern end of Nimmo's Pier-South Park Shore, due to habituation, while the separation of the GHE development site from the Nimmo's Pier-South Park Shore intertidal habitat by a deep tidal channel will also act to reduce the gull's sensitivity to disturbance from land-based activity within the GHE site.

Renmore Beach

Continuous disturbance generating activities at the eastern end of the GHE site could potentially cause complete displacement of birds from Renmore Beach. In reality, activity will not be continuous, so displacement will not occur all the time.

The mean percentage occurrence of the regularly occurring species (and of all SCI species) on Renmore Beach was 0.7%, for Bar-tailed Godwit, and 01.0.2%, for Black-headed and Common Gull, of the mean I-WeBS count. Given that, in contrast to habitat loss, disturbance will not result in complete displacement all the time, it is reasonable to conclude that this very minor displacement impact will not cause any population-level consequences.

4.3.5. Disturbance from additional shipping and boating traffic

Additional shipping and boating traffic will also be generated by the development and may cuase disturbance impacts outside the GHE site.

The shipping traffic will follow the existing shipping lane in the middle of the bay and will only, therefore, potentially affect species associated with deep subtidal habitat (> 5 m deep). The assessment of the impact of additional shipping traffic within the GHE site (Section 4.3.4) will also apply to the impact of additional shipping traffic in the shipping lane outside the GHE site.

A tenfold increase in recreational boat traffic may also be generated. It is anticipated that most of this extra marina traffic will follow established routes from the harbour to the South and West, since many of the areas at the eastern end of the bay can be dangerously shallow, even for small boats. Disturbance from this boat traffic will only affect species associated with moderately deep and deep subtidal habitat, as the boats will not travel into the shallow subtidal habitat. Of these species, the gulls will not be sensitive to such disturbance impacts (see species profiles). Red-breasted Merganser, Great Northern Diver and Cormorant may show avoidance reactions to such boat traffic. However, given the more or less uniform very low densities at which these species occur in Inner Galway Bay (2-5 birds per 100 ha), and the fact that highest intensity of recreational boat traffic will be in the summer, outside the main season of occurrence of these populations, it is unlikely that the increased recreational boat traffic will cause significant disturbance impacts.

4.4. DISTURBANCE (BREEDING POPULATIONS)

4.4.1. Cormorant

Breeding colony

The breeding colony is 8.5 km from the development site of the proposed development and well away from the main shipping route. Therefore, there will be no direct disturbance impacts to the breeding colony.

Foraging

The percentage occurrence of Cormorant within the GHE site during the breeding season is similar to its occurrence there during the non-breeding season. Therefore, the assessment in Section 4.3, which found no significant impacts from disturbance to the non-breeding population, also applies to the breeding population (with the exception that the highest intensity of recreational boat traffic will overlap with the main season of occurrence of this population).

4.4.2. Sandwich Tern

Breeding colony

The breeding colony is 12 km from the development site and well away from the main shipping route. Therefore, there will be no direct disturbance impacts to the breeding colony.

Foraging

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

Blasting and piling will not be carried out during the tern breeding season (01 April to 31 July, inclusive), so major construction disturbance impacts on foraging terns during the breeding season are unlikely. In addition, the distance of the GHE development site from the Sandwich Tern colony suggests that it is unlikely that the site provides important foraging resources for the colony. Therefore, construction disturbance from harbour-related activity, disturbance from harbour-related activity during operation of the completed development, and disturbance from increased shipping and boating traffic, are not likely to cause significant displacement of foraging terns.

4.4.3. Common Tern

Breeding colony

Common Terns appear to be sensitive to disturbance within a zone of around 100-150 m around their breeding colonies. Carney and Sydeman (1999) quote two studies that reported flush distances of 142 m and 80 m for Common Tern colonies approached by humans. Burger (1998) studied the effects of motorboats and personal watercraft (jet skis, etc.) on a Common Tern colony. She found that the personal watercraft caused more disturbance than the motor boats, the factors that affected the terns were the distance from the colony, whether the boat was in an established channel, and the speed of the craft, and she recommended that personal watercraft should not be within 100 m of colonies.

Blasting piling and backhoe dredging will not be carried out during the tern breeding season (01 April to 31 July, inclusive).

The Mutton Island colony is 1 km from the construction area and 300 m from the dredging area. These distances are sufficient to prevent any direct disturbance to the breeding colony from construction or operational activities within the GHE site.

Foraging

Foraging Common Terns are generally tolerant of human disturbance and Furness et al. (2013) gave Common Tern a low vulnerability score for disturbance by ship traffic, referencing “slight avoidance at short range”. In Irish coastal waters they often feed in very close proximity to human activity. For example in Galway Bay, they regularly feed in the mouth of the Corrib inside Nimmo’s Pier. Therefore, construction disturbance from harbour-related activity, disturbance from harbour-related activity during operation of the completed development, and disturbance from increased shipping and boating traffic, are not likely to cause significant displacement of foraging terns.

5. OTHER IMPACTS

5.1. BLASTING

There is a potential risk to the species using moderately deep and deep subtidal habitats of physical impacts during blasting.

5.1.1. Red-breasted Merganser, Great Northern Diver and Cormorant

A RIB will quarter over and around the blast site immediately prior to blasting with the intention that any birds present will be scared away from the danger zone. Blasting will be delayed/postponed if individuals are seen in the area when blasting is scheduled. Therefore any such impact will be very unlikely. Even in the worst case scenario of such an impact occurring, given the numbers present in the area and dispersed distribution of the birds, the number of birds suffering injury would be very low and would not cause population-level consequences.

5.1.2. Black-headed Gull and Common Gull

The probability of injury to individuals during blasting and piling is very low given the very shallow dives and short immersion periods of this species when foraging in the sea.

5.1.3. Sandwich Tern and Common Tern

Blasting and piling will not be carried out during the tern breeding season (01 April to 31 July, inclusive), so the main breeding population cannot be affected. The probability of injury to individuals during blasting and piling will be very low given the very shallow dives and short immersion periods of this species when fishing. Any individuals present during passage periods or during the winter will be very obvious to observers, so the detonation of explosive charges while birds are in the blasting area is very unlikely to occur.

5.2. COLLISIONS

Collision risk is a potential issue with very large structures, such as wind turbines, situated on flight paths or within the foraging ranges of potentially sensitive species. However, there is no evidence to suggest that collisions with built structures in developed coastal areas, such as ports and harbours, pose any significant collision risk.

5.3. OIL/FUEL SPILLAGE

With the completion of the GHE development it is expected that there will be fewer oil tankers docking at Galway Harbour, but that these will be larger and carrying greater tonnages of oil. It is not possible to predict if this will have any effect on the likelihood of a significant oil/fuel spillage, but the proposed Oil Spill Contingency Plan should mitigate any such spillage as much as is possible.

6. IN-COMBINATION EFFECTS

6.1. GALWAY HARBOUR ENTERPRISE PARK

Historical habitat loss from the development of the Galway Harbour Enterprise Park is estimated to have caused the loss of 8.6 ha of intertidal sediments and another 7.7 ha of saltmarsh and *Scirpus maritimus* habitat.

The timing of this habitat loss is not clearly described anywhere. However, OSI orthophotography indicates that by 1995 work had commenced, but had been largely restricted to the terrestrial zones, while by 2000 the infill had been largely completed.

6.1.1. Light-bellied Brent Goose and Wigeon

The habitat loss from the development of the GHEP, in combination with the 5.9 ha remaining within the GHE site, would have amounted to 22.2 ha of potential foraging habitat. This may have provided a sufficient area for birds to remain foraging throughout the low tide period and, therefore, the potential usage of this habitat may have been significantly greater than would be implied by a simple pro-rata calculation from the numbers using the remaining habitat. Therefore, it is possible that the historical habitat loss from the development of the Galway Harbour Enterprise Park caused a measurable level of displacement. However, as the GHE development is not predicted to cause measurable displacement impacts to these species, there will be no cumulative impact from habitat loss due to the GHE development in combination with the historical habitat loss from the development of the Galway Harbour Enterprise Park.

6.1.2. Red-breasted Merganser, Great Northern Diver and Cormorant

The intertidal habitat lost from the development of the GHEP would have been available to these species on all high tides, while the saltmarsh and *Scirpus maritimus* habitat would have been available on spring high tides. However, given that the loss of 75 ha of subtidal habitat is predicted to cause displacement of 1%, or less, of the Inner Galway Bay population of these species, the loss of 16.5 ha of habitat that will only have been partially available to the species is unlikely to have caused any measurable displacement impact.

6.1.3. Grey Heron

The habitat loss from the development of the GHEP, in combination with the 5.9 ha remaining within the GHE site, would have amounted to 22.2 ha of potential foraging habitat. Based on the nature of the habitat (fucoid-dominated) and the mean occurrence of the species in the adjacent subsites 0G497 and 499 (1.8 and 5.4% of the SPA count, respectively), the intertidal habitat and saltmarsh in the GHEP site is unlikely to have held significant numbers of Grey Heron. Therefore, the cumulative impact of the historical habitat loss from the development of the Galway Harbour Enterprise Park in-combination with the projected habitat loss from the GHE development will not result in significant displacement impacts.

6.1.4. Curlew and Redshank

The intertidal habitat lost from the development of the GHEP would have been potential low tide foraging habitat, while the saltmarsh and *Scirpus maritimus* habitat may have been used as roosting habitat. Based on the nature of the habitat (fucoid-dominated) and the mean occurrence of the species in the adjacent subsites 0G497 and 499 (3.1 and 6.0% of the SPA count, respectively, for Curlew; 3.1 and 6.3% of the SPA count, respectively, for Redshank), the intertidal habitat in the GHEP site is unlikely to have held significant numbers of Curlew or Redshank, while it is likely that the saltmarsh habitat would have only been used infrequently. Therefore, the cumulative impact of the historical habitat loss from the development of the Galway Harbour Enterprise Park in-combination with the projected habitat loss from the GHE development will not result in significant displacement impacts.

6.1.5. Turnstone

The fucoid-dominated intertidal habitat lost from the development of the GHEP would have been very suitable foraging habitat for Turnstone and, in combination with the 2.1 ha remaining within the GHE site, would have amounted to 10.7 ha of foraging habitat (around 1% of the total area of fucoid-dominated biotope within the SPA). This may have provided a sufficient area for birds to remain foraging throughout the low tide period and, therefore, the potential usage of this habitat may have been significantly greater than would be implied by a simple pro-rata calculation from the numbers using the remaining habitat.

The population trend for the Inner Galway Bay Turnstone population between 1995/96 and 2007/08 was strongly positive (Table 6) and the increasing trend appears to have begun around 1990 (following a decline in the second half of the 1980s; Nairn et al., 2000). The population trend graph for Turnstone is not included in NPWS (2013a), but examination of the raw I-WeBS count data indicates that the 1995/96-2007/08 indicates that there was a fairly consistent rate of increase across most of this period. Therefore, it appears that the Inner Galway Bay Turnstone population had not reach the effective carrying capacity during this period, so any displacement impact caused by the development of the GHEP would not have had population-level consequences.

6.1.6. Black-headed Gull and Common Gull

The intertidal habitat lost from the development of the GHEP would have been potential low tide foraging habitat, while the saltmarsh and *Scirpus maritimus* habitat may have been used as roosting habitat and/or as subtidal habitat on spring high tides. Based on the mean occurrence of the species in subsite 0G497 and 499 (1.6 and 18% of the SPA count, respectively, for Black-headed Gull; 1.4 and 4.7% of the SPA count, respectively, for Common Gull), the intertidal habitat in the GHEP site is unlikely to have held significant numbers of these species, while it is likely that the saltmarsh habitat would have only been used infrequently. Therefore, the cumulative impact of the historical habitat loss from the development of the Galway Harbour Enterprise Park in-combination with the projected habitat loss from the GHE development will not result in significant displacement impacts.

6.1.7. Sandwich Tern and Common Tern

The intertidal habitat lost from the development of the GHEP would have been available to these species on all high tides, while the saltmarsh and *Scirpus maritimus* habitat would have been available on spring high tides. Given the small area involved, its restricted availability, and its distance from the breeding colonies[4], it is highly unlikely that the habitat lost from the development of the GHEP was ever of significant importance to this species.

[4] In the 1990s, the only known tern breeding colonies were on the southern shore of Inner Galway Bay, with the Sandwich Tern colony in Corranroo Bay (its current location) and the main Common Tern colony in Ballyvaughan Bay (no longer occupied).

6.2. MUSSEL BOTTOM CULTURE

Mussel bottom culture in Inner Galway Bay also has the potential to cause impacts to fish-eating species as tightly packed mussels will result in homogeneous habitat and little provision of refugia for fishes, thereby reducing the availability of prey resources. The Appropriate Assessment of aquaculture and fisheries in Inner Galway Bay (Gittings and O'Donoghue, 2014) considered potential impacts from mussel bottom culture to the fish-eating SCI species of Inner Galway Bay.

The AA concluded that mussel bottom culture could cause displacement of up to 2% of the Great Northern Diver and Cormorant Inner Galway Bay populations, and up to 1% of the Red-breasted Merganser Inner Galway Bay population, under the unrealistic worst-case scenario of complete exclusion from the mussel bottom culture plots (it should be noted that this AA has not yet been published, and so could be subject to change). Therefore, under the unrealistic worst-case scenarios for both assessments, the cumulative effects of the GHE development in-combination with bottom mussel culture would cause displacement of up to 3% of the Great Northern Diver Inner Galway Bay population, up to 2.7% of the Cormorant Inner Galway Bay population, and up to 1.2% of the Red-breasted Merganser Inner Galway Bay population.

The AA identified that there was a potential risk of impact to Sandwich Terns and Common Terns, due to mussel bottom culture in Rinville Bay, which is within the likely core foraging range of their colonies, and occurs partly within shallow water zones where benthic fish prey would be accessible to terns. This potential significance of this impact was not assessed due to lack of information on the foraging range and diet of the Inner Galway Bay tern populations. However, as the GHE development is not considered likely to have measurable impacts on foraging resources for the Sandwich Tern colony, there is no potential for cumulative impacts in-combination with impacts from mussel bottom culture for this species. In the case of the Common Tern, the GHE development could possibly have a measurable, but not significant, impact, so, based on the assessment in the aquaculture AA, there is a possibility for significant cumulative impacts in-combination with impacts from mussel bottom culture for this species.

7. CONCLUSIONS

This assessment has not identified any potential impacts arising from the proposed development that are likely to cause population-level consequences to any of the SCI populations of the Inner Galway Bay SPA.

This assessment has not identified any potential cumulative impacts from habitat loss due to the GHE development in combination with the historical habitat loss from the development of the Galway Harbour Enterprise Park that are likely to cause population-level consequences to any of the SCI populations of the Inner Galway Bay SPA.

This assessment has identified a possibility for significant cumulative impacts from habitat loss due to the GHE development in-combination with impacts from mussel bottom culture to the Common Tern breeding population of the Inner Galway Bay SPA.

REFERENCES

Burger, J. (1998). Effects of motorboats and personal watercraft on flight behavior over a colony of Common Terns. The Condor, 100, 528–534.

Burger, J., Carlucci, S.A., Jeitner, C.W. & Niles, L. (2007). Habitat choice, disturbance, and management of foraging shorebirds and gulls at a migratory stopover. Journal of Coastal Research, 23, 1159–1166.

Burton, N.H.K., Rehfisch, M.M. & Clark, N.A. (2002). Impacts of disturbance from construction work on the densities and feeding behavior of waterbirds using the intertidal mudflats of Cardiff Bay, UK. Environmental Management, 30, 865–71.

Carney, K.M. & Sydeman, W.J. (1999). A review of human disturbance effects on nesting colonial waterbirds. Waterbirds: The International Journal of Waterbird Biology, 22, 68–79.

Crowe, O., Boland, H. & Walsh, A. (2012). Irish Wetland Bird Survey: results of waterbird monitoring in Ireland in 2010/11. Irish Birds, 9, 397–410.
Cutts, N. & Allen, J. (1999). Avifaunal Disturbance Assessment: Flood Defence Work, Saltend. Report to Environment Agency, Institute of Estuarine and Coastal Studies, University of Hull.
Cutts, N., Phelps, A. & Burdon, D. (2009). Construction and Waterfowl: Defining Sensitivity, Response, Impacts and Guidance. Report to Humber INCA, Institute of Estuarine and Coastal Studies University of Hull.
Durell, S.E.A. le V. dit, Stillman, R.A., Triplet, P., Desprez, M., Fagot, C., Loquet, N., Sueur, F. & Goss-Custard, J.D. (2008). Using an individual-based model to inform estuary management in the Baie de Somme, France. Oryx, 42, 265–277.
Dwyer, R.G. (2010). Ecological and Anthropogenic Constraints on Waterbirds of the Forth Estuary: Population and Behavioural Responses to Disturbance. University of Exeter.
Fasola, M. (1986). Resource use of foraging herons in agricultural and nonagricultural habitats in Italy. Colonial Waterbirds, 9, 139–148.
Folmer, E.O., Olff, H. & Piersma, T. (2010). How well do food distributions predict spatial distributions of shorebirds with different degrees of self-organization? Journal of Animal Ecology, 79, 747–756.
Furness, R.W., Wade, H.M. & Masden, E.A. (2013) Assessing vulnerability of marine bird populations to offshore wind farms. Journal of Environmental Management, 119, 56–66.
Gittings, T. and O'Donoghue, P. (2014). Inner Galway Bay Special Protection Area (4031): Appropriate Assessment of Aquaculture and Shellfisheries & Fisheries Risk Assessment. Unpublished draft report to the Marine Institute.
Goss-Custard, J.D. (2014). Bird and People: Resolving the Conflict on Estuaries.
Goss-Custard, J.D., Triplet, P., Sueur, F. & West, A.D. (2006). Critical thresholds of disturbance by people and raptors in foraging wading birds. Biological Conservation, 127, 88–97.
Jacobsen, O.W. & Ugelvik, M. (1994). Grazing and vigilance behaviour of breeding Eurasian Wigeon Anas penelope in relation to distance from water. Wildfowl, 45, 119–123.
Jennings, G., McGlashan, D.J. & Furness, R.W. (2012b). Responses to changes in sprat abundance of common tern breeding numbers at 12 colonies in the Firth of Forth, east Scotland. ICES Journal of Marine Science: Journal du Conseil, 69, 572–577.
Kahlert, J., Coupe, M. & Cooke, F. (1998). Winter segregation and timing of pair formation in Red-breasted Merganser Mergus serrator. Wildfowl, 49, 161–172.
Lascelles, B. (2008). The BirdLife Seabird Foraging Database: Guidelines and Examples of Its Use. Internal report, BirdLife International.
Laursen, K., Kahlert, J. & Frikke, J. (2005). Factors affecting escape distances of staging waterbirds. Wildlife Biology, 11, 13–19.
Lysaght, L. (2002). An Atlas of the Breeding Birds of the Burren and the Aran Islands. BirdWatch Ireland, Dublin.
Mathers, R.G., Watson, S., Stone, R. & Montgomery, W.I. (2000). A study of the impact of human disturbance on Wigeon Anas penelope and Brent Geese Branta bernicla hrota on an Irish sea loch. Wildfowl, 51, 67–81.
Mayhew, P. & Houston, D. (1989). Feeding site selection by Wigeon Anas penelope in relation to water. Ibis, 131, 1–8.
Metcalfe, N.B. & Furness, R.W. (1987). Aggression in shorebirds in relation to flock density and composition. Ibis, 129, 553–563.
Moreira, F. (1995). Diet of Black-headed Gulls Larus ridibundus on emerged intertidal areas in the Tagus Estuary (Portugal): predation or grazing? Journal of Avian Biology, 26, 277–282.
Nairn, R.G.W. (2005). Use of a high tide roost by waders during engineering work in Galway Bay, Ireland. Irish Birds, 7, 489–496.
NPWS (2013a). Inner Galway Bay Special Protection Area (Site Code 4031): Conservation objectives supporting document.
NPWS (2013b). Galway Bay Complex SAC (site code: 0268). Conservation objectives supporting document - Marine habitats and species.
PD Teesport and Royal Haskoning (2007). Northern Gateway Container Terminal. Supplement to the Environmental Statement: Information for Appropriate Assessment.
Percival, S.M., Sutherland, W.J. & Evans, P.R. (1998). Intertidal habitat loss and wildfowl numbers: applications of a spatial depletion model. Journal of Applied Ecology, 35, 57–63.
Rose, K. (2011). Letter from Natural England (Newcastle Upon Tyne office) to Paul Dacombe, Centrica, dated 04 November 2011, Natural England ref 3708.
Smart, J. & Gill, J.A. (2003). Non-intertidal habitat use by shorebirds: a reflection of inadequate intertidal resources? Biological Conservation, 111, 359–369.

Smit, C.J. & Visser, G.J.M. (1993). Effects of disturbance on shorebirds: a summary of existing knowledge from the Dutch Wadden Sea and Delta area. Wader Study Group Bulletin, 68, 6–19.

Sutherland, W.J. & Allport, G.A. (1994). A spatial depletion model of the interaction between Bean Geese and Wigeon with the consequences for habitat management. Journal of Animal Ecology, 63, 51–59.

Vahl, W.K., Lok, T., van der Meer, J., Piersma, T. & Weissing, F.J. (2005). Spatial clumping of food and social dominance affect interference competition among ruddy turnstones. Behavioral Ecology, 16, 834–844.

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

Wright, M.D., Goodman, P. & Cameron, T.C. (2010). Exploring behavioural responses of shorebirds to impulsive noise. Wildfowl, 60, 150–167.

Wright, L.J., Mendez, V. & Burton, N.H.K. (2014). Review of Knowledge Regarding the Effect of Major Estuarine Developments on Bird Populations with Reference to Proposals for an Airport in the Thames Estuary. BTO Research Report No. 657. British Trust for Ornithology, Thetford.

Yates, M.G., Stillman, R.A. & Goss-Custard, J.D. (2000). Contrasting interference functions and foraging dispersion in two species of shorebird (Charadrii). Journal of Animal Ecology, 69, 314–322.

Appendix 1 Information on species distribution in Inner Galway Bay

GENERAL

The following review is based on analyses of data from The National Parks and Wildlife Service Baseline Waterbird Survey (BWS) of Inner Galway Bay, and Irish Wetland Bird Survey (I-WEBS) counts of Inner Galway Bay.

It should be noted that most I-WeBS counts in Inner Galway Bay are carried out at low tide, so, in contrast to most coastal wetland sites in Ireland, the I-WeBS count data can be used to analyse the low tide distribution of waterbirds in Inner Galway Bay.

HABITAT USAGE

The distribution of SCI species that can use more than one tidal zone across the tidal zones in the BWS low tide counts is summarised in Table 12. Around 60% of the total numbers of Light-bellied Brent Goose, Wigeon and Teal occurred in the subtidal zone, with 95% of feeding Shoveler occurring in that zone. By contrast, Grey Heron, Black-headed Gull and Common Gull favoured the intertidal zone, with 70-80% of feeding birds occurring in that zone. The only species that occurred in significant numbers feeding in the supratidal/terrestrial zone were Light-bellied Brent Goose and Common Gull. The supratidal/terrestrial feeding Light-bellied Brent Goose mainly occurred in the north-eastern section of Galway Bay in Oranmore Bay and the subsites around Tawin Island. The supratidal/terrestrial feeding Common Gull mainly occurred in the south-western section of Galway Bay.

Table 12. Habitat usage of species that use intertidal and subtidal zones

Species	Activity	Mean percentage of total count in: supratidal/ terrestrial	subtidal	intertidal
Light-bellied Brent Goose	all	11%	59%	30%
	feeding	12%	59%	29%
Wigeon	all	4%	56%	40%
	feeding	3%	59%	38%
Teal	all	3%	57%	40%
	feeding	0%	66%	34%
Shoveler	all	12%	73%	15%
	feeding	0%	95%	5%
Grey Heron	all	12%	24%	64%
	feeding	2%	28%	70%
Black-headed Gull	all	13%	25%	62%
	feeding	2%	19%	79%
Common Gull	all	8%	20%	58%
	feeding	12%	17%	71%

Data source: BWS low tide counts (2010/11 Waterbird Survey Programme as undertaken by the National Parks & Wildlife Service). October count not included for Light-bellied Brent Goose and Shoveler

A number of the SCI wader species (Golden Plover, Lapwing and Curlew) can utilise terrestrial habitats. However, the numbers of these species recorded in the supratidal/terrestrial zone were very low (5% of Lapwing numbers and 1% or less for the other species), and, in the case of Oystercatcher and Lapwing, these were mainly roosting birds. These low percentages do not necessarily reflect the actual usage of these habitats around Galway Bay, but, instead, probably reflect the focus of the survey on recording waterbird distribution in the tidal zones.

DISTRIBUTION PATTERNS

Methods

We carried out exploratory analyses of the relationships between waterbird subsite distribution and various habitat parameters. We used pooled BWS and I-WeBS data (the latter from the 2006/07-2010/11 winters) to calculate the mean percentage of the total count that occurred in each subsite. We excluded Ahapouleen Turlough (subsite 0G349) from the I-WeBS dataset used for these analyses. We only included counts with complete subsite coverage and, for each species, we excluded counts when the overall numbers of the species recorded were considered to be too low to provide representative analysis of species distribution. We only included high tide counts for Red-breasted Merganser, Great Northern Diver and Cormorant.

We defined the following tidal zones for the analyses: intertidal (as defined by the mapping of intertidal biotopes in the NPWS biotope map, which is based on the mean low tide extent shown on the Ordnance Survey Discovery Series mapping); shallow subtidal (the area between the intertidal zone (as defined above) and the 0 m contour on the Admiralty Chart); moderately deep subtidal zone (defined by the 5 m contour on the Admiralty Chart); and deep subtidal zone.

We then examined the relationships between the species distribution and the distribution between subsites of relevant tidal depth zones and biotopes. The relevant parameters were selected for each species, based on their ecology, to represent habitat features that might be expected to be important determinants of their distribution. These relationships were examined visually, using scattergraphs, as outliers can reveal interesting features about their distribution.

We also used the flock map data from the BWS counts to supplement the above analyses. The flock map data allows analysis of species distribution within subsites and is useful in indicating relationships between species distributions and broad topographical/habitat zones, such as biotopes, edges of tidal channels, upper shore areas, etc. However, 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.

Results

Exploratory analyses indicated that the distribution of most species was not obviously related to habitat availability. However, some clear patterns did emerge for a few species. Red-breasted Merganser, Great Northern Diver and Cormorant (foraging birds only) distribution was correlated with the area of subtidal habitat (Text Figures A1 and A2 and Table 13). Grey Heron, Curlew and Redshank distribution was correlated with the area of intertidal habitat, and the combined area of intertidal and shallow subtidal habitat (Text Figures A3 and A4 and Table 14). Because of the large number of possible correlations investigated, there is a danger of generating spurious correlations. However, the above correlations make ecological sense.

Red-breasted Merganser, Great Northern Diver and (foraging) Cormorant generally occur as widely dispersed individuals or small flocks throughout most of the subtidal zone of suitable depth. The distribution of all subtidal habitat was strongly correlated with the distribution of shallow/moderately deep subtidal habitat. Therefore, while Red-breasted Merganser might be expected to show a stronger correlation with the latter, the dataset may not have had sufficient resolution to detect such a difference. Difficulties in accurately counting offshore waterbirds within defined count subsites are also likely to have affected the resolution of the dataset.

Light-bellied Brent Goose and Wigeon did not show any strong patterns of association with the distribution of suitable tidal zones or biotopes. Light-bellied Brent Goose and Wigeon tend to feed on concentrated food resources, often in the supratidal or terrestrial zone. Therefore, the large-scale distribution of these birds may have been affected by the proximity of suitable supratidal/terrestrial foraging habitat.

Grey Heron, Oystercatcher, Curlew and Redshank all generally occur as widely dispersed individuals or loose flocks throughout most of the intertidal zone and, therefore, might be expected to show simple correlations with the overall amount of intertidal habitat. The other wader species tend to occur in large flocks and/or show distinct preferences for particular habitat types.

Bar-tailed Godwit might be expected to show associations with the intertidal sand biotope. However, there was no overall relationship between the distribution of this species and the distribution of the intertidal sand biotope, and it occurred in relatively high numbers in the subsites around the mouth of the Corrib, which lack any of the intertidal sand biotope.

In the BWS low tide counts, Turnstone showed a strong association with the southern shore of the bay between Aughinish Island and Kinvarra Bay. On average, 50% of the total count occurred in subsites 0G489 and 0H449, and this is reflected in the flock map distribution. The concentration in this area was less marked in the I-WeBS dataset, but this may reflect the difficulties of counting Turnstone.

In the BWS low tide counts, Black-headed Gulls occurred mainly along the northern shore of the bay, possibly reflecting the proximity to Galway Docks and other urban feeding habitats. Common Gulls also showed a concentration in this area, but, on average, over half their numbers occurred along the southern shore of the bay between Aughinish Island and Kinvarra Bay.

Table 13. Pearson's correlation coefficients between species distribution across subsites and availability of subtidal habitat

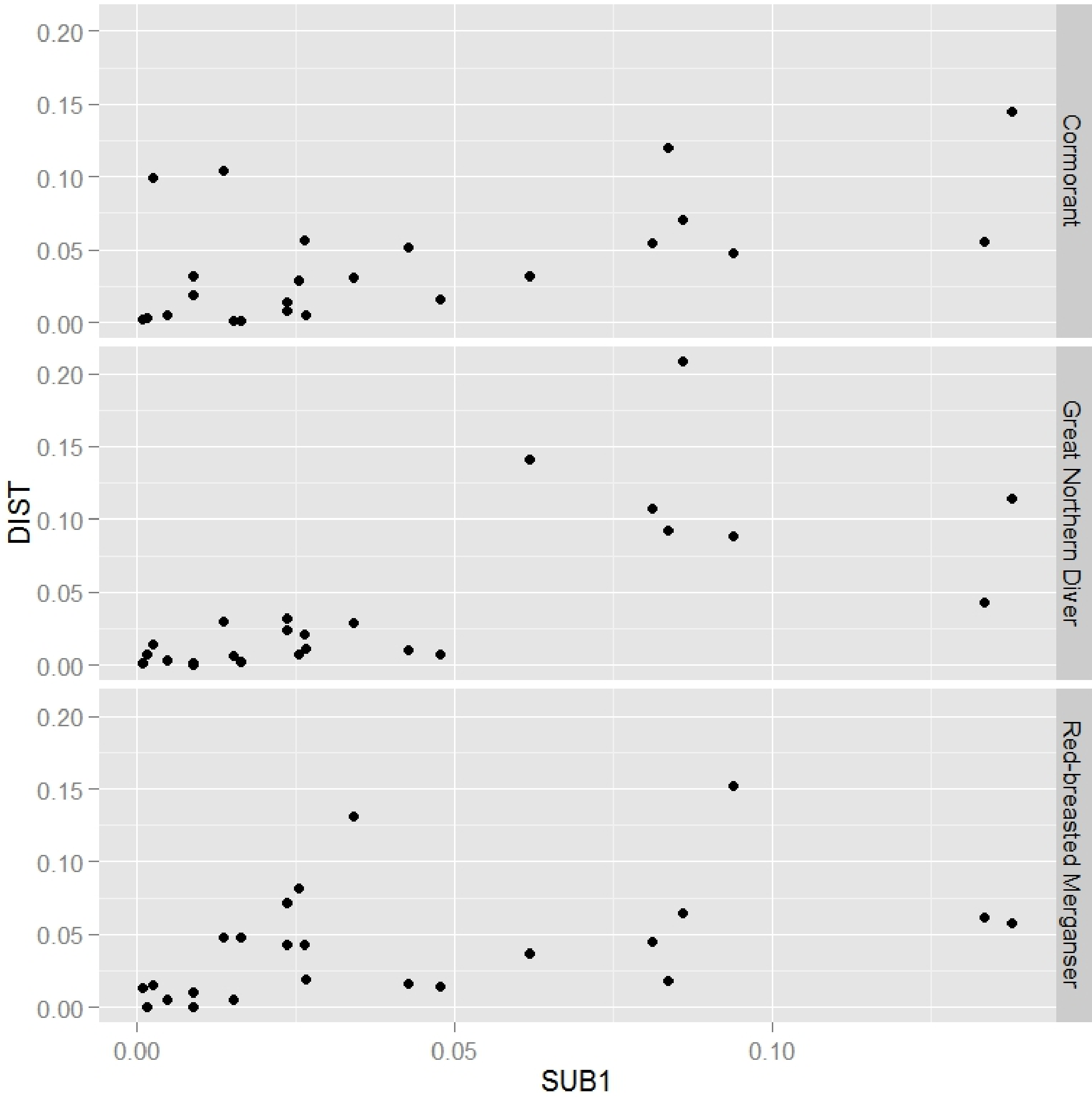
Species	**Shallow and moderately deep subtidal habitat**	**All subtidal habitat**
Red-breasted Merganser	0.431*	0.527**
Great Northern Diver	0.700***	0.797***
Cormorant	0.567**	0.538**

* $p < 0.025$, ** $p < 0.005$, *** $p < 0.0005$ (one-tailed tests, n = 24)

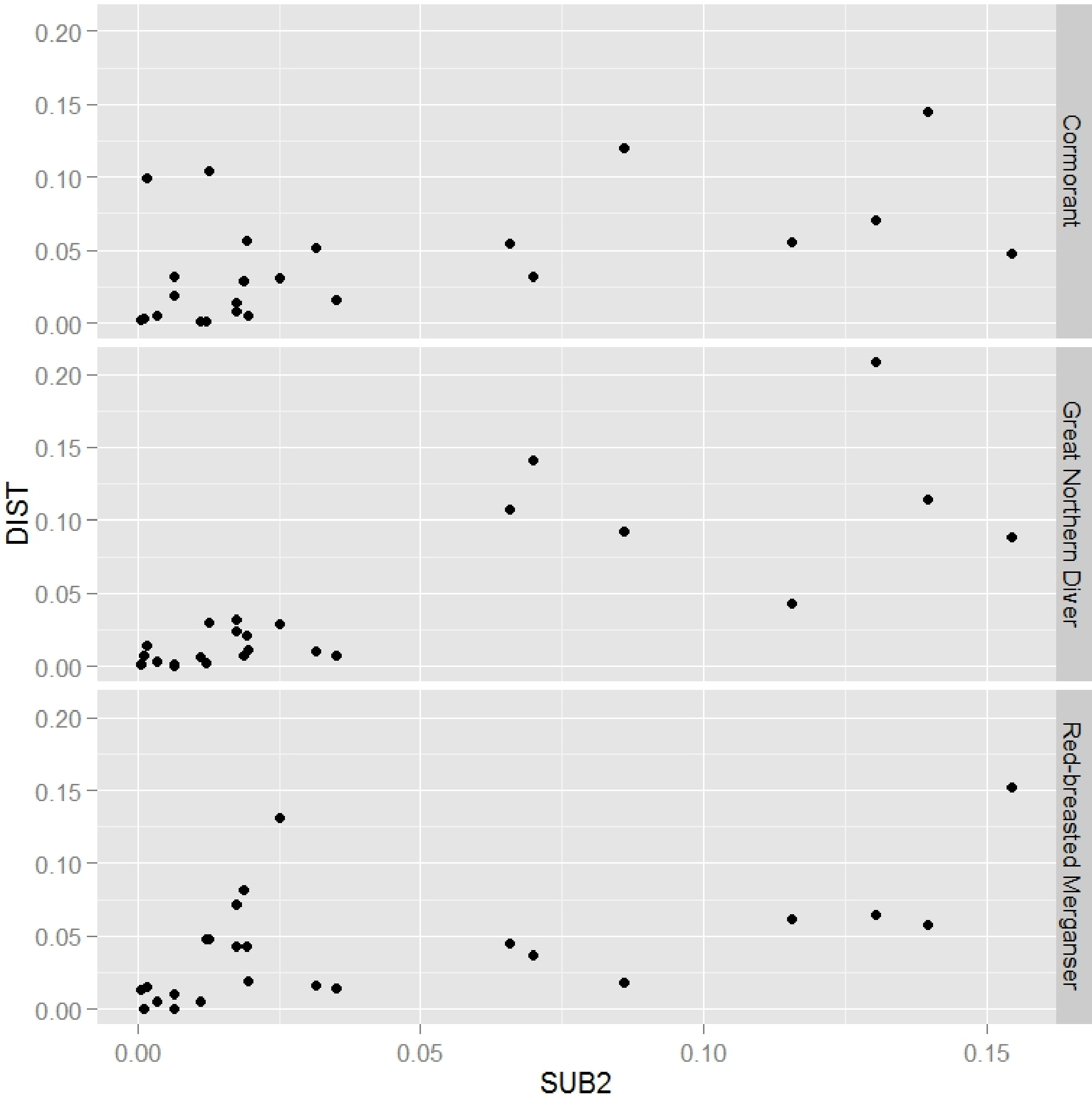
Table 14. Pearson's correlation coefficients between species distribution across subsites and availability of intertidal and shallow subtidal habitat

Species	**Intertidal zone**	**Intertidal and shallow subtidal zones**
Grey Heron	0.475*	0.554**
Curlew	0.606**	0.559**
Redshank	0.449*	0.414*

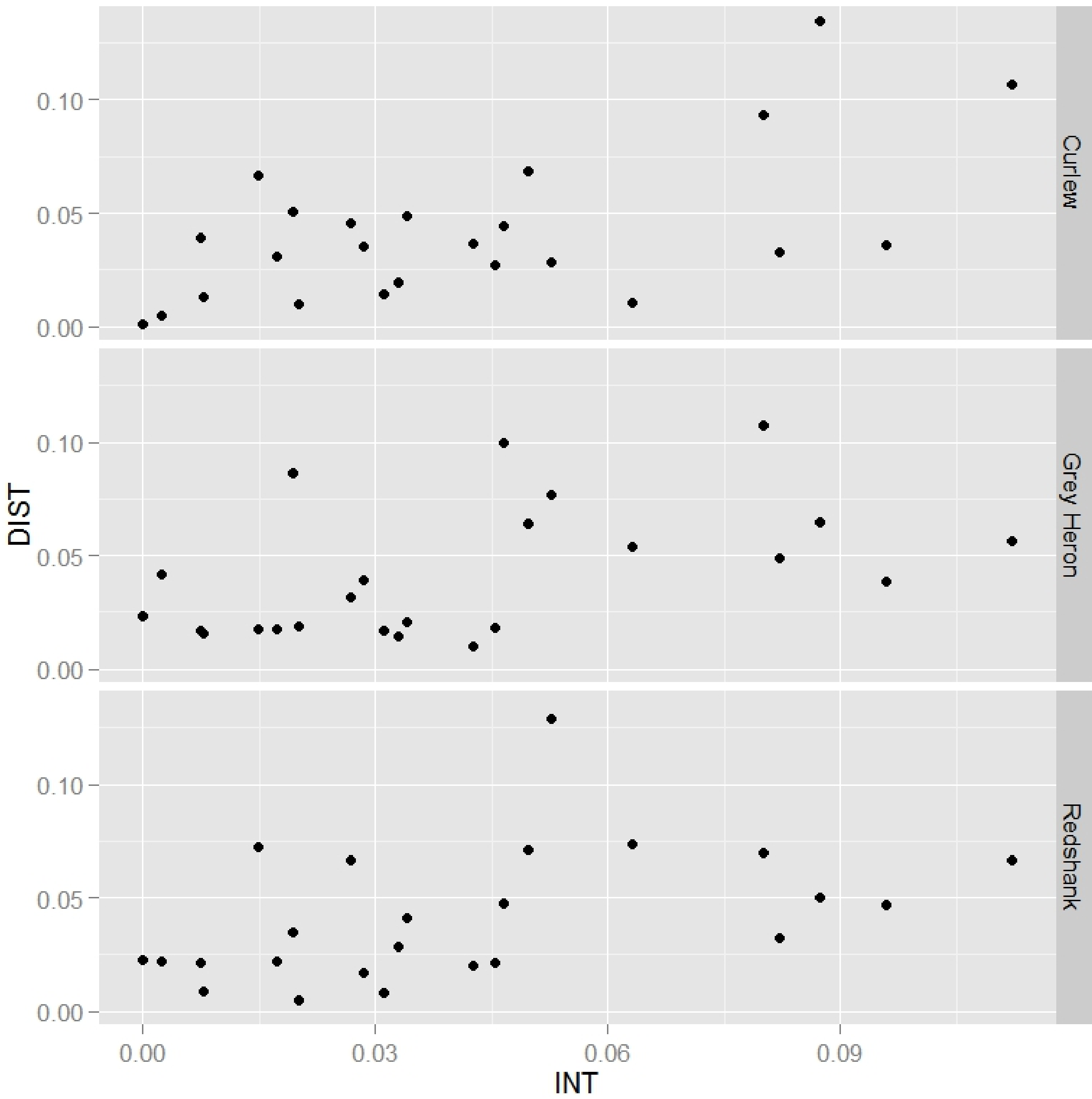
* $p < 0.025$, ** $p < 0.005$ (one-tailed tests, n = 24)



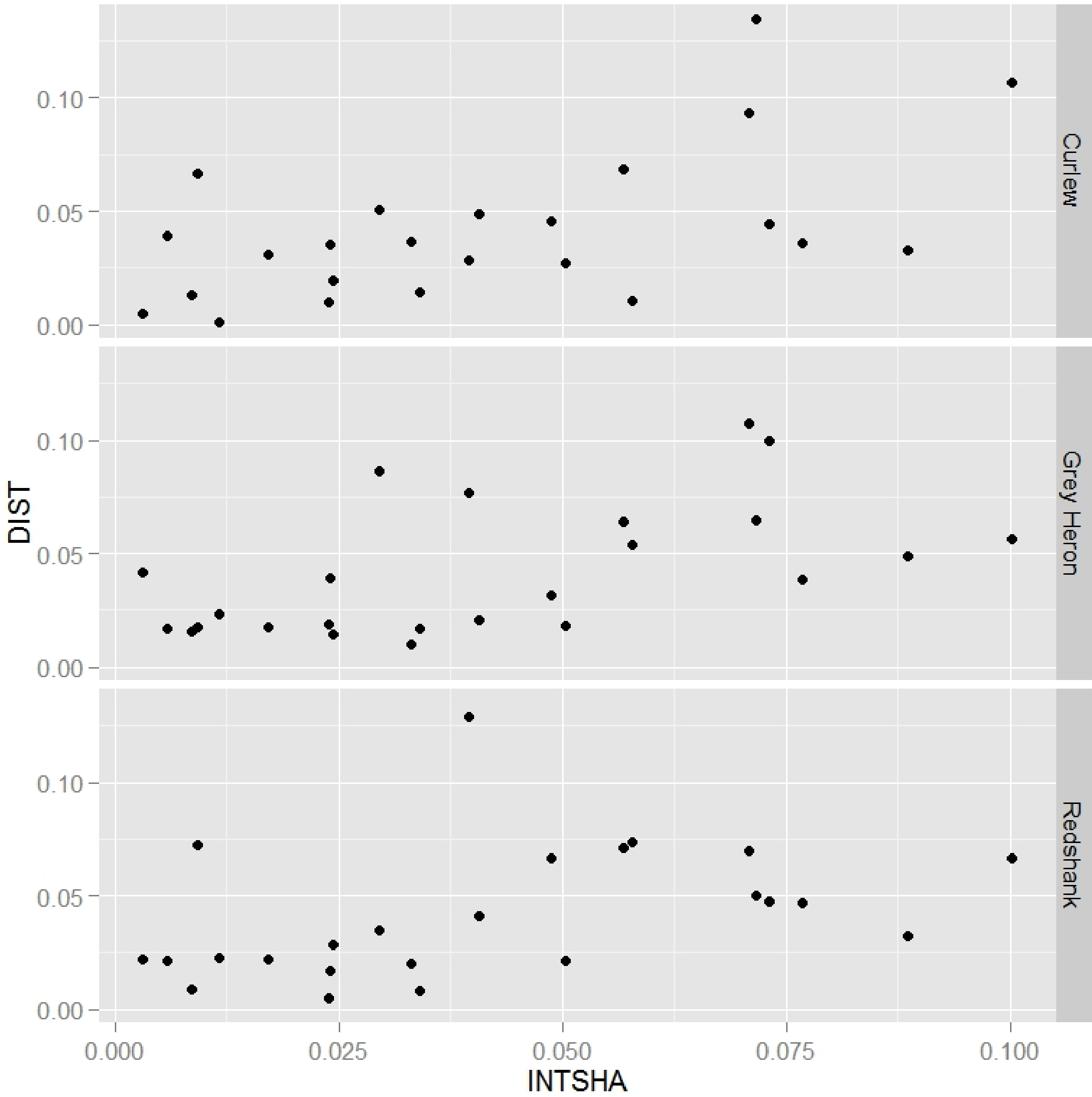
Text Figure A1. Relationship between species distribution among subsites (DIST) and availability of shallow and moderately deep subtidal habitat (SUB1)



Text Figure A2. Relationship between species distribution among subsites (DIST) and availability of all subtidal habitat (SUB2)



Text Figure 3. Relationship between species distribution among subsites (DIST) and availability of intertidal habitat (INT)



Text Figure 4. Relationship between species distribution among subsites (DIST) and availability of all intertidal and shallow subtidal habitat (INTSHA)

Appendix 2 Rationale for the criteria used to assess the significance of displacement impacts

INTERPRETATION OF THE ATTRIBUTES OF THE CONSERVATION OBJECTIVES FOR NON-BREEDING SCI POPULATIONS

In Appropriate Assessments, the conservation objectives, and the attributes and targets specified for these objectives, provide a useful framework for impact assessment. Moreover, not only are they a useful framework, it is a requirement for Appropriate Assessment that the impacts are assessed in terms of the implications of the impacts for the site "in view of the site's conservation objectives" (Article 6(3) of the Habitats Directive). Therefore, it makes sense to frame the assessment of impact significance in the context provided by the relevant conservation objectives.

In the Inner Galway Bay SPA, the conservation objectives for all the waterbird species listed for their non-breeding populations are to maintain their "favourable conservation condition" (NPWS, 2013). The favourable conservation conditions of the species listed for their non-breeding populations in the Inner Galway Bay SPA are defined by two attributes, and their associated targets, which are shown in Table 15. Similar attributes and targets (with minor variation in the precise wording) have been defined for the conservation objectives of all SCI species listed for their non-breeding populations, in all coastal SPAs where site-specific conservation objectives have been published by NPWS

Table 15. Attributes and targets for the conservation objectives for non-breeding populations of Light-bellied Brent Goose, Wigeon, Teal, Shoveler, Red-breasted Merganser, Great Northern Diver, Cormorant, Grey Heron, Ringed Plover, Golden Plover, Lapwing, Dunlin, Bar-tailed Godwit, Curlew, Redshank, Turnstone, Black-headed Gull and Common Gull in the Inner Galway Bay SPA.

Attribute		Measure	Target	Notes
1	Population trend	Percentage trend	Long term population trend stable or increasing	Population trends are presented in part four of the conservation objectives supporting document [NPWS, 2013a].
2	Distribution	Number and range of areas used by waterbirds	No significant decrease in the range, timing or intensity of use of areas by … [the SCI 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 [NPWS, 2013a].

Source: NPWS (2013).
Attributes are not numbered in NPWS (2013), but are numbered here for convenience.

In practice, most assessments explicitly, or implicitly, focus on attribute 2. This reflects the fact that the potential impact on waterbird distribution (i.e., the displacement impact) is relatively straightforward to assess. Assessment of potential impacts on population trends is much more complex and would require detailed research (e.g., development of Individual-based Models; Stillman and Goss-Custard, 2010), which would be beyond the scope of most assessments. Displacement impacts can also be considered as a type of early-warning indicator: developments that affect population trends will usually first cause significant displacement impacts, and these will then translate into impacts on population trends over a period of years. Assessment of displacement impacts can be considered as a very simple form of habitat association model and represents a conservative form of assessment (see Stillman and Goss-Custard, 2010): the population-level consequences of displacement will depend upon the extent to which the remaining habitat is available (i.e., whether the site is at carrying capacity). In general this assessment method "will be pessimistic because some of the displaced birds will be able to settle elsewhere and survive in good condition" (Stillman and Goss-Custard, 2010). For example, the Cardiff Bay Barrage may have displaced up to 296 Redshank but it is estimated that only 43 birds died in the first four post-barrage winters as a result of the habitat loss (Goss-Custard et al., 2006). Similarly, at Dungarvan Harbour intertidal oyster cultivation occupies around 105 ha of intertidal habitat, and is estimated to have caused significant displacement impacts to Grey Plover (up to 10% of the site population), Knot (18%) and Dunlin (30%), but has not had detectable effects on population trends (Gittings and O'Donoghue, 2014).

ASSESSMENT OF THE SIGNIFICANCE OF DISPLACEMENT IMPACTS FOR NON-BREEDING SCI POPULATIONS

While the conservation objectives indicate the importance of focusing on displacement impacts, NPWS have not provided a clear rationale to explain how displacement impacts might affect the overall conservation condition of the species, and have not specified the criteria for the assessing the level of decrease in the numbers or range (distribution) of areas that is considered significant. Therefore, a specific methodology for assessing the significance of displacement impacts has been developed for this assessment. The rationale behind this approach is described below.

The starting point for this methodology is that displacement impacts may have significant population-level impacts if the site is at its effective carrying capacity[5]. 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 (which can affect survival on spring migration) may occur.

Background

Effects of habitat loss on waterbird populations

There have been some studies that have used individual-based models (see Stillman and Goss-Custard, 2010) to model the effect of projected intertidal habitat loss on estuarine waterbird populations. As habitat loss cause displacement impacts, these studies might inform the development of criteria to assess the significance of displacement impacts.

West *et al*. (2007) modelled the effect of percentage of feeding habitat of average quality that could be lost before survivorship was affected. The threshold for the most sensitive species (Black-tailed Godwit) was 40%. Durell *et al*. (2005) found that loss of 10% of mudflat area had significant effects on Oystercatcher and Dunlin mortality and body condition, but did not affect Curlew. Stillman *et al*. (2005) found that, at mean rates of prey density recorded in the study, loss of up to 50% of the total estuary area had no influence on survival rates of any species apart from Curlew. However, under a worst-case scenario (the minimum of the 99% confidence interval of prey density), habitat loss of 2-8% of the total estuary area reduced survival rates of Grey Plover, Black-tailed Godwit, Bar-tailed Godwit, Redshank and Curlew, but not of Oystercatcher, Ringed Plover, Dunlin and Knot. Therefore, the available literature indicates that generally quite high amounts of habitat loss are required to have significant impacts on estuarine waterbird populations, and that very low levels of displacement are unlikely to cause significant impacts. However, it would be difficult to specify a threshold value from the literature as these are likely to be site specific.

Translating habitat loss to displacement rates

The models discussed above use either percentage habitat loss (Stillman *et al*., 2005; West *et al*., 2007), or actual habitat loss (Durell *et al*., 2005) as proximate measures of impact magnitude. However, most real-life assessments of potential impacts of habitat loss on waterbird populations use the number of birds occupying the area affected (i.e., the number of birds that

[5] Based on Goss-Custard (2014), effective carrying capacity is defined in this report as the population level above which density-dependent mortality/emigration and/or loss of body condition occurs. This is referred to as effective carrying capacity distinguish this term from other, quite different, uses of the term carrying capacity.

will be displaced due to the habitat loss), as a percentage of the total site population, as a measure of the impact magnitude. This is a more appropriate measure than the percentage habitat loss, because it may be difficult to define precisely the total area of habitat used by the population and the population may not use all areas of habitat equally. While tidal zones and substrate/biotope types can provide broad indications of the likely usage of habitat, there are often apparently suitable areas (using these criteria) that are rarely, or never, used, while other areas may hold much higher densities than would be predicted if birds were uniformly distributed through the available habitat. These patterns may reflect differences in prey availability, as well as behavioural factors such as proximity to roost sites. If it is assumed that bird distribution reflects habitat quality, the displacement rate is a measure of the impact of habitat loss that combines habitat area and habitat quality and, therefore, provides the most appropriate measure of the impact magnitude.

The model of Stillman *et al*. (2005) incorporated the effects of habitat loss (or gain) by increasing the total area of the entire estuary and assuming that the habitat loss occurred throughout the estuary, rather than in one particular patch. While, not explicitly stated in the paper, this implies that the same percentage habitat loss was applied to each patch. Therefore, in this model, percentage habitat loss is, in fact, equivalent to percentage displacement.

The model of West *et al*. (2007) incorporated the effects of habitat loss by varying the patch area for all prey types between 5-100% of the observed values, and they describe this as “being equivalent to the loss of average quality habitat”. Therefore, again, in this model, percentage habitat loss is, in fact, equivalent to percentage displacement.

The model of Durell *et al*. (2005) differed from the above two scenarios in that it examined a real-life situation where the potential habitat loss was confined to discrete sections of the overall site. The percentage displacement impact of this habitat loss on individual species will, therefore, depend upon the distribution of these species within the site. The data presented in the paper is not sufficient to allow calculations of the percentage displacement impacts that corresponding to the habitat loss scenario.

Factors affecting sensitivity to habitat loss/displacement

As it is not possible to derive clear-cut threshold values of habitat loss/displacement for assessing displacement impacts, it is necessary to consider the factors that will affect the sensitivity of populations to such impacts

The sensitivity of populations to habitat loss/displacement will depend upon both species-specific and site-specific factors. In simple terms the sensitivity will depend upon the degree to which there is suitable alternative habitat available for displaced birds to feed in without having to compete with other birds for the food. This will depend, in part, on how close the site population is to the site carrying capacity (i.e., the number of individuals that the available food resources can support). However, because of the effects of interference competition for food, not all the food resources may be utilisable and the actual numbers of birds that can be supported may be substantially lower than the theoretical carrying capacity. For example, studies of a number of Oystercatcher and Knot populations have indicated that 2-8 times the birds physiological food requirements are needed to ensure that the birds survive in good condition (Goss-Custard et al., 2004; Ens, 2006). The potential effects of interference competition on the proportion of the theoretical carrying capacity that can be consumed will vary between species and, within species, between populations that feed on different prey types. Therefore, high sensitivity to interference effects will result in population-level consequence of displacement at lower densities than would otherwise be the case.

Another factor that may affect the sensitivity of populations to habitat loss is the degree of site fidelity exhibited by the population. Individuals from populations with high site fidelity may find it more difficult to adapt to a new site after being displaced due to lack of familiarity with the location of food resources in the new site.

A further factor is the degree of habitat flexibility displayed by the population. Species that can exploit alternative terrestrial habitats (such as fields) in the vicinity of the site, which may be under-exploited even when the wetland habitat is at its effective carrying capacity (because these habitats are less preferred and, in some cases, are not spatially constrained) are likely to be less sensitive to displacement impacts than species that are confined to the wetland habitat. It should be noted that these alternative habitats may be of lower quality, but may still provide adequate food resources (e.g., the birds may have to feed for longer to meet their daily energetic requirements).

Assessment methodology

Carrying capacity assessment

The limited literature on the effects of habitat loss on waterbird populations has shown population-level consequences resulting from large-scale habitat loss and high percentage displacements. However, if a population is already close to its effective carrying capacity (i.e., taking account of potential interference effects on food availability), then it is possible that even relatively small levels of displacement could have population-level consequences. Detailed population modelling would be required to assess whether a population is at its effective carrying capacity. However, the site population trends provide some indication in this regard.

Comparison of site population trends with national or regional population trends is an established method of assessing whether site-specific factors are likely to be responsible for the site population trends (Cook et al., 2013). A population showing a strong increasing trend is unlikely to have reached its effective carrying capacity, particularly where this increasing trend is stronger than the national trend. A population showing a stable or declining trend may, or may not, have reached its effective carrying capacity. However, a population showing a declining trend, but a stable or increasing national trend, is a strong indication of site-specific factors influencing the population trend, and, therefore, an indication that the population may be at its effective carrying capacity. Similarly, a population showing a stable trend, but an increasing national trend, may also be an indication that the population may be at its effective carrying capacity (although the strength of the inference will be weaker in this case).

Assessing the significance of displacement impacts

Where a species population is considered potentially sensitive to displacement impacts, it is necessary to consider whether the actual displacement impact will have a significant impact on the population.

If the predicted displacement impact is large, then population-level consequences are possible, even if the site population is currently well below the effective carrying capacity (as, in this case, the displacement impact may increase the population density to a level such that it is now at, or close to, the effective carrying capacity).

If the predicted displacement impact is small and the site population is considered to not be at, or close to, the effective carrying capacity, then population-level consequences will not occur (as there will be ample habitat available for displaced birds to feed in without experiencing interference effects) and no further assessment is required.

If the predicted displacement impact is small and the site population may be at, or close to, the effective carrying capacity, then population-level consequences are possible. If there is sufficient information about the distribution and habitat usage of the population within the site, and the population occurs at fairly uniform density across suitable habitat within the site, it may be possible to calculate the mean increase in density that will occur due to the displacement. Where this increase in density is extremely small, it is reasonable to conclude that the predicted displacement will have no population-level consequences. Furthermore, for some species there is information available about the typical densities at which density-dependent processes start to become important.

In many cases, there will not be detailed information available about the distribution and habitat usage of the population within the site, or the population may show a highly aggregated distribution. In these circumstances it will not be possible to make meaningful density calculations. Instead, potential sensitivity to displacement impacts can be assessed more generally, using the following criteria:

- Site fidelity - individuals from populations with high site fidelity may find it more difficult to adapt to a new site after being displaced due to lack of familiarity with the location of food resources in the new site.
- Sensitivity to interference effects - populations that are sensitive to interference effects will not be able to utilise all the available food resources within the site due to density-dependent reductions in food intake at high bird densities.
- Habitat flexibility - species with a high degree of habitat flexibility may be able to utilise alternative, potentially under-utilised, terrestrial habitats, if displaced from the wetland habitats within the site.

DETECTING THE POPULATION-LEVEL CONSEQUENCES OF DISPLACEMENT IMPACTS

The conservation condition of SCI populations is assessed by long-term population trends, using routine waterbird monitoring data (mainly I-WebS data) If a given level of displacement is assumed to cause the same level of population decrease (i.e., all the displaced birds die or leave the site), which is the worst-case scenario, then displacement will have a negative impact on the conservation condition of the species. However, background levels of annual variation in recorded waterbird numbers are generally high, due to both annual variation in absolute population size and the inherent error rate in counting waterbirds in a large and complex site. Therefore, low levels of population decrease will not be detectable (even with a much higher monitoring intensity than is currently carried out). For example, a 1% decrease in the baseline population of Great Northern Diver would be a decrease of one bird. The minimum error level in large-scale waterbird monitoring is considered to be around 5% (Hale, 1974; Prater, 1979; Rappoldt, 1985). Therefore, any population decrease of less than 5% is unlikely to be detectable. This means that even if small displacement impacts have population-level consequences, such consequences are unlikely to affect the recorded conservation condition of the population, as defined by the conservation objectives for the site.

REFERENCES

Cook, A.S.C.P., Barimore, C., Holt, C.A., Read, W.J. & Austin, G.E. (2013). Wetland Bird Survey Alerts 2009/2010: Changes in Numbers of Wintering Waterbirds in the Constituent Countries of the United Kingdom, Special Protection Areas (SPAs) and Sites of S. BTO, Thetford.

Crowe, O., Boland, H. & Walsh, A. (2012). Irish Wetland Bird Survey: results of waterbird monitoring in Ireland in 2010/11. Irish Birds, 9, 397–410.

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

Ens, B.J. (2006). The conflict between shellfisheries and migratory waterbirds in the Dutch Wadden Sea. Waterbirds around the world (eds G.C. Boere, C.A. Galbraith & D.. Stroud), pp. 806–811. The Stationery Office, Edinburgh.

Gittings, T. and O'Donoghue, P. (2014). Dungarvan Harbour Special Protection Area: Appropriate Assessment of Intertidal Oyster Cultivation. Unpublished report to the Marine Institute. http://tinyurl.com/lgq84t2

Goss-Custard, J.D. (2014). Bird and People: Resolving the Conflict on Estuaries.

Goss-Custard, J.D., Burton, N.H.K., Clark, N.A., Ferns, P.N., Reading, C.J., Rehfisch, M.M., Stillman, R.A., Townend, I., West, A.D. & Worrall, D.H. (2006). Test of a behavior-based Individual-Based Model: response of shorebird mortality to habitat loss. Ecological Applications, 16, 2215–2222.

Goss-Custard, J.D., Stillman, R.A., West, A.D., Caldow, R.W.G., Triplet, P., Durell, S.E.A. le V. dit & McGrorty, S. (2004). When enough is not enough: shorebirds and shellfishing. Proceedings of the Royal Society of London B, 271, 233–7.

Hale, W.G. (1974). Aerial counting of waders. Ibis 116:412. Ibis, 116, 412.

NPWS (2013). Conservation Objectives: Inner Galway Bay SPA 004031. Version 1. National Parks and Wildlife Service, Department of Arts, Heritage and the Gaeltacht.

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

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

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

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

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

Appendix 3 Escape distances

THE USE OF ESCAPE DISTANCES IN DISTURBANCE STUDIES

Disturbance to birds can cause a range of behavioural responses the most obvious of which is when the bird interrupts its previous activity and takes evasive action. Typically this will involve the bird flushing and flying away but birds may also walk, run or swim away. The distance at which birds respond to disturbance in this way has been the subject of much of the research into the impacts of disturbance and is often referred to as the Escape Distance (ED) or Flight Initiation Distance (FID). EDs vary between species and, in general, increase with body size (e.g., Laursen et al., 2005). However, quarry species may show higher EDs relative to body size compared to non-quarry species (Laursen et al., 2005) and these differences may persist in migratory species even when they are in areas where they are not hunted (Burger and Gochfield, 1991, cited by Laursen et al., 2005). EDs also vary within species and a wide range of factors can affect them. In particular, the degree of habituation to human activity is generally considered to have a strong potential effect on EDs, with EDs expected to be lower in areas with higher levels of human activity. However, there appears to be little specific research testing this relationship, although it is often invoked to explain differences in reported EDs between studies.

Another factor that may affect EDs is the nature of the approach to the bird. In an extensive study in Australia, Blumstein (2003) found that EDs were positively correlated with starting distance in 64 of the 68 species studied: i.e., EDs were higher when the observer was farther away when they started to approach the bird. This pattern corresponds to the informal knowledge many birders gain through fieldcraft that it is better to approach birds at an oblique angle rather than walking straight towards them. This is an important consideration in the interpretation of many disturbance studies. Most controlled disturbance experiments involve direct approaches to the focal birds. However, most disturbance impacts will generally involve predominantly oblique approaches.

The use of EDs, and other measures of behavioural responses to disturbance, to assess potential sensitivities to disturbance impacts has been criticised. The fact that birds show a behavioural response to disturbance and/or move away from the source of the disturbance does not necessarily mean that disturbance is causing an impact at the population-level. Species responses to disturbance should reflect the costs of responding to the disturbance (Gill et al. 2001): if there is alternative habitat available, and the costs of moving to this habitat are low, species may show larger EDs and a stronger avoidance of disturbed areas, compared to species with little alternative habitat available and/or higher costs of moving to this habitat. However, EDs do provide a useful metric to assess species sensitivities to potential disturbance impacts and to define areas that may be affected by disturbance impacts.

ESCAPE DISTANCES FOR SCI SPECIES OF INNER GALWAY BAY

The main sources of information on escape distances (EDs) for waterbirds in intertidal habitats in Europe come from studies carried out in the Wash, England (West et al., 2007), the Baie de Somme, France (Triplet et al., 1998, 2007), the Dutch Delta area and Wadden Sea (Smit and Visser, 1993) and the Danish Wadden Sea (Laursen et al., 2005); these studies are collectively referred to hereafter as the North Sea disturbance experiments. The Laursen et al. (2005) and Triplet et al. (2007) studies involved controlled disturbance experiments with EDs recorded from direct approaches to the focal birds. The other studies were either not available in full text format for review (Triplet et al., 1998) or present summarised data from unpublished/grey literature sources (Smit and Visser, 1993; West et al., 2007) and details of the methodologies used were not available for this review; however, from the way in which the summarised data is presented and discussed it seems likely that these data are also based upon controlled disturbance experiments with EDs recorded from direct approaches to the focal birds.

The mean EDs reported in these studies are summarised in Table 16. For several of the species the reported EDs are relatively consistent across the studies. However, the range of mean EDs is strongly correlated with the number of studies. Other studies in coastal habitats have reported much lower EDs for some of these species, including 38 m for Curlew and 37 m for Redshank on a rocky beach in Northern Ireland (Fitzpatrick and Boucher, 1998), 10-20 m for Dunlin in China (Yue-wei et al., 2005), and 22-60 m for Bar-tailed Godwit in Australia (Blumstein, 2003; Glover et al., 2011; Weston et al., 2012). Navedo and Herrera (2012) studied EDs in an enclosed estuarine site in northern Spain. While they combine data across all the species that they studied (including Wigeon, Dunlin, Curlew and Redshank) the low mean EDs (31-43 m) and maximum ED (100 m) that they report indicate that these species had much lower EDs here compared to the North Sea disturbance experiments. Overall, while detailed habitat information is not available for all the above studies, it seems that EDs are lower in enclosed coastal habitats and/or where background levels of human activity are higher, compared to the open tidal flats of the North Sea disturbance experiments.

Smit and Visser (1993) include data from a study that examined EDs for Bar-tailed Godwit and Curlew at various distances from the seawall. Both species showed increased EDs at 500-1000 m from the sea wall, compared to 100-200 m from the sea wall, presumably reflecting the results of habituation to disturbance closer to the sea wall. In addition, Curlew EDs within a mussel bed at 1000 m from the sea wall were smaller than their EDs at 100-200 m from the sea wall; this may reflect the increased cost of displacement from mussel beds compared to open sandflats due to the richer food resources in the former.

Laursen et al. (2005) found that EDs of quarry species (including Wigeon, Teal and Curlew) were higher (relative to body size) compared to non-quarry species (including Dunlin, Bar-tailed Godwit and Redshank). They noted that the EDs reported in their study in the Danish Wadden Sea are 1.4-2 times higher than EDs reported for the same species in the Dutch Wadden Sea by Smit and Visser (1993) and suggest these differences may be due to habituation by birds in the Dutch Wadden Sea, the higher levels of recreational disturbance which occurs there, and/or the higher levels of hunting activity in the Danish Wadden Sea.

The Laursen et al. (2005) study also examined a number of factors that can affect variation in EDs within species. They found a significant positive relationship between flock size for various species (including Dunlin, Bar-tailed Godwit, Curlew and Redshank). For Dunlin, the regression equation derived from their results indicates that EDs increase from around 30 m for a single bird to 115 m for a flock of 1,000 and 180 m for a flock of 10,000. They also found that for various species (including Curlew and Redshank) EDs decreased as visibility increased. They also found relationships between EDs and wind strength, but, as the direction of the relationship varied between and within species, the ecological significance of this result is not clear. Triplet et al. (2007) also reported a positive relationship between flock size and ED in various species (including Wigeon and Dunlin). However, their samples included few large flocks so the relationships reported may be dependent on just a few extreme values. They also reported positive relationships between approach distance and ED in various species (including Dunlin, Curlew and Redshank).

EDs for Wigeon and Teal were also investigated by Bregnballe et al. (2009a) using controlled disturbance experiments in a restored freshwater wetland complex in Denmark. The disturbance involved pedestrians walking along a footpath which ran adjacent to the wetland habitat; therefore, it involved pedestrians approaching the birds obliquely. As the study site was a small part of a large wetland complex, with extensive areas of apparently similar habitat contiguous with the study site, the displacement costs were likely to have been small (i.e., the birds could easily move to nearby alternative habitat); in fact, the data reported in a related study (Bregnballe et al., 2009b; see below) indicates that most/all of the birds moved to a zone of the study site more than 250 m from the path. The study reports variation in escape distances in relation to season, flock composition (single versus mixed species) and physical situation (obstructed versus unobstructed views). With unobstructed views there was little variation in EDs (mean values of 190-205 m for Wigeon; 156-181 m for Teal), while EDs were much lower when views were obstructed (117 m for Wigeon, but note small sample size; 84-114 m in single species flocks and 149 m in mixed flocks with Mallard for Teal).

Mathers et al (2000) reported observations of unplanned disturbances on Wigeon feeding on *Zostera* beds in Stangford Lough, Ireland. As the *Zostera* beds are spatially discrete and widely separated, the displacement costs are likely to be high. The EDs were reported in distance bands of 0-100 m, 100-250 m and > 250 m, and for flock sizes of 0-100 and > 100 birds. The median ED was in the 100-250 m band, but there were significant numbers of observations of birds showing both small EDs (< 100 m) and large EDs (> 250 m). It should be noted that, as this was not a controlled study, the distribution of potential disturbances was not necessarily equal across the distance bands.

Table 16. Summary of Escape Distances (EDs) reported for the various studies included in this review

	North Sea disturbance experiments		Other studies	
Species	**Range of mean EDs (m)**	**n**	**Range of mean EDs (m)**	**n**
Wigeon	128-269	2	117-205	4
Teal	197	1	84-181	6
Dunlin	43-80, 163	6	10-20	4
Bar-tailed Godwit	84-219	6	22-60	5
Curlew	102-455	9	38	1
Redshank	82-137	4	37	1

Mean EDs based on small samples sizes (< 10) not included; n = the number of experiments/studies. Sources: North Sea disturbance experiments (Laursen et al., 2005; Smit and Visser, 1993; Triplet et al., 1998, 2007; West et al., 2007); Other studies (Bregnballe et al., 2009a; Blumstein 2003. 2006; Fitzpatrick and Boucher, 1998; Glover et al., 2011; Ikuta and Blumstein, 2003; Weston et al., 2012; Yue-wei et al., 2005).

REFERENCES

Blumstein, D.T. (2003). Flight-initiation distance in birds is dependent on intruder starting distance. The Journal of Wildlife Management, 67, 852–857.

Bregnballe, T., Aaen, K. & Fox, A.D. (2009). Escape distances from human pedestrians by staging waterbirds in a Danish wetland. Wildfowl, 115–130.

Bregnballe, T., Speich, C., Horsten, A. & Fox, A.D. (2009). An experimental study of numerical and behavioural responses of spring staging dabbling ducks to human pedestrian disturbance. Wildfowl, 131–142.

Burger, J. & Gochfeld, M. (1991). Human distance and birds: tolerance and response distances of resident and migrant species in India. Environmental Conservation, 18, 158–165.

Fitzpatrick, S. & Bouchez, B. (1998). Effects of recreational disturbance on the foraging behaviour of waders on a rocky beach. Bird Study, 45, 157–171.

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

Glover, H.K., Weston, M.A., Maguire, G.S., Miller, K.K. & Christie, B.A. (2011). Towards ecologically meaningful and socially acceptable buffers: Response distances of shorebirds in Victoria, Australia, to human disturbance. Landscape and Urban Planning, 103, 326–334.

Laursen, K., Kahlert, J. & Frikke, J. (2005). Factors affecting escape distances of staging waterbirds. Wildlife Biology, 11, 13–19.

Mathers, R.G., Watson, S., Stone, R. & Montgomery, W.I. (2000). A study of the impact of human disturbance on Wigeon Anas penelope and Brent Geese Branta bernicla hrota on an Irish sea loch. Wildfowl, 51, 67–81.

Navedo, J.G. & Herrera, A.G. (2012). Effects of recreational disturbance on tidal wetlands: supporting the importance of undisturbed roosting sites for waterbird conservation. Journal of Coastal Conservation, 16, 373–381.

Smit, C.J. & Visser, G.J.M. (1993). Effects of disturbance on shorebirds: a summary of existing knowledge from the Dutch Wadden Sea and Delta area. Wader Study Group Bulletin, 68, 6–19.

Triplet, P., Bacquet, S., Morand, M.-E. & Lahilaire, L. (1998). La distance d'envol, un indicateur dedérangements: l'exemple de quelqueespèces d'oiseaux en milieu estuarien [Take off distance as an indicator of disturbance: Case study of 8 species in an estuary]. Alauda, 66, 199–206.

Triplet, P., Méquin, N. & Sueur, F. (2007). Prendre en compte la distance d'envol n'est pas suffisant pour assurer la quiétude des oiseaux en milieu littoral [Studying take off distances is not enough to evaluate the disturbances to birds in coastal area]. Alauda, 75, 237–242.

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

Weston, M.A., McLeod, E.M., Blumstein, D.T. & Guay, P.-J. (2012). A review of flight-initiation distances and their application to managing disturbance to Australian birds. Emu, 112, 269–286.

Yue-wei, Y., Gui-rong, X., Ping, D. & Yu-zhao, C. (2005). Effects of human disturbance on foraging behaviour of Dunlin. Zoological Research, 26, 136–141.

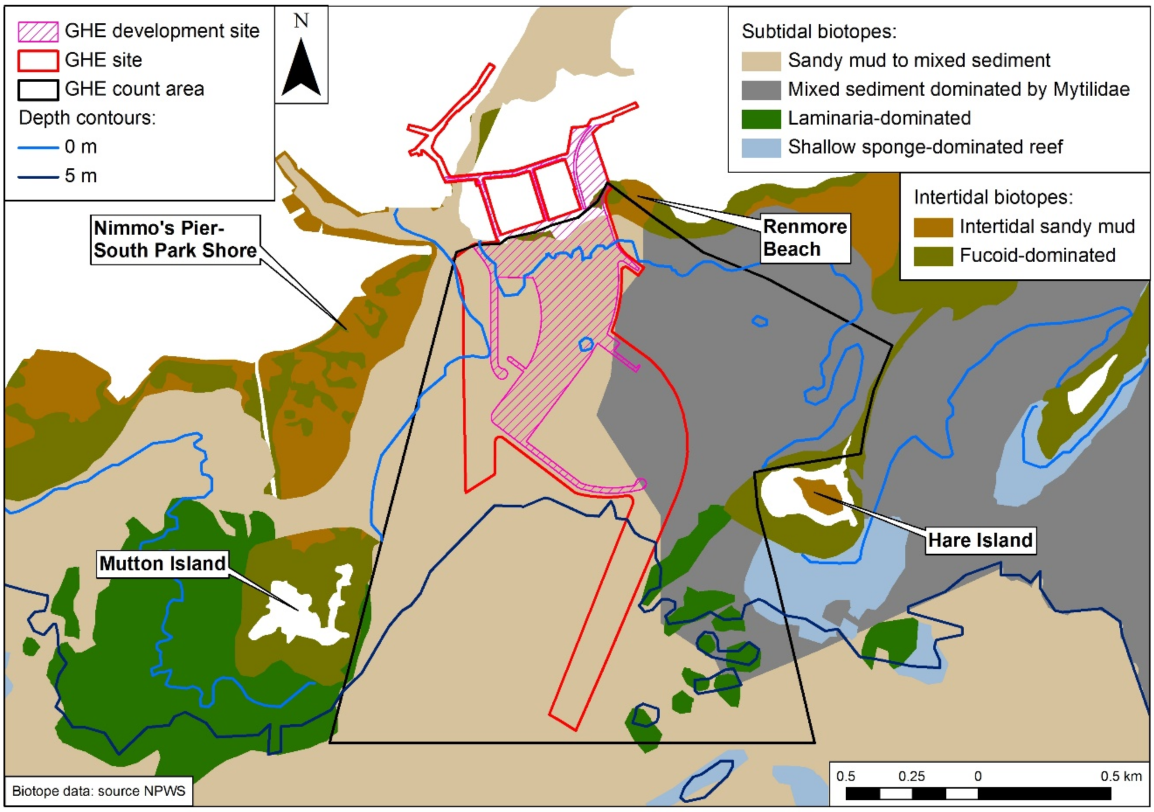


Figure 1. Areas referred to in this report

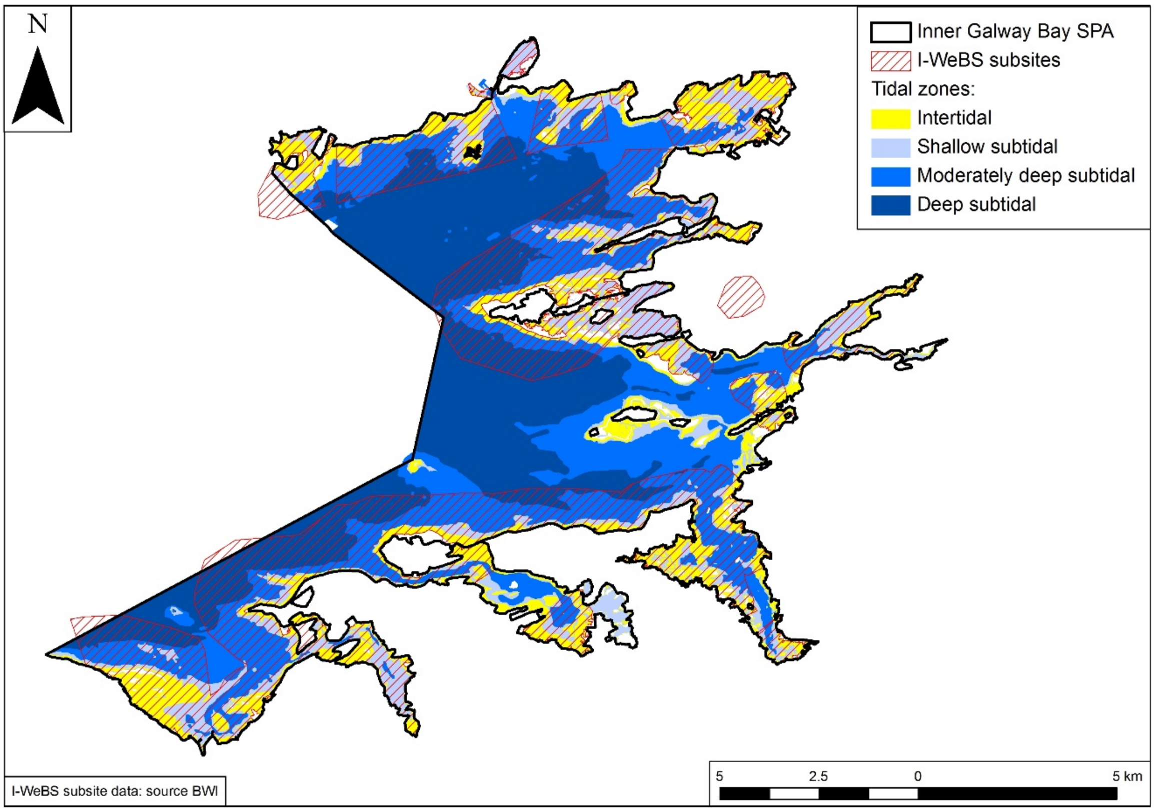


Figure 2. I-WeBS subsite coverage of the Inner Galway Bay SPA.

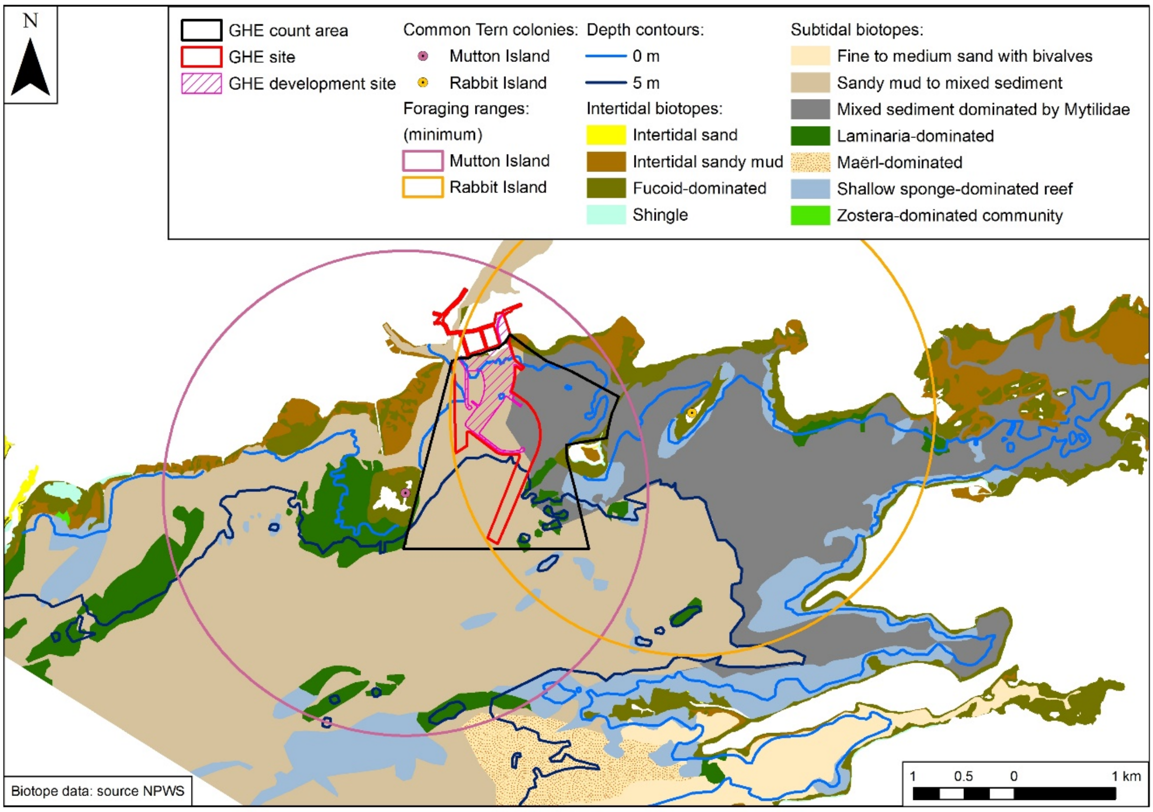


Figure 3. Biotopes and depth zones within the minimum foraging ranges of the Mutton Island and Rabbit Island Common Tern colonies

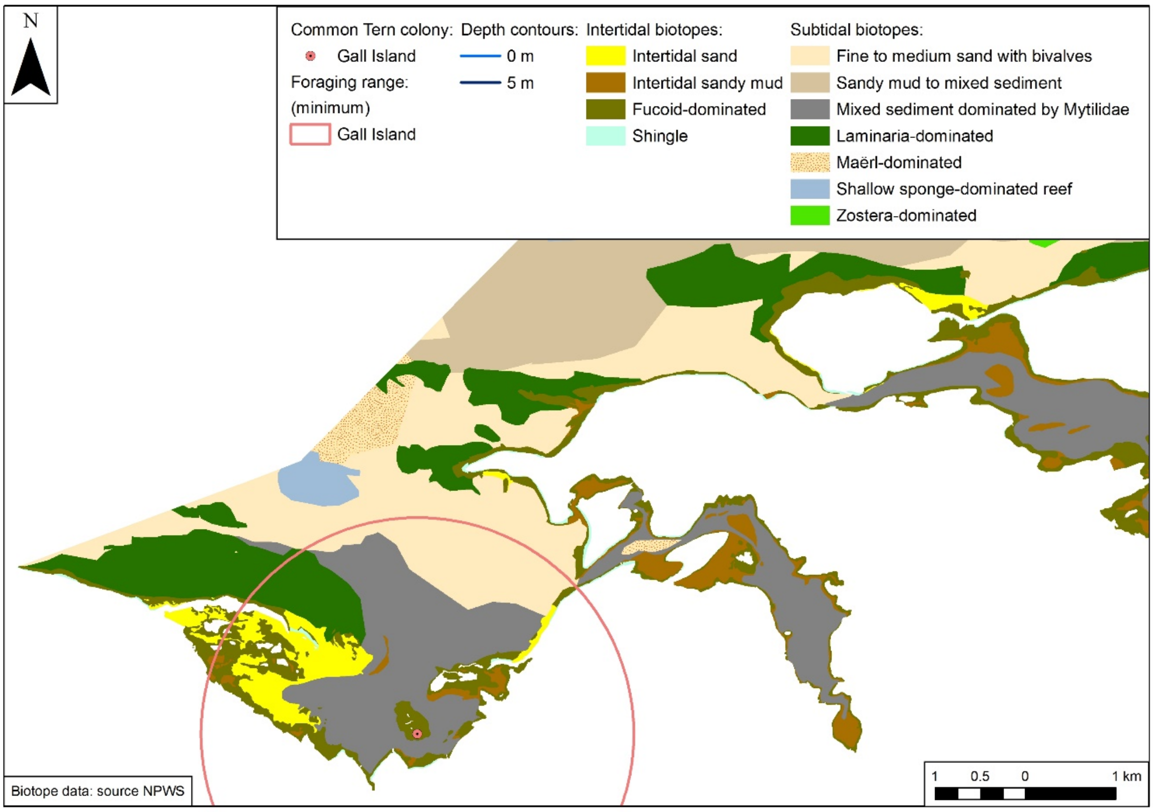


Figure 4. Biotopes and depth zones within the minimum foraging ranges of the Gall Island Common Tern colony