Galway Harbour Company

Galway Harbour Extension

ENVIRONMENTAL IMPACT STATEMENT

ADDENDA / ERRATA TO CHAPTERS

OCTOBER 2014

DOCUMENT AMENDMENT RECORD

Client: Galway Harbour Company

Project: Galway Harbour Extension

Title: Environmental Impact Statement – Addenda / Errata to Chapters

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TOBIN Consulting Engineers							

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 sections 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

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Environmental Impact Statement

Addenda / Errata to Chapters

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1.0 Addendum to Non-Technical Summary

Addenda / Errata arise to Sections 4, 7 and 8 of the Non Technical Summary. These Sections are re-produced here with new script or revised script shaded in light grey.

4 ALTERNATIVES CONSIDERED

4.1 ASSESSMENT OF ALTERNATIVES

The assessment of alternative solutions which were considered at each stage, as part of Environmental Impact Assessment [EIA] examines alternative ways of implementing the project that, where possible, avoid any adverse impacts on the integrity of the Natura 2000 sites. Before a project, that either alone or in combination with other project or plans, has adverse impacts on a Natura 2000 site, can proceed, it must be objectively concluded that no other alternative solutions exist.

The assessment of alternative solutions is required when the competent authority i.e. An Bord Pleanála, having carried out Appropriate Assessment, has concluded that adverse impacts are likely and cannot be ruled out. In examining alternative solutions, other assessment criteria such as economic criteria cannot overrule ecological criteria.

Notwithstand that determination, possible Alternative Solutions could include the following:

- Location
- Scale or size
- Design and orientation
- Means of meeting objectives (e.g. demand management)
- Methods of construction
- Operational methods
- Decommissioning methods at the end of project's life
- Scheduling and timescale proposals (e.g. seasonal working)

The assessment of alternative solutions must include an assessment of the 'do nothing' alternative.

A crucial step in assessing whether alternative solutions exist is the identification of the objectives of the project concerned. From the start it is possible to examine a range of alternative ways of achieving the objectives of the project and these alternatives can then be assessed against their likely impacts on the conservation objectives of the Natura 2000 site.

The primary requirement for the extension arises from the severe constraints with the existing harbour. The objective for the harbour extension therefore is to provide a facility which will service existing and future long term needs over a minimum 30-year period, building on existing landside infrastructure as follows:

- 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 tonnes freight capacity vessel size
- 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

Jumbo Spirit entering Galway Harbour

Alternative solutions assessed include:

1. 'Do Nothing'
2. Improvements to the existing inner harbour
3. Alternative scale/designs as proposed
4. Alternative locations in the inner Galway Bay (i.e. Tawin & Mutton Island)
5. Alternative ports beyond Galway Bay (i.e. ports of national significance as defined in the National Ports Policy)
6. Alternatives abroad

Demand management is not relevant in the context of the GHE project which is designed to cater for economically international trade serving the region.

The ‘do nothing’ scenario and improvements to the existing inner harbour are similar in that existing constraints such as tidal and handling/berthage constraints would persist. Neither alternative would therefore meet the project objectives with fewest / least ecological impacts.

A total of 8 no. alternative scales/designs at the Renmore location were considered over a 7-year period. The proposed GHE evolved from this process as the alternative which best meets the project objectives.

Alternative locations assessed in inner Galway Bay included Tawin and Mutton Island, neither of which have any harbour infrastructure at present and would therefore effectively constitute the development of a new port on a greenfield site together with all of the associated facilities.

The assessment of alternative ports beyond Galway Bay had regard to the National Ports Policy (NPP) which categorises ports into Ports of National Significance [Tier 1 & Tier 2] and Ports of Regional Significance. The function/role of Ports of Regional Significance is to service a particular region while a national port, on the other hand, fulfils both a regional role within its hinterland and a national role. No other regional port can fulfil Galway’s role within its region, while a port of national significance could potentially serve the Galway region. An assessment of alternative ports beyond Galway bay therefore, excludes other ports of regional significance but includes ports of national significance Tiers 1 & 2. These ports were assessed against the objectives for the new port which were translated into qualifying criteria as follows:

- Available land
- Vessel draft capacity
- Total available quay length
- Capable of handling a range of commodities
- Links to established transport/distribution network
- Proximity principle
- SEVESO compliant

The ports assessed included Shannon Foynes, Dublin, Cork, Rosslare and Waterford. The only port which satisfied all of the qualifying criteria, including the proximity principle, is Shannon Foynes.

The final step in the assessment of alternative ports beyond Galway Bay was to determine whether Shannon Foynes fulfils national and regional policy in terms of both balanced regional development and sustainable development, and provides a feasible alternative to GHE from a socio-economic and environmental perspective. To assist in this evaluation process, DKM Economic Consultants prepared both a cost benefit analysis of GHE, followed by a report on the feasibility of Shannon Foynes as an alternative port location to serve Galway port’s region. The report on the Shannon Foynes alternative concludes that there are compelling reasons why the alternative solution of the port of Shannon Foynes servicing the Galway port region is not feasible from a policy, socio-economic and environmental perspective and that there are overriding reasons of public interest why GHE should proceed at the proposed location.

An environmental comparison with Foynes shows the Shannon Estuary to be more environmentally sensitive than Galway Bay.

The assessment of alternative ports abroad concluded that, as an island, alternatives such as road and rail transport alone are not an option and consequently locations abroad do not meet the project objectives.

The assessment of alternative solutions concluded as follows:

- Project objectives cannot be met in a ‘do nothing’ scenario
- The outcome in the case of improvements to the existing Inner Harbour is similar to the ‘do nothing’ scenario
- The alternative scales/designs and alternative locations in Inner Galway Bay are more damaging to the Natura 2000 sites
- Alternative solutions beyond Galway Bay do not meet the project objectives
- The project aims cannot be met by locating the facility abroad

The proposed GHE therefore represents the least damaging option environmentally in terms of meeting the project objectives, including compliance with national policy and the socio-economic wellbeing of the region.

4.2 CONSULTATIONS AND SCOPING

Over a seven year period from 2006, an extensive consultation process was undertaken with the Planning Authority, An Bord Pleanála and with many local and national interest groups. A public consultation seminar was also held in January 2011.

A series of eight pre-application consultations were held with An Bord Pleanála who then decided that the proposed development would be strategic infrastructure and accordingly any application for planning permission must be made directly to the Board under section 37E of the Planning and Development Act, 2000, as amended.

A scoping request “on the information to be included in an EIS” to support the proposed Port development was made to An Bord Pleanála who responded with their written opinion.

7 FLORA AND FAUNA

7.1 INTRODUCTION

The site of the proposed development is located within the Galway Bay Complex candidate Special Area of Conservation (cSAC) and proposed Natural Heritage Area (pNHA). The site also falls within the Inner Galway Bay Special Protection Area (SPA).

The conservation objectives of the Galway Bay Complex cSAC are:
"to maintain or restore the favourable conservation condition of the Annex I habitat(s) and/or Annex II species for which the SAC has been selected".

The conservation objectives of Inner Galway Bay SPA are:-

"to maintain or restore the favourable conservation condition of the bird species listed as Special Conservation Interests for this SPA".

The development will cause the permanent loss of *ca* 27 ha of cSAC and SPA and the temporary loss of a further *ca* 46.5 ha. This will also represent a loss of feeding and foraging area to seals, otters, some bird species, lamprey and salmon which are listed as Qualifying Interests for the cSAC and SPA.

7.2 EXISTING ENVIRONMENT

7.2.1 Habitats

With regard to the EU Habitats Directive, two Annex I habitats *(Mud Flats and Sandflats not covered by Seawater at Low Tide and Reefs)* are present within the site of the proposed development and one priority habitat [Lough Atalia, a Lagoon] is adjacent to it. None of the habitats are exclusive to the area and are present at many other locations within the cSAC. The area of habitat lost within the cSAC would represent *ca.* 0.3% of the total Galway Bay cSAC.

The diversity of terrestrial habitats within the site is poor and much of the area has been or is still subject to human disturbance 9shipping, channel etc). There are no annexed terrestrial habitats within the site of the proposed development.

7.2.2 Flora

All marine flora recorded at the proposed development site are common species throughout Ireland and NW Europe. None are regarded as rare or sensitive. None are listed in the EU Habitats Directive.

None of the terrestrial plants that are found in this area are of particular conservation significance, some of them being introduced or escaped alien species.

7.2.3 Fauna

All marine benthic faunal species recorded at the proposed development site are common throughout Ireland and NW European intertidal habitats. None are regarded as rare or sensitive. None are listed in the EU Habitats Directive.

Due to the naturally high physical and chemical variations in the area where the proposed development is to take place, there are no sensitive invertebrate species present and the habitat type can be found throughout Irish inshore waters.

Otter is listed in Annexes II and IV of the EU Habitats Directive and is a qualifying interest of the Galway Bay Complex cSAC. Otter was recorded on several occasions within the site of the proposed development. No sign of any otter holt was recorded during a dedicated survey of the area and it is considered that the conditions on-site mean that its potential as a site for a regularly used holt (particularly a natal holt) is low.

Common seal is listed in Annexes II and V of the EU Habitats Directive and is a Qualifying Interest of the Galway Bay Complex cSAC. Common seal was recorded foraging in the subtidal portion of the development site and using small haul-out sites in the wider area. There are no colonies of seals within the larger development site. There are a number of seal haul outs within Inner Galway Bay, most notably at Tawin Island and Oranmore Bay.

Harbour porpoise was recorded once in the wider area around the site of the proposed development during watches from the Mutton Island lighthouse. Additionally, a CPOD static acoustic monitoring device (moored underwater close to the site of the proposed development, near to the tip of Mutton Island) was deployed for eight extended survey periods between June 2011 and October 2013. Cetaceans were recorded on the majority of deployment days. A large majority of the recordings were of Harbour porpoise, while there were also recordings made of unidentified dolphin species (probably Bottle-nosed and/or Short-beaked Common dolphin).

Two species of bat (Common pipistrelle and Soprano pipistrelle) were recorded during a dusk-dawn survey covering the foreshore at the site of the proposed development and adjacent areas of the Galway Harbour Park. Only six bat passes were recorded during the course of a full night. Given the small number of registrations of bats made, the behaviour observed and the species involved, indications are that the site is not of significance for bats, only for small-scale foraging during calm weather.

A total of 31 bird species were recorded using the shoreline and marine area in the site of the proposed development. This list includes 13 of the 20 bird species listed as Special Conservation Interests of the Inner Galway Bay SPA. In addition, five of the species recorded (Common Tern, Great Northern Diver, Little Egret, Red-throated Diver and Sandwich Tern) are listed in Annex I of the EU Birds Directive. An additional thirteen species of mainly terrestrial birds were recorded within the existing harbour park close to the site of the proposed development.

7.3 IMPACTS

7.3.1 Impacts on Designated Natura 2000 Sites

Impacts to habitats, flora and fauna can arise from:

- loss of terrestrial and marine habitats due to the reclamation and dredging work
- physical damage to species from noise and vibration from underwater activities of dredging, rock blasting and pile driving
- physical damage to species *e.g.* seals from vessels' propellers
- siltation of sea bed by release of suspended solids into the sea
- alteration to current directions and possible shift in erosion and deposition sites
- release of cement, sewage, grey water or oil during construction stage
- sediment suspension due to propeller wash
- alteration to salinity levels at the mouth of the Corrib and in Lough Atalia and Renmore Lough
- introduction of non-native species from commercial and/or pleasure craft.

The permanent loss of 26.93 ha of cSAC and SPA and the associated loss of feeding and foraging area to seals, otters, some bird species, lamprey and salmon which are listed as Qualifying Interests for the cSAC and SPA is regarded as a significant negative impact on the conservation objectives for both Natura 2000 sites.

While there is potential for minor short term disturbance impacts on fish, birds and aquatic mammals during the construction phase, best practice and specific mitigation measures will avoid permanent significant negative impacts on migratory fish, seals and birds.

There is potential for some injury or disturbance to Atlantic salmon, sea lamprey, Common seal, otter and small cetaceans during construction but this will be mitigated by the timing of the works and by precautionary monitoring before and during works.

Modelling exercises carried out indicate that while there will be changes in current velocities and directions, these changes are considered to be insignificant. Salinity levels on the Renmore side of the harbour extension will increase, leading to a positive impact on species. Although salinity levels in Lough Atalia and Renmore Lagoon will decrease marginally, this will not impact the species of plant and animal that occur there. This is because these species have evolved to live under highly variable salinity conditions. Short term impacts in suspended solids loading will be localised around the dredgers and will be lower than naturally occurring disturbed sea levels. Impacts as a result of the increased sheltering of the Renmore Beach are considered likely to have an impact on stony bank habitats present in the area, resulting in loss of habitat.

The impact of the development will only affect an area in the immediate vicinity of the new structure, an area that is already significantly impacted by current usage. The designated habitats within the marine footprint of the development correspond to only ca. 0.3% of the overall cSAC and would not be considered of high quality relative to other areas within the cSAC site boundary.
With regard to the Inner Galway Bay SPA, no significant impacts are anticipated on bird species that are Special Conservation Interests for this SPA. In particular, no impacts are predicted on nearby nesting colonies of Cormorant and Common Tern. However, the level of significance of in combination impacts with aquaculture projects within Galway Bay on Common Tern cannot be ruled out and is therefore considered a significant impact on one of the conservation objectives of the Inner Galway Bay SPA

There is some potential for disturbance to Atlantic Salmon and Sea Lamprey migrating past the site to the Lough Corrib cSAC but this will be mitigated by prohibiting working in water during April – July i.e. no drilling, blasting, pile driving or dredging in those months.

7.4 MITIGATION MEASURES

The project design includes for various mitigation measures as follows:-

- habitat creation in rock walls
- restricting underwater construction works during months April to July.
- provision of walled-in lagoons with filter blankets to capture dredging sediments
- adoption of good construction practice including maximising use of precasting to minimise risk from cement spillages

- Implementation of Oil Spill Contingency Plan and Environmental Management Plan to control potential for release of oil or other products.

Despite the mitigation as outlined above, permanent loss of habitat within the cSAC and SPA will arise, which is considered a significant negative impact on the conservation objectives of the Galway bay Complex cSAC and an in combination effect on one of the special conservation objectives of the Inner Galway Bay SPA cannot be ruled out, and is thereby considered a significant negative impact.

8 WATER

8.1 INTRODUCTION

The aquatic section of the EIS describes the existing marine water environment in respect to water quality and hydrodynamics, it quantifies the potential operational and constructional impacts to this environment from the proposed development, it develops appropriate mitigation measures to prevent or reduce impact and quantifies post mitigation, any residual, cumulative or in combination impacts.

The hydrodynamic assessment examined tidal and fluvial flow regime, tidal storm surges, wave climate and flood risk assessment. The water quality assessment examined general water quality, sedimentation and salinity changes. Mathematical modelling techniques comprising hydrodynamic, pollutant transport and dispersion, sediment transport and wave climate models were used to quantify and predict potential impact and to develop appropriate mitigation and assess residual impacts. Survey information regarding tidal heights and velocities, bathymetric survey, sediment characteristics and wave climate were carried out to support and develop these models.

The proposed harbour extension development will involve encroachment into Galway Bay immediately to the east and south of the mouth to the existing Galway Harbour resulting in the reclamation from the sea of approx. 27 ha of land and also the dredging of approach channels, berths and turning circle and construction of harbour walls and breakwaters. Such an encroachment of the marine environment has the potential to alter the tidal circulation, morphology of the sea bed and the wave climate with potential impacts on turbidity and general water quality, salinity distribution, sedimentology, wave environment and flood risk.

The TELEMAC package was the software of choice for modelling the complicated hydrodynamics of the Galway Bay area and particularly the varying refinement of the computation required (*i.e.* inner harbour and proposed extension area requiring high resolution and the open sea requiring less resolution). TELEMAC is a software system designed to study environmental processes in free surface transient flows. It is therefore applicable to seas and coastal domains, estuaries, rivers and lakes. Its main fields of application are in hydrodynamics, water quality, sedimentology and water waves. A three-dimensional hydrodynamic model was developed to firstly examine the potential impact to turbidity levels, salinity and hydrodynamics.

8.2 HYDRODYNAMICS

The hydrodynamic modelling predicts a deflection to the west of the flood and ebb flows of both tidal and freshwater stratified surface flow to and from the Corrib estuary. These deflected flows follow the new north-south orientated Galway Docks dredge channel and Marina Breakwater. The impact on flow velocities and water depths upstream of Nimmo's pier, in the approaches to the existing Dock Gates, Claddagh Basin and entrance to Lough Atalia is shown to be negligible under the full range ot tidal and freshwater flows. Immediately to the east of the Harbour Extension in the Ballyloughaun and Renmore area a shelter effect with reduced hydrodynamic environment is predicted. Slight increases in flow velocity are predicted past the head of the proposed Harbour southern beakwater between Hare Island and the development. Hydrodynamic modelling indicates that the overall impact on tidal circulation within the Inner Galway Bay area will be negligible.

8.2.1 Sedimentology

The implications of the development on sedimentation are shown to be minor in respect of impacts from erosion and deposition. The main changes in shear stresses were found to occur along the proposed new dredge channel to Galway Docks and past the head of the southern breakwater. These changes will be beneficial in respect to maintaining the dredged channel and reducing the deposition of silt within the channel. The results show that the proposed development produces shear stresses during spring tides sufficient to erode silt and fine sands in these areas. This is considered desirable in respect to maintaining the dredge channels. The simulation shows no erosive impact elsewhere.

The neap tides are sufficiently slack not to result in erosive shear stresses outside of the Corrib estuary for both proposed and existing cases and therefore no erosive impact is predicted under Neap tide conditions.

Under River Corrib flood conditions, the proposed development restricts the area of the erosive flow to the proposed dredged channel immediately to its west. This is considered beneficial in respect to reducing the dredging maintenance requirement which is currently not very excessive (500 mm depth removed at approximately a 10-year interval). Similar shear stresses sufficient to erode fine sand are generated in the vicinity of the southern breakwater head. This is also considered beneficial as this is the location of proposed dredge channel to the New commercial Port. No significant impacts are predicted elsewhere.

The overall conclusion is that the proposed harbour extension configuration confines the high flows and critical bed shear to the approach channels and will not result in any erosive impact elsewhere over the existing situation. This will reduce deposition in the new approach channel to Galway Docks while avoiding scour elsewhere.

The upstream characteristics of the River Corrib, with its very large lake (Lough Corrib) for settlement, results in the sediment content comprising primarily of the finer silt and sand fractions (even under flood conditions). Simulation of the fine sediment from the River Corrib showed the proposed development pushing the river and suspended sediment plume southwards out to sea past Mutton Island on the ebbing tide and away from the Renmore area only returning in a much more dilute plume on the flooding tide. The simulation results indicate a reduction generally of between 40 and 60% in fine sediment load east of the proposed development.

The impact of capital and maintenance dredging activity by a trailing suction hopper dredger or back hoe dredger on suspended solids and sediment deposition was assessed using a three dimensional sediment plume model. The modelling showed the sediment deposition to be generally localised close to the dredging location. The simulations demonstrated that the suspended sediment concentrations are only significantly elevated above background in the vicinity of the dredging point with the plume enjoying reasonable dispersal thereafter. The suspended solids concentrations of less than 1 mg/l above ambient that may enter Lough Atalia are extremely low compared to naturally occurring background levels and will have no effect on the functioning of this lagoonal ecosystem. Under larger river flows, the sediment plume will have greater dispersal out to sea resulting in lower sediment plume concentrations within the study area. The critical hydrodynamic conditions for sediment entering Lough Atalia are Spring tides and low Corrib Flow conditions.

Mitigation to protect Lough Atalia will involve confining dredging activities to the outgoing ebbing flow for the channel to the Docks and Marina. No mitigation measures will be required for the main commercial harbour approach channel, turning circle and berths as the suspended sediment disperses quickly due to the large depths and the dredging methods proposed. Monitoring at the entrance to the Lough Atalia channel will be undertaken during capital and maintenance dredging to ensure that dredging during ebbing flow is controlled and ceases sufficiently in time before rising flow discharges into Lough Atalia.

The potential impact of suspended solid concentrations from the proposed dredging activity will, except immediately local to the dredger, achieve salmonid water standards for suspended solids.

8.3 SALINITY

8.3.1 Salinity at the extension site

The tide simulations for various freshwater inflows from the Corrib show the deflection of the Corrib freshwater plume westward due to the proposed harbour extension with that freshwater only arriving into Renmore Bay and Ballyloughan area on the subsequent flooding tide. In the undeveloped existing case there is a wider area for the freshwater plume to disperse with no physical structure to prevent the plume migrating east and southeast on the ebbing tide. That allows it to avail of a greater area for dispersion. With the proposed development, the Corrib plume is directed more southwards with reduced opportunity for the freshwater plume to directly disperse into the Renmore Bay area on the returning flood tide. The modelling demonstrates significant increases in salinity to the east of development with greatest changes occurring to the northeast of the proposed harbour extension showing an average rise in salinity of 2.4 to 5.4ppt. This area will receive less freshwater, it will also receive less suspended sediments and debris that are carried by the River Corrib. These changes will bring about improved bathing water conditions at Renmore Beach and at Ballyloughan. These increases in salinity may bring about a change in benthic fauna whereby lower salinity-intolerant species such as echinoderms may colonise the muddy sands/sands in this area.

Changes in salinities levels (reduction in salinity) are predicted to take place to the west of the structure and very minor changes predicted for Lough Atalia and the waters beyond Mutton Island. In the approaches to Galway Docks, south of Nimmo's Pier reduction in average salinity concentrations of 1.5 to 2ppt are predicted.

8.3.2 Salinity in Lough Atalia & Renmore Lough

Lough Atalia and Renmore Lough fall under the definition of "coastal lagoons" [1150] under the EU Habitats Directive and are categorised as a priority habitat, described as being in danger of disappearing and therefore requiring protection. However conservation objectives recently published by NPWS describe the conservation status of Lough Atalia and Renmore Lough as of no conservation value as coastal lagoons.

The modelled impact of the Harbour Extension Development on salinity concentrations within Lough Atalia will be to reduce salinities on average by 1.29ppt over the complete range of flow and tide conditions. Given the existing relative range of salinities within the Lough from *ca* 30ppt to nil ppt, this reduction of 1.29ppt in salinity, which is only 10% of the mean salinity, is not considered significant. The model analysis also demonstrates that the range of salinities (maximum to minimum) within Lough Atalia will not alter as a result of the harbour extension; only the frequency of occurrence will change.

Periodic large and extreme flood flows in the Corrib will reduce salinities to practically nil in Lough Atalia for both the existing and proposed cases, principally during neap tides but also on spring tides for a less frequent more extreme flood flow. Over the full tidal range the probability of nil Salinity in a given year occurring within Lough Atalia will increase from 0.08% to 0.21% (7 to 18hours in an average year).

The overall impact on salinity within Renmore Lough by the proposed Harbour extension will be to decrease the median salinity within the Lough by 1.22ppt. The overall water balance and inflows to and from Renmore Lough will not be affected by the proposed development as the tidal elevations in Lough Atalia will not be altered by the development and thus the inflow rates to Renmore Lough will remain unchanged.

8.4 OUTFALL DISPERSION SIMULATIONS

8.4.1 Introduction

The potential impact on transport and dispersion of the Existing Mutton Island outfall and the proposed Galway East outfalls was examined using the TELEMAC2D Hydrodynamic model for the existing and proposed development cases.

The Mutton Island outfall and the proposed Galway East outfall were specified.

8.4.2 Discussion

The modelling concluded that the Galway East proposed outfall location will not be impacted by the proposed port development.

The outfall dispersion results for the existing Mutton Island outfall show some variation in the plume characteristics to the east of Mutton Island. The overall impact is considered to be local and minor, and importantly the simulations show no impact along the Salthill/Silverstrand, South Park and Renmore shoreline areas or upstream at the existing Galway Harbour where amenity and bathing standards are important. There are no perceptible impacts to bathing waters of Silver Strand, Barna and Furbo and no impact to the designated shellfishery waters located in the south inner Galway Bay area.

Specific wind impacts on model surface layer tracer were studied and did not indicate a significant issue at the mouth of the Corrib either in calm or high wind circumstances.

8.5 IN COMBINATION EFFECT OF THE MUTTON ISLAND CAUSEWAY ON HYDRODYNAMICS AND SALINITIES

In order to assess the cumulative impact of the proposed harbour extension development on the hydrodynamics of Inner Galway Bay, an understanding of the hydrodynamics of Galway Bay prior to recent major developments is required. The most significant recent change to the coastline of the Galway City is the Mutton Island causeway which was completed in 2002.

The causeway is shown to essentially partition the shallow shoreline area to the west of the causeway (Grattan Road and Whitestrand Beach area) from the estuarine waters of the Corrib estuary to the east. The effect of this is to increase salinity along the shoreline to the west of the causeway. The impact of the causeway on velocities, tide levels at the entrance to the docks and Lough Atalia and more remote at Renmore is shown to be negligible.

The combined effect of the causeway and the proposed harbour extension will be to concentrate the plume of Corrib freshwater flow southwards between the proposed harbour and the causeway and thereby reduce salinities within the new approach channel to the docks area and increase salinities along the shoreline to the east of the new harbour towards Renmore Beach.

8.6 WAVE CLIMATE

A detailed wave climate analysis was carried out to examine the exposure of the site and proposed development and assist in designing the required breakwater protection for the Commercial Port and proposed marina. A model of the existing environment shows the principal area of exposure is from offshore waves propagating inshore from west to southwest directions, diffracting around Mutton Island and impacting on the southern breakwater. These wave heights have been used to design the new port wave walls.

Modelling work on wave propagation within the greater Bay area shows that the maximum value of the significant wave height that reaches inner Galway Bay, just to the southwest of Mutton island was found to be slightly less than 4 m (3.77 m on Southwest and 3.3 m for a west southwest wind and offshore condition). For westerly winds the significant wave height at this location is 2.9 m. Southerly and north-westerly offshore waves have very limited effect on the Inner Galway Bay area. It is clear that the Aran Islands and the reducing sea depth east of the islands provide crucial protection to the Inner Galway Bay area. This is primarily due to the position of the Aran Islands at the entrance to Galway Bay which act as a very effective breakwater for deepwater waves entering Galway Bay.

The modelling was also run for storm waves generated by local fetch from the east, southeast and south sectors respectively. These runs were specifically aimed at assessing the potential impact on the local wave climate on the Claddagh Basin, Corrib Estuary, existing Harbour, Lough Atalia and South Park shore and the protection afforded by the proposed breakwaters in respect to conditions within the mooring areas of the Commercial Harbour and Fisherman's pier and within the proposed marina area and any other operational areas. The southerly and southwesterly sector was considered the critical direction for storm waves acting on the proposed Harbour and on the South Park shoreline area (inside the Mutton Island Causeway) on the mouth of the Corrib Estuary and on the existing docks entrance adjacent to Nimmo's Pier.

The breakwater protection is not designed to protect the commercial harbour against storm waves propagating locally from the east and southeast with model results predicting 0.25 to 0.8 m waves within the commercial harbour for the easterly design storm waves, being afforded protection by Hare Island. The simulations for the south to west sectors show the breakwaters protecting well the harbour and marina areas against wave climate.

Moveable breakwater barriers will be used to address the impact of South Easterly waves on the fishing pier.

The breakwater protection varies in height depending on the location and exposure to wave climate with the southerly breakwater having a crest elevation of 9.1 to 10.1 m O.D. which provides 4.45 to 5.45 m above the design tide level (4.635 m O.D.) for wave climate and wave run-up effects. This level of protection will minimise the risk of overtopping of the breakwater structure by extreme waves. The westerly breakwater located in the more sheltered waters has a top elevation 6.35 to 6.65 m O.D. which based on wave climate analysis will protect this area from overtopping by the extreme waves predicted for these locations.

A simulation was also carried out assuming the Mutton Island causeway to be completely submerged by 200-year Tide with Sea level Rise (4.635 m O.D. Malin). It would then be covered by over 1m of water depth. A westerly deepwater design wave of 4 m significant wave height was applied to the model. The simulation shows that the Mutton Island Causeway would under these submerged conditions break the storm waves and dissipate much of its energy and thus provide protection to the westerly face of the proposed development even under submerged conditions.

The wave climate simulations show that the proposed harbour development impacts the local wave climate environment through a combination of sheltering via dissipation and reflection off its breakwaters and diffraction and refraction of the wave field around the development over the dredged channels. The development generally shelters the eastern section of the adjacent Renmore shoreline against storms from the south to southwesterly sector. It protects the Galway Docks entrance and much of the Southpark shoreline against south easterly and easterly storms. The simulations show, under south and south westerly storms, increased wave activity along the south face of Nimmo's Pier and the entrance to Galway Docks and the Corrib channel. These are not the most significant waves which presently occur at this location and these waves are directed across the Corrib channel as opposed to running up along it.

The wave simulations show that this increased wave activity at Nimmo's pier entrance does not appreciably impact wave heights within the inner Claddagh Basin area and such impacts are less than those which presently arise from the southeast direction which will now be blocked by the proposed development.

Specific wave issues were raised by the RFI.

The impact of current on opposing waves, was assessed and shown to arise but does not impact on existing development or Corrib entrance and Claddagh Basin.

The impact of breaking waves on sea level was shown not to occur at critical locations.

The impact of seabed roughness was investigated and shown not to be greater in the proposed case than in the existing and that wind wave impact on seabed friction was not critical.

8.7 FLOOD RISK

The critical flood level for the harbour and surrounding areas is produced by a tidal storm surge event of 4.146 m O.D. Malin (200year tide) plus a climate change allowance (sea level rise) of 0.5m over the next 100 years giving a flood design level of 4.646 m. Such an event would inundate a large portion of the city centre.

The proposed development site is located within the High Flood Risk Zone (*i.e.* Zone A of the Planning Guidelines). Flood Zone A is the high flood risk zone and represents lands that are below the 100year fluvial Flood level or the 200-year tidal or combined (tidal and fluvial) flood level. The Flood Risk Assessment shows the critical condition for the harbour is the 200-year tidal storm surge event. The proposed development [a Commercial Harbour and Marina with associated dockside activities] is classified as a *"water compatible development"* and recognised as appropriate development for Flood Zone A in the Flood Risk Management Planning Guidelines (Nov 2009).

The quay height and operational ground level are set at 4.7 m O.D. Malin which is above the design flood level of 4.646 m O.D. and therefore considered safe from inundation from storm surge tides. The minimum finish floor level for all buildings on the port site is to be 5.5 m O.D. which is well above the design flood level providing a freeboard of 850 mm and thus not considered at risk of flooding from tidal/combined fluvial flood inundation.

The proposed port development has been shown not to impact on flood risk for the adjoining areas. It has no impact on peak combined tide and river levels within the Claddagh Basin, Spanish Arch and Galway Docks area upstream of Nimmo's Pier. The development does not adversely impact on wave climate and tidal hydrodynamics in respect to flooding and flood risk. The harbour development generally shelters the shoreline areas along South Park, Nimmo's Pier, the existing docks and the Renmore shoreline area against local and offshore generated waves.

This is further confirmed by the additional wave model work requested by the RFI.

In conclusion, the Flood Risk Assessment shows that the proposed development is appropriate development for Flood Zone A. It also concludes that the development will not increase flood risk to adjacent lands and developments as a result of any changes to sea levels, wave climate and river flows.

Addendum to Chapter 3 – Background and Alternatives

Chapter 3 Addendum:

The addendum to Chapter 3 has been prepared arising from issues raised with respect to the assessment of whether there are Alternative Solutions and in particular any possible alternative locations for the development. This issue was raised in an Bord Pleanála's Further Information request of 27th May 2014. The background to the preparation of this addendum is set out in the introduction contained in Section 1.0 of the document.

This addendum to Chapter 3 sets out a number of other possible options, including possible alternative locations which were previously assessed but omitted from Chapter 3 due to their elimination on initial analysis.

The addendum also revisits those 3 no. ports which met a number of the assessment criteria which were ultimately found to be non-feasible by reason of their inability to meet the necessary project objectives, in particular the proximity principle. These are Dublin Port, Cork Port & Foynes Port.

The addendum also further addresses the issue of feasibility in relation to the assessment of whether there are alternative solutions, citing relevant references in EU commission guidance and other documents referring to this matter.

The methodology and format in this addendum is similar to chapter 3, the content of which is summarised in the addendum for ease of reference. **This addendum however should be read in conjunction with chapter 3 in the EIS.**

Chapter 3 – Assessment of whether there are Alternative Solutions

Addendum

Table of Contents

1 INTRODUCTION:

This addendum has been prepared in light of issues raised with respect to the assessment of whether there are Alternative Solutions in particular in relation to any possible alternative locations for the development in question. Item No. 01 of ABP's Further Information request, dated the 27th of May, 2014 also refers.
The assessment of whether there are any Alternative Solutions as set out in Chapter 3 of the EIS was undertaken in accordance with requirements of Article 6.4 of the Habitats Directive; Guidance Documents from the European Commission, as well as having regard to precedents established in the case of projects elsewhere which were successful in satisfying the requirements under Article 6.4.

The Assessment of whether there are Alternative Solutions, as set out in Chapter 3 of the EIS, involves firstly identifying potential alternatives followed by a determination as to whether these are feasible.

The methodology applied to the assessment of whether Alternative Solutions, exist as set out in Chapter 3, involved firstly identifying the project objectives. From these objectives criteria were then derived which allowed other possible options to be measured in a systematic way.

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 are 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 confirms 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 is also demonstrated in the Business Case.

This addendum to Chapter 3 sets out a number of other possible options which were previously assessed but omitted from Chapter 3 due to their elimination on initial analysis. These include the following:

- **Rossaveel port in Galway Bay**
- **Air, road and rail transport as possible other modes of transport**
- **Limerick docks beyond Galway Bay**
- **Other commercial/regional ports on the island of Ireland**

The addendum is also revisiting those three ports which met a number of the assessment criteria but which were ultimately found to be non-feasible by reason of their inability to meet the necessary project objectives, including the proximity principle, namely **Dublin, Cork and Foynes**.

The addendum also further addresses the issue of feasibility in relation to the assessment of whether there are alternative solutions, identifying relevant references in EU Commission Guidance as well as other Documents referring to this matter.

The methodology and format in this addendum is similar to Chapter 3, the content of which is summarized here for ease of reference. This addendum however should be read in conjunction with Chapter 3 in the EIS.

2 FEASIBILITY

In carrying out an assessment of whether there are alternative solutions, cognisance has been taken of the underlying principles guiding Article 6(4) of the Habitats Directive and the statement in associated guidance publications that other assessment criteria such as economic criteria should not be treated as overruling ecological criteria. Nevertheless to be considered as an alternative solution, the possible alternative must be **feasible**.

Some sites which may appear to present an alternative solution may, on first glance, appear to have reduced impacts upon the Natura 2000 network. A determination needs to be made however, as to whether these alternatives are feasible. In other words, if a possible alternative does not in any meaningful way achieve the objectives of the project, it cannot be accepted as feasible. While EU guidance does not define the criteria which might be used to determine a "**feasible**" alternative, a number of relevant documents refer to this issue as follows:

1. **Guidance document on Article 6(4) of the Habitats Directive 92/43/EC**
2. **UK - Department for Environment, Food & Rural Affairs (defra)**
3. **Marine Management Organisation (MMO) '*Guidance on imperative reasons of overriding public interest under the Habitats Directive*'**
4. **Birdlife International*: "Position paper of the Birds and Habitats Directives Task Force on the approach to alternative solutions and imperative reasons of overriding public interest under Article 6(4) of the EU Habitats Directive***
5. **UK -*"Transport National Policy Statement for Ports – January 2012".***

2.1 Guidance document on Article 6(4) of the Habitats Directive 92/43/EC

'Section 1.2.1 Substantial Scope
The alternative put forward for approval, is the least damaging for habitats, for species and for the integrity of the Natura 2000 site, regardless of economic considerations, and that no other ***feasible*** *alternative, exists that would not affect the integrity of the site.*

Section 1.3.1. Examining alternative solutions
All ***feasible*** *alternatives, in particular, their relative performance with regard to the conservation objectives of the Natura 2000 site... '*

2.2 UK - Department for Environment, Food & Rural Affairs (defra)

In addressing alternative solutions, this document includes the following:

'Test 1: alternative solutions
10. The purpose of the alternative solutions test is to determine whether there are any other ***feasible*** *ways to deliver the overall objective of the plan or project which would be less damaging to the integrity of the European site(s) affected. For the test to be passed the competent*

*authority must be able to demonstrate objectively the absence of **feasible** alternative solutions'*

*18. The consideration of alternatives should be limited to options which are financially, legally and technically **feasible**. An alternative should not be ruled out simply because it would cause greater inconvenience or cost to the applicant. However, there would come a point where an alternative is so very expensive or technically or legally difficult that it would be unreasonable to consider it a **feasible** alternative. The competent authority is responsible for making this judgement according to the details of each case. If the authority considers an option is not **feasible**, it would not be necessary to continue to assess its environmental impacts.*

2.3 Marine Management Organisation (MMO) 'Guidance on imperative reasons of overriding public interest under the Habitats Directive

"An argument of "no alternative solutions" must show that:

1. *No other **feasible** alternatives exist that would not…..*
   - *All **feasible** alternatives must be analysed….* "

2.4 Birdlife International: 'Position paper of the Birds and Habitats Directives Task Force on the approach to alternative solutions and imperative reasons of overriding public interest under Article 6(4) of the EU Habitats Directive'

This document identifies situations where an option may not be **feasible**, although these are cited as exceptional. These include:

- *"Unacceptable negative public health or safety implications for which there are no available measures (whatever the cost)*
- *Where demonstrated that the solution is so excessively expensive, it is not **feasible**, it would never come into effect"*

2.5 UK - "National Transport Policy Statement for Ports – January 2012"

The following are extracts from Section 4.9 which deals with alternatives:

"Section 4.9.3

Where there is a legal requirement to consider alternatives, the applicant should describe the alternatives considered in compliance with these requirements. Given the public interest in provision of new port infrastructure, the decision-maker should, subject to any relevant legal requirements (e.g. under the habitats Directive) which may indicate otherwise, be guided by the following principles when deciding what weight should be given to alternatives:

- *the consideration of alternatives in order to comply with policy requirements should be carried out in a proportionate manner;*
- *whether there is a realistic prospect of the alternative delivering the same infrastructure capacity (including energy security and climate change benefits) in the same timescale as the proposed development;*
- *the decision-maker should not reject an application for development on one site simply because fewer adverse impacts would result from developing similar infrastructure on another suitable site, and it should have regard as appropriate to the possibility that other suitable sites for*

port infrastructure of the type proposed may be needed for future proposals;

- *alternatives not among the main alternatives studied by the applicant (as reflected in the ES) should only be considered to the extent that the decision-maker thinks they are both important and relevant to its decision;*
- *if the IPC, which must (subject to the exceptions set out in the 2008 Act) decide an application in accordance with the relevant NPS, concludes that a decision to grant consent to a hypothetical alternative proposal would not be in accordance with the policies set out in this NPS, the existence of that alternative is unlikely to be important and relevant to the IPC's decision;*
- *suggested alternative proposals which mean the primary objectives of the application could not be achieved, for example because the alternative proposals are not commercially* ***feasible*** *or alternative proposals for sites would not be physically suitable, can be excluded on the grounds that they are not important and relevant to the decision;*
- *it is intended that potential alternatives to a proposed development should, wherever possible, be identified before an application is made in respect of it (so as to allow appropriate consultation and the development of a suitable evidence base in relation to any alternatives which are particularly relevant). Where, therefore, an alternative is first put forward by a third party after an application has been made, the person considering that application may place the onus on the person proposing the alternative to provide the evidence for its suitability as such, and the applicant should not necessarily be expected to have assessed it."*

The concept of feasibility for Alternative Solutions therefore is well established under the provisions of Article 6(4).

3 PROJECT OBJECTIVES

The objectives for GHE are set out in Section 3.1 of the EIS and are repeated here for ease of reference. The basis for the objectives, is related to the socio-economic wellbeing of the west region as identified in the Cost Benefit Analysis, and is summarised in Section 1 of this addendum. The objectives also had regard to National Ports Policy and are supported by the Business Case.

In designating Galway as a port of regional significance, the NPP has identified Galway harbour's role as a commercial port within the national context. The business case identifies commodities currently using Galway port, together with potential commodities and opportunities, in addition to projections for future growth.

The primary objective of Galway Harbour Extension (GHE) is to provide new port facilities, building on existing port infrastructure, to replace existing inadequate facilities, in line with National Policy which is aimed at achieving balanced regional development and supporting the strategic role of Galway as the Gateway City within the west region.

Galway City has an extensive maritime history and tradition and has served as the primary maritime access between the west region and continental Europe since the 12th Century. The existing port serves a number of different functions/sectors. The predominant activity is freight, in particular bulk freight. The existing port also serves as a fishing port, a centre for international cruise tourism, a marina as well as servicing offshore exploration, research and offshore renewable energy generation. The proposed harbour extension is required so that Galway Harbour Company can continue to fulfill 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.

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 constraints within the existing harbour. The objectives for the extension therefore are to provide a facility which will serve existing and future long term needs 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 an increase in vessel size – upwards of 20,000 tonnes
- 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. Replacing current unloading operations within the existing harbour/city centre area is an extremely important objective to remove potentially hazardous unloading operations in close proximity to the city centre and to allow for the sustainable development of the city centre.

3.1 Qualifying Criteria

Criteria, derived from the GHE project objectives, were drawn up for the purposes of assessing the viability of possible other ports beyond Galway Bay. These qualifying criteria require a port capable of handling a range of commodities with sufficient quay length, vessel draft capacity and available land to accommodate the regions long term needs. These qualifying criteria in this case are as follows:

Brief Requirements	Qualifying criteria
Available land	Min. 40ha
Vessel draft capacity	Capable of handling vessels of max. 8m draft float in all tides
Total available quay length	660m
Capable of handling a range of commodities (including petroleum & bitumen)	Have existing landside infrastructure
Link to established transport/distribution network	Rail access & national road access
Proximity Principle	Within 1.5 hours/150km of customer/region
SEVESO	SEVESO compliant storage facilities (i.e. petroleum & bitumen)

Table 3.7.1 - Qualifying Criteria in identifying a shortlist of sites

The qualifying criteria listed above require sufficient capacity to cater for the region's long term needs in a sustainable manner. In this regard, the objectives involve the utilisation of or expansion of established commercial port facilities and infrastructure:

- **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 is deemed necessary
- **Draft capacity**: A port capable of handling vessels with upwards of 20,000 tonne capacity which is deemed to be the minimum commercially viable vessels size and draft capacity
- **Quay length**: Sufficient quay length to accommodate dry bulk, liquid bulk and cruise vessels berthing at any one time is required in order to meet the objectives
- **Commodities:** In line with its role, as identified in NPP, servicing the west region, the port must be capable of handling a range of commodities including dry and liquid bulk cargos
- **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 national road and rail networks and services in proper condition were deemed to be a requirement in this regard
- **SEVESO:** 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.

Proximity Principle

As a relatively small Island, with limited natural resources, the vast bulk of commodities and raw materials consumed come from abroad and the predominant mode of transport is shipping. As the bulk of imports and exports are transported by ship in any event, this affords an opportunity to ship goods closest to the region and customers served. This is the optimum approach in terms of environmental sustainability and indeed viability through minimising trips and transport distances by road between the port and its hinterland. This is viewed as fundamental to economic development and competiveness, particularly in an economy heavily dependent on both imports and exports.

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 max. 1½ hours or 150KM from Galway City, as the regional gateway and main population centre within the region, was deemed to be the 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 and therefore not feasible on this basis if the costs associated with transporting such goods to and from such port are non-sustainable from the customers point of view.. 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. This is particularly so when attempting to use the road network outside the main inter-urban routes. Similarly significant difficulties are likely in attempting to use outdated railway lines and in this regard it is noted that there is in fact no service to one of the other ports considered (Foynes) since the year 2000.

4 ASSESSMENT OF WHETHER ALTERNATIVE SOLUTIONS EXIST

The assessment of whether Alternative Solutions exist examines a range of possible other ways of implementing the project and, if any such alternative solutions are determined to exist, to assess whether such alternatives would be likely to have less adverse environmental impacts on the particular or other European sites. Possible alternative solutions and factors to be considered will, where appropriate, include the following:

- Locations
- Scale or size
- Means of meeting objectives (e.g. demand management)
- Methods of construction
- Operational methods
- Decommissioning methods at the end of the projects life
- Scheduling & timescale proposals (e.g. Seasonal working)

4.1 Demand Management and Other Solutions

Demand management is not relevant in the context of the GHE project which is designed to cater for economically international trade serving the region.

A number of the potential alternative solutions identified above, such as **methods of construction; operational methods; decommissioning methods at the end of the project life,** as well as **scheduling and timescale proposals**, do not in themselves meet the project objectives.

In terms of alternative transport modes, where trade is import and export with commodities being transported onto and off the island, **road or rail transport** do not in themselves meet the project objectives. **Air transport** was also considered and deemed non-**feasible** arising from the nature of the commodities transported, mainly bulk commodities, which have a high weight/bulk and are unsuited to air transport.

4.2 Other Scales, Designs and Locations

Other possibilities assessed in this regard are wide ranging, from the Do Nothing to Ports located elsewhere in Ireland. Foreign possibilities are also considered. The following alternatives were assessed:

- ‘Do nothing’
- Improvements to the existing Inner Harbour (Do Minimum)
- Other scales/designs at proposed/ location
- Other locations in the inner Galway Bay (i.e. Tawin and Mutton Island)
- Other locations elsewhere in Galway Bay (Rossaveel)
- Other ports beyond Galway Bay: Dublin, Cork, Foynes Port Limerick Docks, Rosslare and Waterford
- Other Locations Abroad

4.3 ‘Do Nothing’ Scenario

The ‘do nothing’ scenario was assessed in Section 3.5.1 of EIS Chapter 3 and concluded that this would result in:

- Continued tidal constraints

- Continued handling/berthage constraints
- No freight rail link
- Continued SEVESO issues
- Decline of port
- Economic decline
- Loss of maritime tradition
- Unrealised maritime tourism potential

The "Do Nothing" scenario therefore does not meet the project objectives and is therefore not considered a **feasible** alternative.

4.4 Improvements to the existing Inner Harbour (Do Minimum)

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 at very significant cost. It would still be limited by vessel turning capacity and quay length which would allow an improvement only generally from 5,000T to 10,000T vessels. Access would continue to be restricted to 2 hours per tide. Such development would have negative impacts on existing and proposed urban developments and would not resolve Seveso concerns.

This is the do minimum scenario addressed in Section 3.5.2 of EIS Chapter 3 and concludes that the existing constraints at the inner harbour location render this scenario non-feasible. In particular the tidal and handling/berthage constraints would persist, as would the SEVESO issues. The do minimum therefore would be similar to the 'do-nothing' scenario.

4.5 Possible other Scales/Designs

A total of 8 no. other scales/designs were prepared over a 7 year period and each of these was assessed in terms of meeting the project objectives (EIS chapter 3, Section 3.5.3). There is nothing further to be added in this addendum in terms of Alternative Scales/Designs.

4.6 Possible other Locations in Inner Galway Bay

These are set out in Section 3.6 of the EIS and include Tawin and Mutton Island, There is nothing further to add to these possible other locations in this addendum.

4.7 Possible other Locations elsewhere in Galway Bay

Rossaveel is the only other commercial harbor in Galway Bay. It was assessed but eliminated on initial analysis and the following is a summary of this assessment.

Rossaveel is a designated fishery harbour and 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. A dedicated fishing berth of some 200m is planned. 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 larger vessels of over 2,000 tonnes to anchor and 1,000 tonnes to dock. Even following the current improvements, the 200m quay is unable to handle a number of vessels at the same time, as is required at Galway Harbour. Similarly, the proposed turning circle would be inadequate to accommodate larger vessels. There are also navigational restrictions on approach that would be a danger for larger seagoing vessels.

The relocation of Galway Harbour to Rossaveel would impose greater cost on customers and the importers of petroleum and bitumen products would have to construct tankage in Rossaveel and then transport the product by road to customers. Significant investment would be required to provide tank farms to cater for the region's liquid fuel storage requirements. On the basis of current petroleum and bitumen throughput in Galway Harbour, this will account for approximately 78,500 truck movements to travel the 37 kms between Rossaveel and Galway to reach the main market. This raises significant cost, environmental and road safety issues. In addition, Rossaveel is not considered an optimum location to take advantage of increased maritime tourism, mainly due to its remoteness from the services available in Galway City, which is a key tourism destination.

In summary, the "relocate to Rossaveel" scenario would result in:

- Port handling constraints
- Port access constraints
- Increased journey costs/times
- Requirement for new landside storage facilities
- No potential rail link
- Unrealised maritime tourism potential

4.8 Possible other Locations/Ports beyond Galway Bay

EIS Chapter 3 in Section 3.7 examines possible other ports beyond Galway Bay. However, in addition other commercial/regional ports on the island were also assessed against the qualifying criteria. These included Sligo, Killybegs, Derry, Larne, Belfast, Greenore, Warrenpoint, Drogheda and Arklow. These were eliminated on initial analysis for a range of reasons including the following:

- Excessive distance from Galway/region;
- 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, whereby ports of regional significance should cater for their own regional traffic.

4.9 Limerick Docks

Shannon Foynes Port Company services six facilities on the Shannon Estuary: the facilities at Foynes, Limerick Docks and Shannon Airport are owned by the company. The three other dedicated terminals, which are privately owned, are Moneypoint (ESB) a coal transhipment facility, Tarbert Island for heavy fuel and Aughinish for bauxite imports and alumina exports.

Limerick Docks suffers from significant tidal, draft and beam constraints. Furthermore access to the docks via the estuary which is narrow and winding is also subject to severe tidal constraints. The total throughput for Limerick docks in 2013 was 300,000 tonnes. This is relatively small in the context of the projections for GHE at 2m tonnes. Furthermore, Limerick no longer has facilities for liquid fuels which is one of the largest commodities utilising Galway Port.

Consequently Limerick Docks does not meet the qualifying criteria or the project objectives

4.10 Shortlisted Ports

In total 5 no. ports were identified as having the potential to meet the project objectives namely Dublin Port; Port of Cork; Foynes Port; Rosslare Port and Port of Waterford.

The 5 no. identified ports were then assessed against the qualifying criteria (See EIS Section 3.7.3) and the ports of Dublin, Cork and Foynes met virtually all of the selection criteria in that they have sufficient land, vessel draft capacity, quay length, wet and dry bulk cargo facilities, links to established transport/distribution networks, hazardous materials storage and compliance with the SEVESO Directive (Section 3.7.4). Rosslare and Waterford did not meet all of the qualifying criteria and where therefore deemed non-feasible in terms of meeting the project objectives.

In summary:

- Dublin meets all criteria with the exception of proximity;
- Foynes meets all criteria with the exception of a functioning 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; it lacks the land requirement, as well as not meeting the proximity and hazardous material storage criteria.

It is noteworthy that none of the possible other ports fully meets all of the criteria. While the port at Foynes, is located 130 kilometres from Galway this is close to the outer limit of what is considered acceptable even from the Galway City in terms of proximity and is outside the limit of 150 km in relation to a significant portion of the region served by the GHE. Dublin fails on the proximity criterion. Cork, in addition to failing the proximity criterion, also lacks rail connections and as noted Foynes also lacks a rail service and a rail network capable of taking rail traffic without significant upgrading.

Data and information received from a number of customers of Galway port has indicated that using possible other ports will impose significant increased transport costs. In summary, there are compelling reasons why the possible other solution, whereby additional port traffic is catered for at Shannon-Foynes is not feasible from a socio-economic perspective and would fail to meet the overriding socio-economic reasons of public importance including the sustaining of employment within Galway and its hinterland. **Since other ports were further away, we conclude that there is no feasible alternative to the proposed project**.

5 CONCLUSION OF ASSESSMENT OF WHETHER OR NOT ALTERNATIVE SOLUTIONS EXIST

The preceding sections have outlined the assessment of alternatives in terms of the following scenarios:

- Do-nothing
- Improvements to existing Inner Harbour
- Possible other Scale/design
- Possible other locations in Inner Galway Bay
- Possible others locations/ports beyond Galway Bay
- Possible other locations abroad

The following conclusions have been drawn from this exercise:

- Project objectives cannot be met in a ‘do nothing’ scenario
- The outcome in the case of improvements to the existing Inner Harbour is similar to the ‘do nothing’ scenario
- The possible other scales/designs and possible other locations in Inner Galway Bay are more damaging to the Natura 2000 site
- Possible other ports beyond Galway Bay are not **feasible** and do not meet the requirements necessitating the project.
- The reasons for which the project is required cannot be met by locating the facility abroad

It is concluded therefore that no alternative solution exists which meets the reasons of overriding public interest necessitating the proposed GHE development. Furthermore, in relation to a number of the other possible locations it is determined that, even if these were considered to be alternative solutions the GHE in any event comprises the option that best respects the integrity of the site in question (in relation to those other possible locations within Galway Bay SAC/SPA and in relation to a number of those outside that area but located within areas of other SACs/SPAs). It is therefore considered that GHE is the option that best protects the integrity of the Natura 2000 network.

Addendum to Chapter 7 – Flora and Fauna

7 FLORA AND FAUNA

7.0 GUIDANCE

Generally, the information presented in the EIS Addendum is new information which should be considered as ADDITIONAL to that included in the EIS 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 EIS Addendum should supersede information presented in the main EIS document. Where new information has been prepared by external consultants, relevant portions have been incorporated into the body text of the EIS Addendum, with their original report presented in an Appendix for reference. Where possible, the EIS Addendum follows the same sequence and numbering system as the original EIS, hence there may be instances where the EIS Addendum numbering is not in sequence within the document itself – this will occur where no additional information or errata are relevant, but it was considered preferable to maintain the numbering system in line with the original NIS for ease of cross reference. Where no additional information has been added to a section, this is stated within the document. Where some of the original information from the EIS Chapter has been included for introduction or reference, it is included in grey text.

7.1 INTRODUCTION

No additional information.

7.2 BACKGROUND TO METHODOLOGY

No additional information.

7.3 DESIGNATED SITES

No additional information.

7.3.1 Qualifying Interests and Conservation Objectives

No additional information.

7.4 FLORA IN THE EXISTING ENVIRONMENT

No additional information.

7.4.1 Habitats within the Site of the Proposed Development

No additional information.

7.4.1.1 Marine Habitats

No additional information.

7.4.1.2 Terrestrial Habitats

No additional information.

7.4.1.3 Habitats in the Surrounding Area

No additional information.

7.4.1.3.1 Terrestrial habitats in zone of potential influence

Dr. Michelene Sheehy-Skeffington, an acknowledged expert on salt marshes and stony bank habitats in Ireland was commissioned to undertake a site visit and to complete an assessment of the habitat. A visit was made to the seaward edge of L. Atalia to establish the changes in habitat brought about by the winter storms. The upper strandline, shingle area and habitat immediately north of this ridge were walked. The site was visited on 22nd July, 2014.

The shingle bank, formerly ca 1m in height, has been completely altered. Most of the shingle has been moved inland, forming a spit immediately to the south of Renmore Lough (site number 1 Fig. 1 below). More was spread along the inner edge of the grassy bank that used to form the inner (northern) edge of the shingle. It is likely that there were two sources of shingle –1) that present on the shore line and 2) material thrown up from the sea floor to the south of Renmore Lough.The shingle has been moved to such an extent that the seaward edge now forms part of the strandline and vegetation comprises species tolerant of tidal submergence such as spear-leaved orache *Atriplex prostrata,* sea rocket *Cakile maritima,* sea mayweed *Tripleurospermum maritimum,* sea radish *Raphanus raphanistrum maritimum*. On the higher ground, the vegetation and its soil was broken up, but still formed a band of grassy vegetation with creeping bent grass *Agrostis stolonifera,* perennial ryegrass *Lolium perenne,* red fescue *Festuca rubra,* false oatgrass *Arrenatherum elatius* forming the grass layer and a mixture of ruderal (weed) species such as colt's foot *Tussilago farfara,* nettle *Urtica dioica,* ragwort *Senecio jacobaea,* perennial sow-thistle *Sonchus arvensis* and smooth sow-thistle *Sonchus oleraceus*, along with calcareous coastal grassland species such as ribwort plantain *Plantago lanceolata,* field medick *Medicago lupulina,* bird's foot trefoil *Lotus corniculatus* and kidney vetch *Anthyllis vulneraria.*

The shingle, between sections of grassland, supports sea radish, spear-leaved orache and curled dock *Rumex crispus*.

Notable on the strandline and shingle was the rare *Lactuca tatarica*, once abundant on the shingle, but which had disappeared in recent years. This is the only known site for this alien species in Ireland (Reynolds 2002). The disturbance of the storms has exposed the seed-bank and this and the rare native black mustard, *Brassica nigra*, have appeared, the latter occurring sporadically on the inner edge of the shingle. This is the first time the black mustard has been recorded not only here, but in all of east county Galway (see map Fig 2 below; Preston *et al*., 2001), though it has been recorded on Inishbofin and on Inishmore, Aran Islands in the past (Webb and Scannell 1983). Another rare coastal transient species that used to be common on this shingle bar is henbane *Hyoscyamus niger*. It has disappeared since the 1980s, but the recent storm-induced re-working of the shingle and exposure of dormant seed banks may yet bring about a return of the species. This illustrates the conservation interest of such naturally disturbed habitats as shingle. But, since the former shingle ridge has largely now been flattened, it is unlikely that many species not tolerant to tidal inundation will remain, as the shingle is either at the strand-line, or adjacent to grassland that is likely to eventually colonise it. The effects of the construction are likely to only serve to stabilise the structure of the bar, though storm surges may wash over it, thus preventing the establishment of scrub with bramble sycamore and ash – all noted on this ridge. The complex of shingle and strandline vegetation comprise EU Habitats Directive Annex I habitats 1210 Annual vegetation of drift lines and 1220 Perennial vegetation of stony banks.

The southwest edge of the shingle merges into an eroded salt marsh. It is not clear to what extent it was intact before the storms, but it probably has been fragmentary for some time. Upper marsh species are present such as red fescue *Festuca rubra,* sea milkwort *Glaux maritima,* sea arrow-grass *Triglochin maritimum,* salt marsh rush *Juncus gerardii,* scurvey grass *Cochlearia officinalis* and sea aster *Aster tripolium.*

Most of the vegetation landward of the shingle bar comprises marsh and wet grassland. A small, probably brackish, pond has abundant reedmace *Typha latifolia* (area 2 on map Fig 1) and areas possibly intermittently flooded support extensive creeping bent grass *Agrostis stolonifera* with a fringe of sea rush *Juncus maritimus.* The edge of the inlet south of the railway line is bordered by some sea rush and salt marsh rush as well as sea club-rush *Bolboschoenus maritimus* and all three species indicate that this is largely a lagoonal type salt marsh. The drier –more elevated– parts of this area support bracken *Pteridium aquilinum* and some hawthorn *Crataegus monogyna* bushes. Some reed *Phragmites australis*, also occurs nearer the railway line.

In summary, the shingle now forms a low area of cobbles below High Water Spring Tide (HWST) with strand-line species and the bank behind this is mixed shingle and grassland on soil. This bank would only be breached by a storm surge, but if the wave force is attenuated by the proposed construction, it is less likely to be structurally altered to the extent it was in January 2014. A storm surge may flood the grassland behind the shingle, via the inlet from Lough Atalia or over the shingle, but the sea-water would drain off, such that the lagoonal salt marsh and grassland will not become very saline and the vegetation, already a mosaic of species tolerant of brackish or saline water (lagoonal marsh) is unlikely to alter to a great extent.

With the predicted greater stability as a result of the proposed construction, less storms will reach the shingle and salt marsh area. As shingle is of its nature a naturally unstable habitat, it is likely that the increased stability will alter the vegetation in the area of shingle above the HWST. This includes the shingle moved inland during the January 2014 storms. Shingle that becomes stable eventually becomes colonised with a heath grassland and/or grassland community, with a reduction of the adventive ruderals that benefit from the regular disturbance of the cobbles.

The salt marsh per se is only extensive north of the railway line. This is as mapped in Figure 1 below. Most of this salt marsh comprises upper marsh species, notably the relatively large sea rush that defines the physiognomy of much of the vegetation on the eastern side of L. Atalia. It overlies a deep peat that has fragments of reed suggesting it was a freshwater marsh in the past. Other species present are red fescue and salt marsh rush. This comprises EU Habitats Directive Annex I 1410 Mediterranean salt meadows (*Juncetalia maritimi*).

The only lower marsh present is in depressions, notably at points along the track north of the railway line, but this is very fragmentary. Species such as common salt marsh grass *Puccinellia maritima,* sea plantain, scurvy grass and sea aster are more abundant in these lower, more frequently-inundated areas. This is too fragmentary to be noted as a significant amount of Habitats Directive Annex I 1330 Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*).

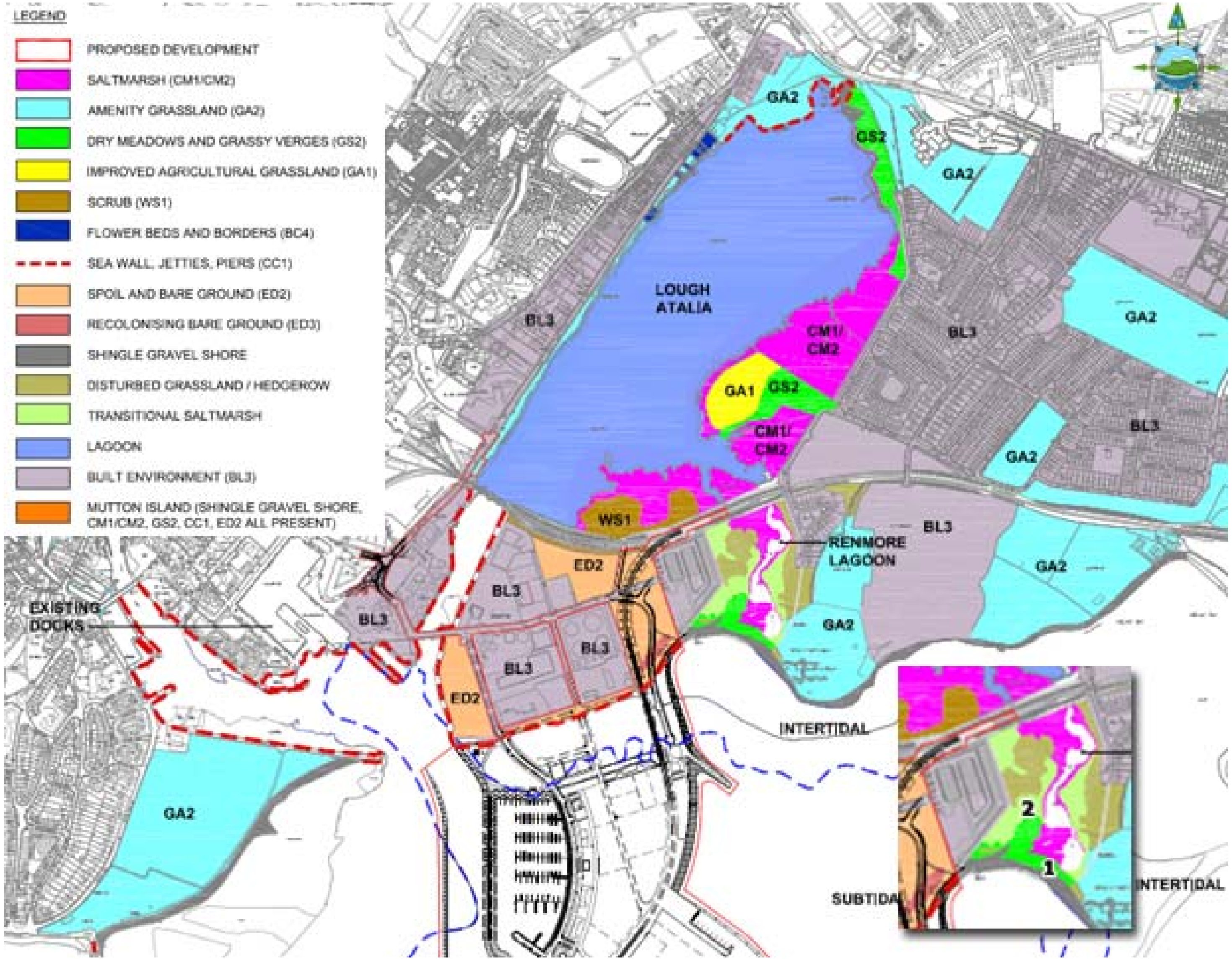


Figure.1 Terrestrial habitats present in the vicinity of the proposed harbour extension (copied from Original report Fig 2.8).

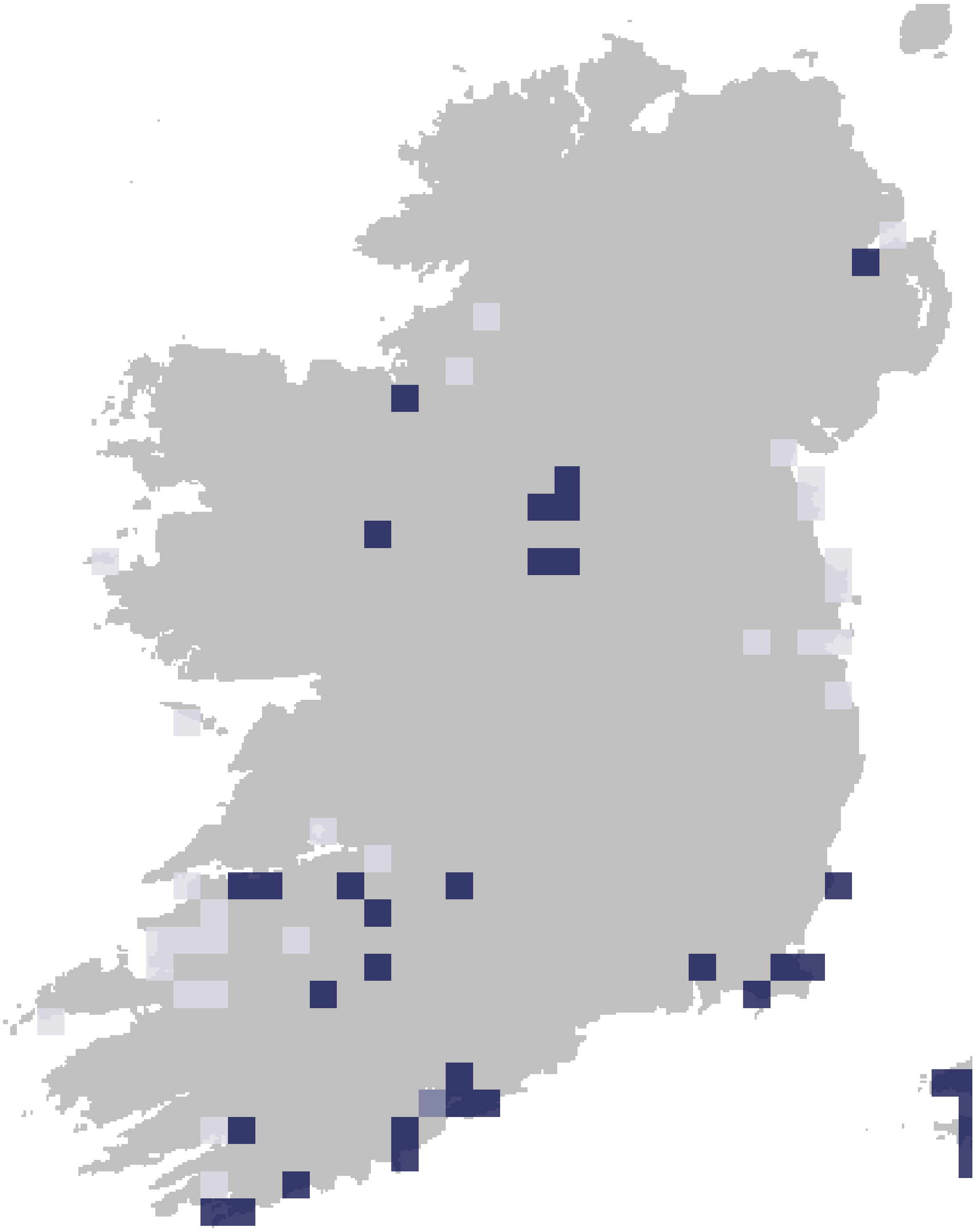


Figure.2 BSBI map of 10 x 10km squares where Brassica nigra was recorded in Atlas 2000 (Preston et al 2001). Lighter squares represent pre-1970 records. Note its complete absence from mainland County Galway and from inner Galway Bay specifically.

7.4.1.3.2 Lough Atalia and Renmore Lough

No additional information.

7.4.2 Conservation Status

No additional information.

7.4.3 Description of Lough Atalia and Renmore Lough

No additional information.

7.4.4 Bathymetry

No additional information.

7.4.5 Current speeds and directions

No additional information.

7.4.6 Salinity

No additional information.

7.4.7 Turbidity

No additional information.

7.4.8 Flora and Fauna

No additional information.

7.4.9 Potential impacts from the proposed development on flora and faunal species

No additional information.

7.4.10 Conclusions

No additional information.

7.4.10.1 Flora in the surrounding area

No additional information.

7.5 FLORA IN THE EXISTING ENVIRONMENT

No additional information.

7.5.1 Benthic Fauna – Intertidal Survey

No additional information.

7.5.1.1 Methodology

No additional information.

7.5.1.2 Results

No additional information.

7.5.2 Benthic Fauna & Sediments – Subtidal Survey

No additional information.

7.5.2.1 Station locations

No additional information.

7.5.2.2 Methodology

No additional information.

7.5.2.2.1 Sedimentology

No additional information.

7.5.2.2.2 Macrofauna

No additional information.

7.5.2.2.3 Sediment Profile Imagery

No additional information.

7.5.3 Results

No additional information.

7.5.3.1 Sedimentology

No additional information.

7.5.3.1.1 Granulometry

No additional information.

7.5.3.1.2 Sediment Chemistry

No additional information.

7.5.3.2 Macrofauna (2004 Survey)

No additional information.

7.5.3.2.1 Univariate Analyses

No additional information.

7.5.3.2.2 Multivariate Analyses

No additional information.

7.5.3.3 Macrofauna (2010 Survey)

No additional information.

7.5.3.3.1 Univariate Analyses

No additional information.

7.5.3.3.2 Multivariate Analyses

No additional information.

7.5.3.4 Sediment Profile Imagery (SPI)

No additional information.

7.5.3.4.1 Major mode

No additional information.

7.5.3.4.2 Mean penetration

No additional information.

7.5.3.4.3 Surface boundary roughness

No additional information.

7.5.3.4.4 Mean Redox discontinuity

No additional information.

7.5.3.4.5 Successional Stage

No additional information.

7.5.3.4.6 Organism Sediment Index

No additional information.

7.5.3.4.7 Benthic Habitat Quality

No additional information.

7.5.4 Discussion

No additional information.

7.5.4.1 Sedimentology

No additional information.

7.5.4.1.1 Granulometry

No additional information.

7.5.4.1.2 Sediment Chimistry

No additional information.

7.5.4.2 Macrofauna

No additional information.

7.5.4.3 Sediment Profile Imagery

No additional information.

7.5.5 Fish in the Existing Environment

No additional information.

7.5.5.1 Methodology and Limitations

No additional information.

7.5.5.2 Desk Study

No additional information.

7.5.5.2.1 Available Information concerning Fish and Shellfish

No additional information.

7.5.5.2.2 Species of Conservation Importance that use the Site and Surrounding Area

No additional information.

7.5.5.2.3 Other Fish Species

No additional information.

7.5.5.2.4 Crustaceans and Shelled Molluscs

No additional information.

7.5.5.3 Field Surveys – Elver Survey

No additional information.

7.5.5.4 Field Surveys – Salmon Smolt Tracking

No additional information.

7.5.5.4.1 Matherials and Methods

No additional information.

7.5.5.4.2 Salmon Smolt Tracking Results

No additional information.

7.5.5.4.3 Tag detections

No additional information.

7.5.5.4.4 Discussion

No additional information.

7.5.5.5 Timetable of important fisheries events

No additional information.

7.5.5.6 Fish Predation Surveys

No additional information.

7.5.5.6.1 Introduction

No additional information.

7.5.5.6.2 Methodology

No additional information.

7.5.5.6.3 Results

No additional information.

7.5.6 Birds

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.

NB

The full data set is presented in Appendix EIS(A) 7.1 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. The following information therefore supersedes that included in sections 7.5.6.1 to 7.5.6.3 of the 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-W*e*BS 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.

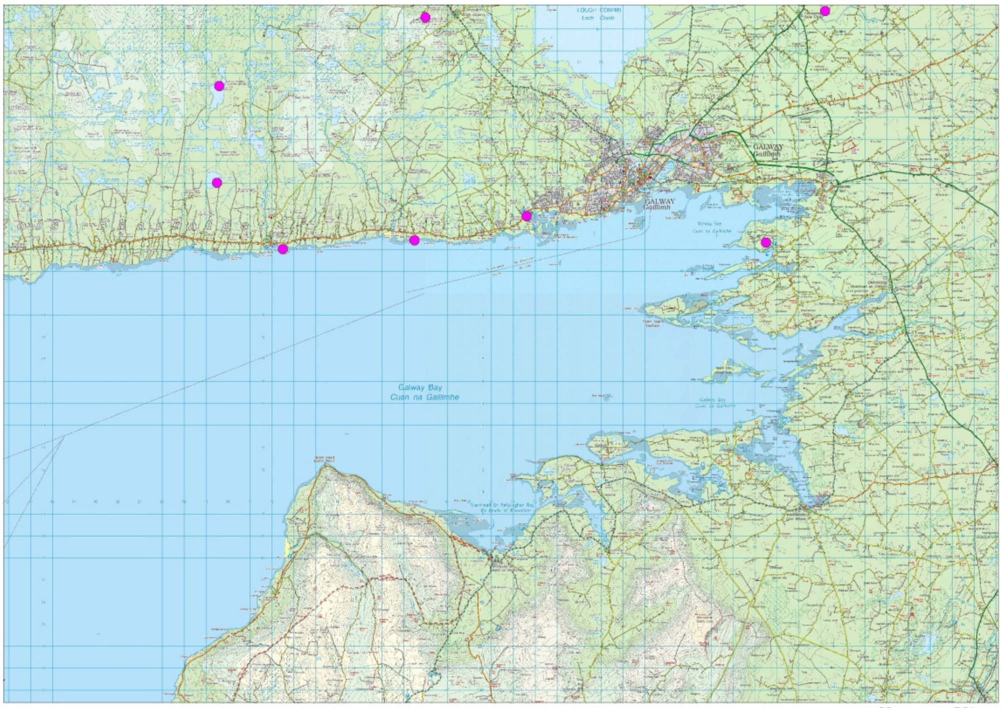
Grey Heron feed along the coastline, including in shallow water. They are thus very vulnerable to oil spills that can oil the birds and kill/contaminate prey.

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 7.5.6.1. below.



Heronry Sites

Fig. 7.5.6.1 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).

[1] The distance flown in response to disturbance

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 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-W*e*BS/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.

7.5.7 Mammals

7.5.7.1 Desk Study

No additional information.

7.5.7.1.1 Otter Records

No additional information.

7.5.7.1.2 Seal Records

A more robust and comprehensive desktop analysis with regard to Harbour Seal was completed by Kelp Marine Research. A full copy of their report is included as Appendix 2.2 to this document.

Aquatic Habitat use of the Harbour Seal (Phoca vitulina)

7.5.7.1.2.1 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.

7.5.7.1.2.2 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).

7.5.7.1.2.3 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 an 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 during 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).

7.5.7.1.2.4 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).

7.5.7.1.2.5 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).

7.5.7.1.2.6 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 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 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 $\mu Pa^2 Hz^{-1}$ 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. The impact assessment model predicted based on the spatial overlap of received sound levels and seal distribution, in combination with estimates of the impacts of noise exposure, potentially predicts a 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.

7.5.7.1.2.7 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.

7.5.7.1.3 <u>Cetacean Records</u>

Three other species occur in Inner Galway Bay and these are Bottle nosed Dolphin, Grey Seal and Harbour Porpoise, the latter being present on almost a daily basis.

A comprehensive risk assessment specific to cetacean species occurring within the operational area of the proposed development was undertaken by Kelp Marine Research. A full copy of their report is included as Appendix 2.2 (Kelp Report) to this document. This risk assessment was completed in line with the Department of Arts Heritage and the Gaeltacht Guidance to Manage the Risk to Marine Mammals from Man-made Sound Sources in Irish Waters (January 2014).

7.5.7.2 Mammal Surveys

7.5.7.2.1 <u>Otter Survey Results</u>

No additional information.

7.5.7.2.2 <u>Seal Survey Results</u>

Seal Counts Methodology, Observations and Results

A full dataset of seal observation records (based on various surveys, some of which were included in the EIS and NIS) has been presented in Appendix 2.5. This data is based on six different surveys, which encompassed different areas and included a variety of methodologies in terms of location and duration of surveys. An outline of the methodologies is provided below.

7.5.7.2.2.1 Observations from Nimmo's Pier

Aquafact observation information was originally provided as Figure 7.5.29 in the EIS document, but has been updated with data since the submission of the EIS and planning application. This survey included observations of seal numbers from Nimmo's Pier. Observations were made with x10 binoculars from the end of Nimmo's Pier with broad scale sweeps from the Dock Gates around to Mutton Island. Observation periods were of 10 – 15 minutes duration, within varying weather and tidal conditions. 147 surveys of this nature have been completed to date. A maximum number of 50 seals was observed during the winter of 2010/11, which was associated with a shoal of sprat within the area. Outside that time, the maximum count was six individuals.

7.5.7.2.2.2 Marine Mammal Observer Records

As part of site investigation works in 2012, a marine mammal observer completed observations of the marine area within the development site. Eight days of surveys averaging over 10 hours each were completed, in good visibility and weather conditions. No marine mammals were present before operations began but a number of observations were made during the works. A maximum number of three seals were observed.

7.5.7.2.2.3 Observations from Mutton Island Lighthouse

From June 2011 until May 2012, Chris Peppiatt undertook twelve monthly 100-minute cetacean and marine mammal watches over the site of the proposed development. The vantage point used was the top of the Mutton Island Lighthouse. The optical equipment used was an 8.5x magnification Swarovski binoculars with 42mm objective lenses and a tripod-mounted Swarovski telescope with a 20-60 x zoom eyepiece lens and an 80mm objective lens. Only one individual common seal was observed on two occasions during the 12 month count.

7.5.7.2.2.4 Observations from Current Harbour Park

In addition, monthly observations from a vantage point above the foreshore of the current harbour park (i.e. from the area from which the reclamation of land out into the current harbour area is proposed) at E130500 N24595 were also undertaken by Chris Peppiatt. The survey area consisted of the shoreline of the current harbour park (i.e. from Rinmore Point to just to the West of Renmore Beach), including all of the intertidal area that is exposed at low tide and the marine area from this shoreline out as far as the end of Mutton Island and bounded by Mutton Island in the west and Hare Ireland in the east. The survey included observations of known seal haul out locations at Renmore Barracks and Rabbit island which were visible from the vantage point. This marine area within the survey was approx. 2.5km^2 in extent at high tide. Initially watches lasted three hours, but in 2012 these were later extended to eight hours (effectively covering the whole day). All states of the tide were covered. Watches were carried out in acceptable visibility conditions (minimum 2km) and when the sea conditions were no worse than Sea State 4 (in most cases, sea state 2 or better). The optical equipment used was 8.5x magnification Swarovski binoculars and a tripod-mounted Swarovski telescope with a 20-60 zoom lens. The maximum count recorded in the water were five individuals, with an average of 1.07 recorded over the 228 hours of surveying. A maximum of five individuals were recorded hauled out at Renmore site during these surveys, with 14 individuals the maximum hauled out at Rabbit Island.

7.5.7.2.2.5 Observations from Seal Haul Out Locations Surveys

Twelve monthly surveys of known seal haul out sites in the area around the site of the proposed development were conducted in 2011-2012. Haul out site surveys were conducted over the four-hour period lasting from two hours before low tide until two hours after low tide. The surveys were completed by Chris Peppiatt using 8.5x magnification Swarovski binoculars and a tripod-mounted Swarovski telescope with a 20-60 x zoom lens. The haul out sites covered during this survey work were situated along the coastline of inner Galway Bay from the vicinity of the site of the proposed development eastwards and then south as far as known haul-out sites in Kinvara Bay and at Deer Island. Some sites were observed from the shoreline, while for others (e.g. Deer Island, Earl's Rock/St. Brendan's Island and the seaward side of Hare Island) observations were made from a rigid inflatable boat. The haul out survey work gave counts of between 31 and 169 common seal at or close to the eleven haul out sites between Renmore and Deer Island. There was some variation, although the numbers were higher in the months before and after the birth of pups (June/July), with the lowest counts being made in the December-March period. On the 14th of July 2011, pups were recorded at the breeding sites in Oranmore Bay (8), Kinvara Bay (17) and Deer Island (6).

7.5.7.2.2.6 Observations from Lough Atalia Surveys

Between November 2011 and May 2012, 25 visits were made specifically to Lough Atalia to conduct surveys for seals. The survey method included general observation using binoculars and a scope from four locations along Lough Atalia Road and at the mouth of Lough Atalia, to encompass possible haul out areas and ensure full visibility of the lagoon. Approximately ten minutes observation was spent at each location, in all states of the tide. A maximum of two seals were observed hauled out and a maximum of one seal was observed in the water at any time. Seals were recorded on ten occasions out of 28 overall visits to the Lough Atalia area (note that 28 visits includes three additional records from Chris Peppiatt based on bird count visits and a specific seal haul out survey record).

7.5.7.2.2.7 Survey Information Summary

The survey data demonstrates that Common Seal are often seen at the mouth of the River Corrib, close to Nimmo's Pier, use Lough Atalia as an occasional haul out and can generally be said to be a common sight all around Galway Bay. There are no colonies of seals within the harbour itself and the number of seals using the marine development site area are not extensive, with the exception of an occasion where a shoal of sprat were within the harbour area, the maximum counts were up to six individuals and average counts were very low numbers and single individuals. There are a number of seal haul-outs in the Inner Galway Bay, including a large colony on Tawin Island, although this is not a breeding colony. The closest important site to the proposed development is at Oranmore Bay, which is home to a breeding colony of approximately 30 – 40 seals. Common seal occasionally haul out on Rabbit Island (approximately 2km from the development site).

7.5.7.2.3 <u>Cetacean Survey Results</u>

No additional information.

7.5.7.2.4 <u>Bat Survey Results</u>

No additional information.

7.5.7.3 Species of Conservation Importance within the Site and surrounding Area

No additional information.

7.6 SIGNIFICANCE OF HABITATS AND SPECIES

No additional information.

7.6.1 Significance of Habitats

No additional information

7.6.2 Significance of Flora

No additional information.

7.6.3 Significance of Fauna

No additional information.

7.7 POTENTIAL IMPACTS AND MITIGATION

7.7.1 Do Nothing Impact

No additional information.

7.7.2 Impacts on Designated Sites

No additional information.

7.7.3 Impacts on Terrestrial Communities

7.7.3.1 Impacts on Terrestrial Communities during the Construction Phase

A visit was made to the seaward edge of L. Atalia by Dr. Michelene Sheehy-Skeffington to establish the changes in habitat brought about by the 2013/2014 winter storms. The upper strandline, shingle area and habitat immediately north of this ridge were walked. The report is presented in full in Section 7.4.1.3 of this document. The complex of shingle and strandline vegetation comprise EU Habitats Directive Annex I habitats 1210 Annual vegetation of drift lines and 1220 Perennial vegetation of stony banks.

It was considered that the effects of the construction of the proposed development are likely to only serve to stabilise the structure of the bar, though storm surges may wash over it, thus preventing the establishment of scrub with bramble sycamore and ash – all noted on this ridge.

The shingle now forms a low area of cobbles below High Water Spring Tide (HWST) with strand-line species and the bank behind this is mixed shingle and grassland on soil. This bank would only be breached by a storm surge, but if the wave force is attenuated by the proposed construction, it is less likely to be structurally altered to the extent it was in January 2014. A storm surge may flood the grassland behind the shingle, via the inlet from Lough Atalia or over the shingle, but the sea-water would drain off, such that the lagoonal salt marsh and grassland will not become very saline and the vegetation, already a mosaic of species tolerant of brackish or saline water (lagoonal marsh) is unlikely to alter to a great extent.

With the predicted greater stability as a result of the proposed construction, less storms will reach the shingle and salt marsh area. As shingle is of its nature a naturally unstable habitat, it is likely that the increased stability will alter the vegetation in the area of shingle above the HWST. This includes the shingle moved inland during the January 2014 storms. Shingle that becomes stable eventually becomes colonised with a heath grassland and/or grassland community, with a reduction of the adventive ruderals that benefit from the regular disturbance of the cobbles.

The salt marsh per se is only extensive north of the railway line. This is as mapped in Figure 1 below. Most of this salt marsh comprises upper marsh species, notably the relatively large sea rush that defines the physiognomy of much of the vegetation on the eastern side of L. Atalia. It overlies a deep peat that has fragments of reed suggesting it was a freshwater marsh in the past. Other species present are red fescue and salt marsh rush. This comprises EU Habitats Directive Annex I 1410 Mediterranean salt meadows (*Juncetalia maritimi*).

The only lower marsh present is in depressions, notably at points along the track north of the railway line, but this is very fragmentary. Species such as common salt marsh grass *Puccinellia maritima,* sea plantain, scurvy grass and sea aster are more abundant in these lower, more frequently-inundated areas. This is too fragmentary to be noted as a significant amount of Habitats Directive Annex I 1330 Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*).

7.7.4 Impacts on Marine Communities

7.7.4.1 Impacts on Marine Communities during the Construction Phase – Habitat Loss Permanent Significant Negative Impact

No additional information.

7.7.4.2 Impacts on Marine Communities during the Construction Phase – Habitat Creation Permanent Moderate Positive Impact

No additional information.

7.7.4.3 Impacts on Marine Communities during the Construction Phase – Habitat Loss of Dredge Area

No additional information.

7.7.4.4 Impacts on Marine Communities during the Construction Phase – Physical Damage of Destruction Caused by Underwater Blasting

No additional information.

7.7.4.5 Impacts on Marine communities during the Construction Phase – Physical Damage of Destruction Caused by Pile Driving

No additional information.

7.7.4.6 Impacts on Marine Communities during the Construction Phase – Physical Damage of Destruction Caused by the Noise of Dredging.

No additional information.

7.7.4.7 Impacts on Marine Communities during the construction Phase – Adverse Impacts caused by Shipping

No additional information.

7.7.4.8 Impacts on Marine Communities during the Construction Phase – Adverse Impacts caused by Suspended Solids/Sediment

No additional information.

7.7.4.9 Impacts on Marine Communities as a Result of Potential for Spillages during Construction

No additional information.

7.7.4.10 Impacts on Marine Communities as a result of Use of Concrete during Construction

No additional information.

7.7.4.11 Impacts on Marine Communities during Operation Phase caused by Changed River Flow and Sediment Export

No additional information.

7.7.4.12 Impacts on Marine Communities during Operation Phase due to Changes in Salinity Regime

No additional information.

7.7.4.13 Impacts on Marine Communities during Operation Phase due to Pollution associated with Wastewater from Operations

No additional information.

7.7.4.14 Impacts on Marine Communities during Operation Phase due to Suspended Solids from Reclaimed Land

No additional information.

7.7.4.15 Impacts on Marine Communities during Operation Phase due to Regular Maintenance Dredging

No additional information.

7.7.4.16 Impacts on Marine Communities during Operation Phase due to Potential for Increased Suspension of Bottom Sediemnt caused by Increased Ship Traffic

No additional information.

7.7.4.17 Impacts on Marine Communities during Operation Phase due to Increased Potential for Increased Pollution from Shipping

No additional information.

7.7.4.18 Impacts on Marine Species during Operational Phase due to Increased Potential for Risk of Introduction of Invasive Alien Species by Shipping

No additional information.

7.7.5 Impacts on Lough Atalia/Zone of Potential Influence

No additional information.

7.7.6 Impacts on Fish

No additional information.

7.7.7 Impacts on Birds

A comprehensive desk study and species-specific assessment, based on and including national and international scientific research was undertaken by Dr. Tom Gittings and Dr. Chris Peppiatt. The information is presented as two documents, Species Profiles and Species Assessments (included as Appendix 3.2 and 3.3 of this document) which presents the information comprehensively on a species-by-species basis.

The species assessments outlined below, provide site and species-specific assessments of the potential impacts of the Galway Harbour Extension project on the Special Conservation Interest species (SCI) species of the Inner Galway Bay SPA.

NB

The species assessment information outlined below replaces the impact assessment as provided in Section 7.7.7 of the EIS document submitted for planning. All information presented below should be taken to supersede the impact assessment of likely impacts on bird species in Inner Galway Bay SPA and its special conservation interests as presented previously.

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 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.

7.7.7.1.1 Background information

7.7.7.1.1.1 Areas referred to in this Assessment

The various areas referred to this report are defined in Table 7.1 and are shown in Figure 1 of Appendix 3.3. 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 NIS(A) 3.1 does not map the full extent of the intertidal habitat within the GHE development site.

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.

Table EIS(A) 7.1 Areas referred to in this assessment

7.7.7.1.1.2 Habitat definitions and areas

7.7.7.1.1.2.1 Habitat definitions

The definition of intertidal and subtidal habitat used in this report follows that used in the SPA Conservation Objectives.

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.

7.7.7.1.1.2.2 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).

7.7.7.1.1.2.3 Habitat loss

All figures for permanent habitat loss used in this report are based on Table 3.13 of the original NIS, now included as Table 7.12 of this EIS Addendum. 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 EIS(A) 7.12). 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>
<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>

Table EIS(A) 7.2 Permanent habitat loss in relation to tidal zones used in the NIS and by NPWS

7.7.7.1.1.3 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. The associated raw data information is presented as Appendix 2.7.

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.

7.7.7.1.1.4 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 of Appendix EIS(A) 3.3. 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.

7.7.7.1.1.5 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, as well as the descriptions in the species profiles that were informed by the local knowledge of the author (Chris Peppiatt).

7.7.7.1.2 <u>Impact assessment methodology</u>

7.7.7.1.2.1 Habitat loss and degradation (non-breeding populations)

7.7.7.1.2.1.1 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.

7.7.7.1.2.1.2 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.

7.7.7.1.2.1.3 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, use BWS/I-WeBS data to provide both the numerator and the denominator..

As a simple assessment measure, we used the mean proportion of the SPA count (see Section 7.7.7.1.1.5 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, 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.

7.7.7.1.2.1.4 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 of appendix EIS(A) 3.3. 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 of Apendix EIS(A) 3.3) . 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 7.10), 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.

7.7.7.1.2.1.5 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 of Appendix EIS(A) 3.3.

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,

[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.

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.
- 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.

7.7.7.1.2.2 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.

7.7.7.1.2.3 Disturbance impacts

7.7.7.1.2.3.1 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.

7.7.7.1.2.3.2 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 of Appendix EIS(A) 3.3 to provide a general context for the specific discussion of EDs in this report.

7.7.7.1.2.4 In-combination effects

7.7.7.1.2.4.1 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.

7.7.7.1.2.4.2 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.

7.7.7.1.2.4.3 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.

7.7.7.1.3 Impact assessment

7.7.7.1.3.1 Habitat loss and degradation (non-breeding populations)

7.7.7.1.3.1.1 Impact magnitude

The predicted displacement due to habitat loss assessed on its own is shown in Table EIS(A) 7.3, 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 EIS(A) 7.4. Alternative displacement estimates for the three species dependent on subtidal habitat are presented in Table EIS(A) 7.5. 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 7.7.7.1.1.3). 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).

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%

Table EIS(A) 7.3 Predicted displacement due to habitat loss

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.

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%

Table EIS(A) 7.4 Predicted displacement due to habitat loss and habitat degradation (worst-case scenario)

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%).

Species	Method	Predicted occurrence: GHE count area	GHE site	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%

Table EIS(A) 7.5 Alternative displacement predictions for the main subtidal species

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.

7.7.7.1.3.1.2 Species sensitivities

Population trends

The population trend data is summarised in Table NIS(A) 3.8. 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.

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		

Table EIS(A) 7.6 Population trend data for the Inner Galway Bay SCI species included in this assessment

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 of Appendix EIS(A) 3.3. 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 EIS(A) 7.7. 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.

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%

Table EIS(A) 7.7 Predicted increase in overall densities of selected SCI species due to displacement

Displacement figures are from Table EIS(A) 7.4 (Grey Heron, Curlew and Redshank) and **Error! Reference source not found.** (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 EIS(A) 7.8..

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

Table EIS(A) 7.8 Factors affecting sensitivity to displacement impacts

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.

7.7.7.1.3.1.3 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 under-utilised 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 7.7.7.1.3.1.1), 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.

7.7.7.1.3.2 Habitat loss and degradation (breeding populations)

7.7.7.1.3.2.1 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 7.7.7.1.3.1.3), 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.

7.7.7.1.3.2.2 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

[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.

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.

7.7.7.1.3.2.3 Common Tern

Breeding colonies

Breeding Common Terns have been recorded at a number of different sites in Inner Galway Bay (EIS(A) 7.9). 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.

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

Table EIS(A) 7.9 Common Tern colonies in Inner Galway Bay

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 of Appendix EIS(A) 3.3) 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 (NIS(A) 3.1). 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.

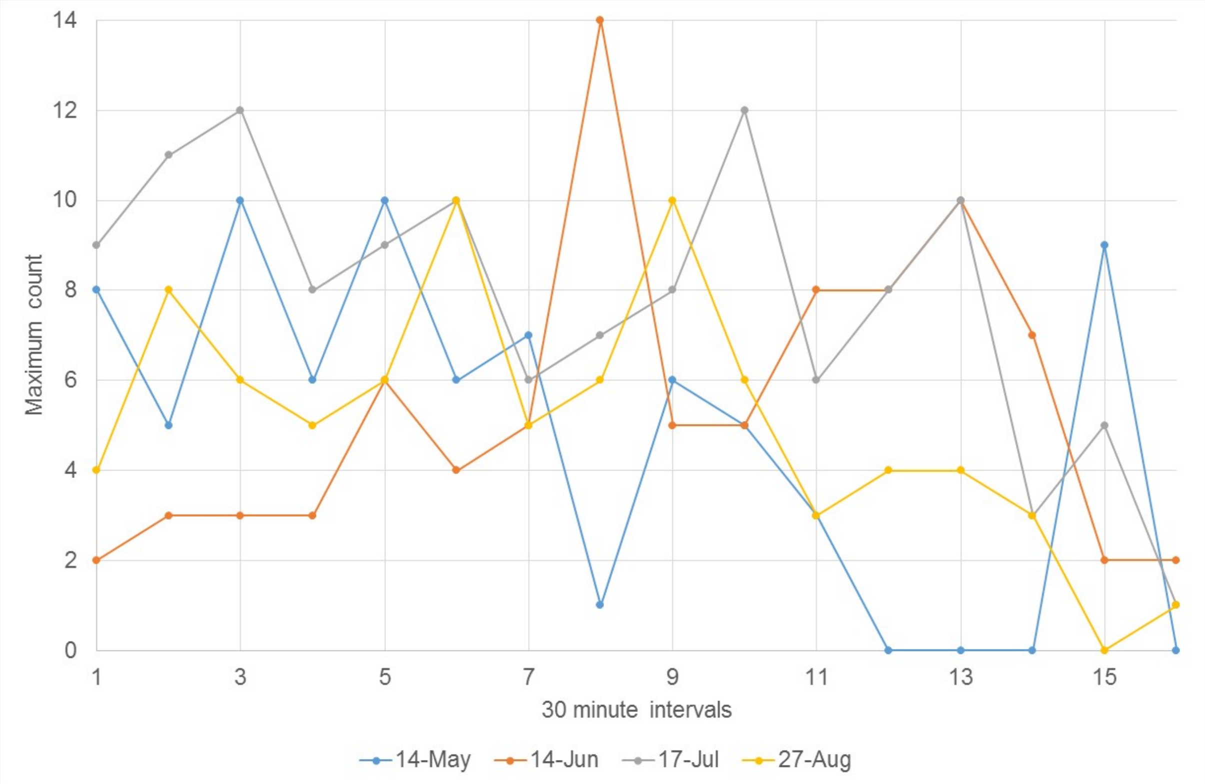


Figure EIS(A) 7.1 Half-hourly maximum counts of Common Terns in the GHE count area, May-August 2014

7.7.7.1.3.2.4 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.

7.7.7.1.3.3 Disturbance (non-breeding populations)

7.7.7.1.3.3.1 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. 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 7.7.7.1.3.1.1.

The occurrence of the intertidal/shallow subtidal species in Nimmo's Pier-South Park Shore and Renmore Beach is summarised in Table EIS(A) 7.10. 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.

Species	Nimmo's Pier-South Park Shore				Renmore Beach			
	mean	SD	non-zero counts	% of I-WeBS	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%

Table EIS(A) 7.10 Count data for intertidal/shallow subtidal species in Nimmo's Pier-South Park Shore and Renmore Beach

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.

7.7.7.1.3.3.2 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).

7.7.7.1.3.3.3 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

<u>Displacement</u>

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 EIS(A) 7.11). 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 EIS(A) 7.6) 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 (EIS(A) Table 7.8) 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 7.7.7.1.3.1.2), and is also relatively tolerant of disturbance (Section 7.7.7.1.3.3.4). Therefore, it is unlikely that displacement due to construction disturbance could cause a non-negligible increase in mortality rates.

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%

Table EIS(A) 7.11 Predicted increase in overall densities of subtidal SCI species due to worst-case scenario of displacement by construction disturbance

Displacement figures are the mean count in the GHE count area.

<u>Energetic impacts</u>

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.

<u>Disturbance to high tide roosts</u>

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.

7.7.7.1.3.3.4 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 of Appendix EIS(A) 3.3). 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 of Appendix EIS(A) 3.3). 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 of Appendx 3 of Appendix EIS(A) 3.3).

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.

7.7.7.1.3.3.4.1 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 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.

7.7.7.1.3.4 Disturbance (breeding populations)

7.7.7.1.3.4.1 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 7.7.7.1.3.3, 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).

7.7.7.1.3.4.2 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.

7.7.7.1.3.4.3 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.

7.7.7.1.4 Other impacts

7.7.7.1.4.1 Blasting

There is a potential risk to the species using moderately deep and deep subtidal habitats of physical impacts during blasting.

7.7.7.1.4.1.1 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.

7.7.7.1.4.1.2 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.

7.7.7.1.4.1.3 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.

7.7.7.1.4.2 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.

7.7.7.1.4.3 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 against any such spillage as much as is possible.

7.7.8 Impacts on Mammals

Impacts on Marine Mammals were considered within a risk assessment completed by Kelp Marine Research (included as Appendix X) which was based on scientific literature and reports. The risk assessment was completed in line with the Department of Arts Heritage and the Gaeltacht Guidance to Manage the Risk to Marine Mammals from Man-made Sound Sources in Irish Waters (January 2014). Impacts as a result of the construction process, including dredging, pile driving and general construction were considered, in addition to impacts from shipping noise, collision and secondary impacts. The summary table of impacts with regard to marine mammals is presented in Table EIS(A) 7.12 below.

TableEIS(A) 7.12. ***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

In addition to those previously proposed, mitigation measures as per Kelp Marine Research report (Appendix EIS(A) 2.2) will be undertaken. These include:

- 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.

7.7.9 Additional Monitoring

7.7.9.1 Biological

No additional information.

7.7.9.1.1 Intertidal benthos

No additional information.

7.7.9.1.2 Subtidal benthos

No additional information.

7.7.9.1.3 Salmon smolts

No additional information.

7.7.9.1.4 Marine Mammals

Monitoring as per Kelp Marine Research report (Appendix EIS(A) 2.2) will be undertaken. This includes

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.

7.7.9.1.5 Birds

No additional information.

7.7.10 In Combination Effects of the Project

7.7.10.1 Plans, Directives and Regional/National Projects

No additional information.

7.7.10.2 Water Frame Work Directive

No additional information.

7.7.10.3 Marine Strategy Framework Directive (MSFD)

No additional information.

7.7.10.3.1 Aquaculture

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.

7.7.10.3.2 Harbour Flights

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.

7.7.10.3.3 Changed Galway Coastline

No additional information.

7.7.10.3.4 Ocean Energy Test Site, east of Spiddal

No additional information.

7.7.10.3.5 Terrea pontoon

No additional information.

7.7.10.3.6 Conclusion of In Combination Effects

The paragraph within the original EIS is replaced with the following:

Having considered other plans and projects within the vicinity of the relevant Natura 2000 sites, it is regarded that the proposed project and implementation of effective mitigation measures to avoid impacts does not have the potential for further in-combination impacts arising in combination with any other plans and projects, with the exception of potential in-combination effects with Aquaculture licences. 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. Therefore significant impacts on the conservation objectives and integrity of the Inner Galway Bay SPA cannot be ruled out.

7.7.10.3.7 Assessment of Residual Impacts

No additional information.

7.7.11 Attributes and Targets to provide for Fabourable Conservation Condition of Relevant Annex I Habitats and Annex II Species

Table 7.7.12 of the EIS included a Summary of Impacts. However, the intertidal/subtidal boundary used for the derivation of these figures was based upon the extent of the intertidal zone shown in the Admiralty Chart, with a few modifications. Figures for habitat loss from Table 7.7.12 of the NIS have been adjusted (with an updated Table EIS(A) 7.13 presented below) 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 from the figure for intertidal habitat loss given in Table 7.7.12 of the EIS, and adding this area to the figure for subtidal habitat loss given in Table 7.7.12 of the EIS. 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.

Summary Table of Impacts on Annex II Habitats, cSAC QIs and SCI Species								
Habitat Type		Galway Harbour Enterprise Park	New Development					
			Construction Stage			Operations	
			Permanent Loss	Temporary Loss	Permanent Gain	Temporary Loss	Permanent Gain
****		A	B	C	D	E	F
1	Stony Banks	0.28 ha	0.35ha *	None	None	None	None
2	Salt Marsh (incl Transitional)	7.39 ha	None*	None	None	None	None
3	Scirpus Maritimus	0.30 ha	None	None	None	None	None
4	Terrestrial	7.97 ha	None	None	None	None	None
5	Subtidal	None	***24.8 ha***	***51.8 ha****	None	50.44 ha***	None
6	Intertidal	8.58 ha	***2.1 ha***	***0 ha****	1.69 ha	1.34 ha***	None
7	Otter	5.52 ha	4.21 ha	2.04 ha	16.04 ha	None	None
8	Seal	8.58 ha	26.93 ha	51.78 ha**	None	51.78 ha***	None
9	Salmon	8.58 ha	26.93 ha	51.78 ha**	None	51.78 ha***	None
10	Lamprey	8.58 ha	26.93 ha	51.78 ha**	None	51.78 ha***	None
11	All SCI species	8.58 ha	26.93 ha	51.78 ha**	None	51.78 ha***	Possible

Table EIS(A) 7.13 – Summary Table of Impacts on Annex II Habitats, cSACs, QIs & SCI Species

Notes:

** Even though there is no direct loss of area of these 2 habitats, it is uncertain as to what the long term effect of the development will be on them. For this reason, the impact is considered indeterminate.*

*** This denotes temporary loss of seabed during capital dredging of approach channels and turning circle*

**** This denotes temporary loss of seabed during maintenance dredging of approach channels and turning circle (which is estimated to be every 10 years).*

*****Cell references applied to identify source of areas of impact noted in Tables 7.14 to 7.26.*

On the basis of these amended areas, the additional raw data and more detailed impact assessments as presented in this EIS Addendum, Tables 7.14 to 7.26 have been updated to reflect this information. Where no changes are proposed, this has been stated within the abbreviated table. The information presented below therefore supersedes information presented in the NIS document previously submitted.

Attributes and Targets to Provide for Favourable conservation Condition of Relevant Qualifying Interests of cSACs		
Attributes	**Targets**	**Comment on Potential Impact on Attribute/Target**
Annex I Habitat	**Mudflats and sandflats not covered by seawater at low tide [1140]** and reefs [1170]**** **NPWS describes the intertidal community at the proposed development site as "fucoid-dominated intertidal reef complex", these two habitats are considered together.	
	Attribute: Distribution **Target:** The distribution of reefs is stable or increasing, subject to natural processes.	Permanent loss of *ca 2.1*ha (see 6B of table 3.13) of this habitat.
	Attribute: Habitat Area **Target:** The permanent habitat area is stable or increasing, subject to natural processes. The mud/sandflat habitat area was estimated using OSI data as 744ha. The reef habitat area was estimated as 2,773ha using survey data.	Permanent loss of *ca 2.1*ha of this habitat.
	Attribute: Community Distribution **Target:** Conserve the following community types in a natural condition: intertidal sandy mud community complex and intertidal sand community complex	Permanent loss of *ca 2.1*ha of this habitat.
	Attribute: Community Extent **Target:** Maintain the extent of the *Mytilus*-dominated reef community, subject to natural processes.	*Permanent loss of ca 2.1*ha *of this habitat.*
	Attribute: Community Structure: *Mytilus* density **Target:** Conserve the high quality of the *Mytilus*-dominated community, subject to natural processes.	Permanent loss of *ca 2.1*ha of this habitat.
	Attribute: Community Structure **Target:** Conserve the following community types in a natural condition: fucoid-dominated community complex, *Laminaria*-dominated community complex, and shallow sponge-dominated community complex.	Permanent loss of *ca 2.1*ha of this habitat.

Impacts during Construction Phase	Permanent loss of intertidal plant and animal communities due to infilling in the construction site. Suspended sediment levels will temporarily increase around the construction site; this will have a minimal impact on the neighboring intertidal communities. There is the potential for contamination of the nearby intertidal area if spillages occur during the construction phase; however, strict adherence to the Environmental Management Plan will minimise the impact.
Impacts during Operational Phase	The changes to the physical oceanography of the area will result in a change in grain size distribution and therefore faunal communities present; however, model predictions show these changes will only occur in the dredge site and approach channel and these are too far from the intertidal areas to have an impact. The predicted increase in traffic levels will have no impact on the intertidal areas. The intertidal communities to the east of the proposed development will experience increases in salinity and as a result euryhaline species will dominate in these areas. There will be no discharges from the development into the marine environment and therefore there will be no impact from this activity.
In Combination Effects	Permanent loss of 10.68ha (6A+6B of table 3.14)
Proposed Mitigation	There are no specific mitigation measures available to reduce the loss of habitat.
Level of Residual Impact	The permanent loss of 2.1ha (6A of table 3.14) of this Annex I habitat equates to a residual negative impact on one of the targets and attributes of the qualifying interest of the Galway Bay Complex cSAC. This is considered to be a negative impact on one of the conservation objectives of the Natura 2000 site. The level of residual impact is not considered to be significant as the habitats present are of poor quality; but on the basis of the precautionary principal, the level of effect is indeterminate and must therefore be considered significant.

Table EIS(A) 7.14 Attributes and Targets to provide for Favourable Conservation Condition of Relevant Qualifying Interests of cSACs

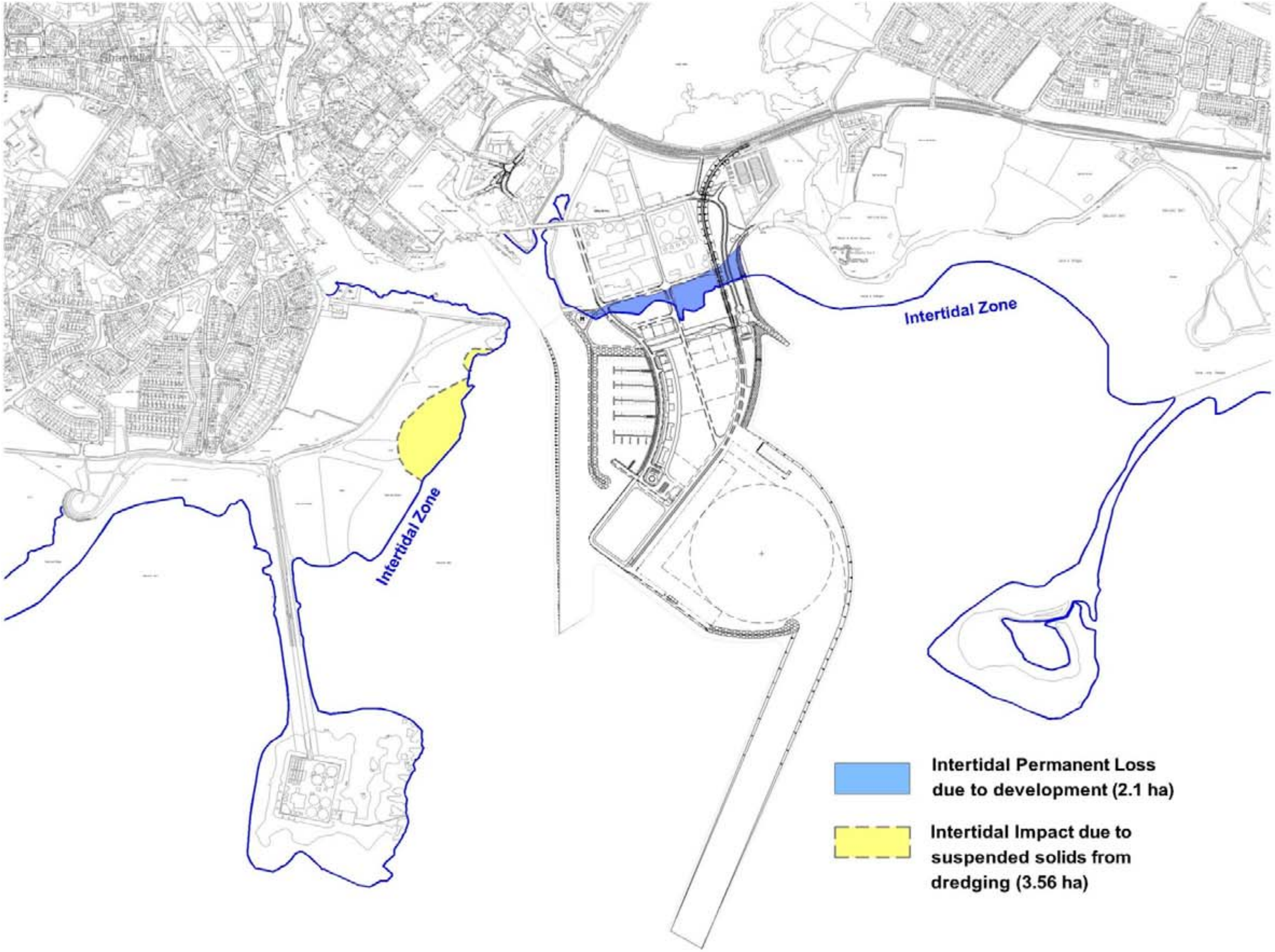


Figure EIS(A) 7.2 Map showing intertidal areas

Attributes and Targets to Provide for Favourable conservation Condition of Relevant Qualifying Interests of cSACs		
Attributes	**Targets**	**Comment on Potential Impact on Attribute/Target**
Annex I Habitat	. **Coastal lagoons* [1150]**	
	Attribute: Habitat Area **Target:** Area stable subject to slight natural variation.	There will be no impact on the area of Lough Atalia and Renmore Lough.
	Attribute: Habitat distribution **Target:** No decline subject to natural processes.	There will be no impact on the area of Lough Atalia and Renmore Lough.
	Attribute: Salinity regime **Target:** Median annual salinity and temporal variation within natural ranges. The lagoons in the site vary from oligohaline to euhaline. Lough Atalia and Renmore Lough are poikilohaline systems	Fluctuations on the existing variability possible though deemed not to have any impact on the functioning of the ecosystem.
	Attribute: Hydrological regime **Target:** Annual water level fluctuations and minima within natural ranges. Most of the lagoons listed for the site are considered to be shallow; however, Aughinish and Lough Atalia do have deeper (at least 3m) parts.	Water levels will be maintained and will not be altered by the development.
	Attribute: Barrier **Target:** Permeability of barrier maintained. Appropriate hydrological connections between lagoons and sea, including where necessary, appropriate management. The lagoons within this site exhibit a variety of barrier types including cobble/shingle, karst and artificial embankment/causeway. Several are recorded as having sluices.	There will be no impact on the barrier/silll.

Table EIS(A) 7.15 Attributes and Targets to provide for Favourable Conservation Condition of Relevant Qualifying Interests of cSACs

Attributes and Targets to Provide for Favourable conservation Condition of Relevant Qualifying Interests of cSACs		
Attributes	**Targets**	**Comment on Potential Impact on Attribute/Target**
Annex I Habitat	. **Coastal lagoons* [1150]**	
Level of Residual Impact	No change to previous conclusion: Fluctuations on the existing variability possible though deemed not to have any impact on the functioning of the ecosystem.	

Table EIS(A) 7.16 Attributes and Targets to provide for Favourable Conservation Condition of Relevant Qualifying Interests of cSACs

Attributes and Targets to Provide for Favourable conservation Condition of Relevant Qualifying Interests of cSACs		
Attributes	**Targets**	**Comment on Potential Impact on Attribute/Target**
Annex I Habitat	**Large shallow inlets and bays [1160]**	
Level of Residual Impact	No change to previous conclusion: The level of impact of sediment settling out is very low. The level of residual impact is not considered to be significant on this habitat.	

Table EIS(A) 7.17 Attributes and Targets to provide for Favourable Conservation Condition of Relevant Qualifying Interests of cSACs

Attributes and Targets to Provide for Favourable conservation Condition of Relevant Qualifying Interests of cSACs		
Attributes	**Targets**	**Comment on Potential Impact on Attribute/Target**
Annex I Habitat	**Perennial vegetation of stony banks [1220] and Annual vegetation of drift lines (Natura 2000 Code 1210)**	
	Attribute: Habitat Area **Target:** Area stable or increasing, subject to natural processes, including erosion and succession.	Potential slight impact associated with increased shelter of area. Cannot predict exact level of change.
	Attribute: Habitat Distribution **Target:** No decline or change in habitat distribution subject to natural processes.	Potential slight impact associated with increased shelter of area. Cannot predict exact level of change.
	Attribute: Physical Structure: functionality and sediment supply **Target:** Maintain the natural circulation of sediment and organic matter, without any physical obstructions.	No impact anticipated.

Table EIS(A) 7.18 Attributes and Targets to provide for Favourable Conservation Condition of Relevant Qualifying Interests of cSACs

Attributes and Targets to Provide for Favourable conservation Condition of Relevant Qualifying Interests of cSACs		
Attributes	**Targets**	**Comment on Potential Impact on Attribute/Target**
Annex I Habitat	**Perennial vegetation of stony banks [1220] and Annual vegetation of drift lines (Natura 2000 Code 1210)**	
	Attribute: Vegetation structure: zonation **Target:** Maintain range of coastal habitats including transitional zone, subject to natural processes.	Potential slight impact associated with increased shelter of area. Cannot predict exact level of change.
	Attribute: Vegetation composition: typical species and sub communities **Target:** Maintain the typical vegetated shingle flora including range of subcommunities within the different zones.	Potential slight impact associated with increased shelter of area. Cannot predict exact level of change.
	Attribute: Vegetation composition: negative indicator species **Target:** Negative indicator species (including non-natives) to represent less than 5% cover.	Potential slight impact associated with increased shelter of area. Cannot predict exact level of change.
Impacts during Construction Phase	No loss of, or impact on this habitat is expected during the construction phase.	
Impacts during Operational Phase	***Impacts associated with increased shelter to the habitat following construction of proposed development.***	
In Combination Effects	An assessment of previous works completed at the Galway Harbour Enterprise Park has identified loss of this habitat, of a total extent of *ca* 0.28 ha (1A of table 3.13)	
Proposed Mitigation	Further to mitigation by design, no additional suitable mitigation is considered available.	

Table EIS(A) 7.18 contd/.. Attributes and Targets to provide for Favourable Conservation Condition of Relevant Qualifying Interests of cSACs

Attributes and Targets to Provide for Favourable conservation Condition of Relevant Qualifying Interests of cSACs		
Attributes	Targets	Comment on Potential Impact on Attribute/Target
Annex I Habitat	**Perennial vegetation of stony banks [1220] and Annual vegetation of drift lines (Natura 2000 Code 1210)**	
Level of Residual Impact	***Potential for residual negative impact on the targets and attributes of this habitat, a qualifying interest of the Galway Bay Complex cSAC exist. This is considered to be a negative impact on one of the conservation objectives of the Natura 2000 site. This will arise due to the greater level of protection afforded by the new structure preventing storms and waves surges from accessing the stony bank habitat. Stabilised shingle becomes colonised with a heath grassland and/or grassland community, with a reduction of the adventive ruderals that benefit from the regular disturbance of the cobbles.***	

Table EIS(A) 7.18 contd/.. Attributes and Targets to provide for Favourable Conservation Condition of Relevant Qualifying Interests of cSACs

Attributes and Targets to Provide for Favourable conservation Condition of Relevant Qualifying Interests of cSACs		
Attributes	**Targets**	**Comment on Potential Impact on Attribute/Target**
Annex I Habitat	**Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*) [1330]**	
	Attribute: Habitat Area **Target:** Area increasing, subject to natural processes, including erosion and succession.	No impact anticipated.
	Attribute: Habitat Distribution **Target:** No decline or change in habitat distribution, subject to natural processes.	No impact anticipated.
	Attribute: Physical Structure: sediment supply **Target:** Maintain/restore natural circulation of sediments and organic matter, without any physical obstructions.	No impact anticipated.
	Attribute: Physical Structure: sediment supply **Target:** Maintain/restore natural circulation of sediments and organic matter, without any physical obstructions.	No impact anticipated.
	Attribute: Physical Structure: creeks and pans **Target:** Maintain creek and pan structure subject to natural processes, including erosion and succession.	No impact anticipated.
	Attribute: Physical Structure: flooding regime **Target:** Maintain natural tidal regime.	No impact anticipated.
	Attribute: Vegetation Structure: zonation **Target:** Maintain range of coastal habitat zonations including transitional zones, subject to natural processes, including erosion and succession.	No impact anticipated.

Table EIS(A) 7.19 - Attributes and Targets to provide for Favourable Conservation Condition of Relevant Qualifying Interests of cSACs

Attributes and Targets to Provide for Favourable conservation Condition of Relevant Qualifying Interests of cSACs		
Attributes	**Targets**	**Comment on Potential Impact on Attribute/Target**
Annex I Habitat	**Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*) [1330]**	
	Attribute: Vegetation structure: vegetation height **Target:** Maintain structural variation within sward.	No impact anticipated.
	Attribute: Vegetation structure: vegetation cover. **Target:** Maintain more than 90% area outside creeks vegetated.	No impact anticipated.
	Attribute: Vegetation composition: typical species and sub-communities. **Target:** Maintain range of sub-communities with typical species listed in Saltmarsh Monitoring Project.	No impact anticipated.
	Attribute: Vegetation composition: negative indicator species – *Spartina anglica* **Target:** There is currently no spartina in this cSAC.	No impact anticipated.
Impacts during Construction Phase	No loss of, or impact on this habitat is expected during the construction phase.	
Impacts during Operational Phase	No impacts are expected during the operational phase.	
In Combination Effects	Permanent loss of *ca* 14 ha.	
Proposed Mitigation	There are no specific mitigation measures available to reduce the loss of habitat.	
Level of Residual Impact	The permanent loss of 5.93 ha of this Annex I habitat equates to a residual negative impact on one of the targets and attributes of the qualifying interest of the Galway Bay Complex cSAC. This is considered to be a negative impact on one of the conservation objectives of the Natura 2000 site. The level of residual impact is not considered to be significant as the habitats present are of poor quality; however, a measure of the level of impact is difficult to assess in the context of the overall Natura 2000 site. While it is considered that the effect of this loss is not significant, on the basis of the precautionary principal, the effect must be considered to be indeterminate and therefore significant.	

EIS(A) Table 7.19 cont'd. Attributes and Targets to provide for Favourable Conservation Condition of Relevant Qualifying Interests of cSACs

Attributes and Targets to Provide for Favourable conservation Condition of Relevant Qualifying Interests of cSACs		
Attributes	**Targets**	**Comment on Potential Impact on Attribute/Target**
Annex I Habitat	**Mediterranean salt meadows (*Juncetalia maritimi*) [1410]**	
	Attribute: Habitat Area **Target:** Area stable or increasing, subject to natural processes including erosion and succession.	No impact anticipated.
	Attribute: Habitat Distribution **Target:** No decline, subject to natural processes.	No impact anticipated.
	Attribute: Physical Structure: sediment supply **Target:** Maintain/restore natural circulation of sediments and organic matter, without any physical obstructions.	No impact anticipated.
	Attribute: Physical Structure: Creeks and Pans **Target:** Maintain creek and pan structure, subject to natural processes, including erosion and succession.	No impact anticipated.
	Attribute: Physical Structure: flooding regime **Target:** Maintain natural tidal regime.	No impact anticipated.
	Attribute: Vegetation Structure: zonation **Target:** Maintain range of coastal habitat zonations including transitional zones, subject to natural processes, including erosion and succession.	No impact anticipated.
	Attribute: Vegetation structure: vegetation height **Target:** Maintain structural variation in the sward.	No impact anticipated.

Table EIS(A) 7.20 Attributes and Targets to provide for Favourable Conservation Condition of Relevant Qualifying Interests of cSACs

Attributes and Targets to Provide for Favourable conservation Condition of Relevant Qualifying Interests of cSACs		
Attributes	**Targets**	**Comment on Potential Impact on Attribute/Target**
Annex I Habitat	**Mediterranean salt meadows (*Juncetalia maritimi*) [1410]**	
	Attribute: Vegetation structure: vegetation cover. **Target:** Maintain more than 90% of area outside creeks vegetated.	No impact anticipated.
	Attribute: Vegetation composition: typical species and sub-communities. **Target:** Maintain range of sub-communities with typical species listed in Saltmarsh Monitoring Project.	No impact anticipated.
	Attribute: Vegetation composition: negative indicator species – *Spartina anglica* **Target:** No *Spartina* in the SAC at present.	No impact anticipated.
Impacts during Construction Phase	No loss of, or impact on this habitat is expected during the construction phase.	
Impacts during Operational Phase	No impacts are expected during the operational phase.	
In Combination Effects	An assessment of previous works completed at the Galway Harbour Enterprise Park has identified loss of Salt Marsh habitat, of a total extent of *ca* 7.69ha (2A+3A of table 3.14) - mosaic of Atlantic and Mediterranean Salt Meadows habitats).	
Proposed Mitigation	Further to mitigation by design, no additional suitable mitigation is considered available.	
Level of Residual Impact	The permanent historic loss of *ca* 7.69 ha (2A+3A of table 3.14) of this Annex I habitat equates to a residual negative impact on one of the targets and attributes of the qualifying interest of the Galway Bay Complex cSAC. This is considered to be a negative impact on one of the conservation objectives of the Natura 2000 site. The level of residual impact is not considered to be significant as the habitats present are of poor quality, however, a measure of the level of impact is difficult to assess in the context of the overall Natura 2000 site. While it is considered that the effect of this loss is not significant, on the basis of the precautionary principle, the effect must be considered to be indeterminate and therefore significant.	

Table EIS(A) 7.21 Attributes and Targets to provide for Favourable Conservation Condition of Relevant Qualifying Interests of cSACs

Annex II Species Tables

Attributes and Targets to Provide for Favourable conservation Condition of Relevant Qualifying Interests of cSACs		
Attributes	**Targets**	**Comment on Potential Impact on Attribute/Target**
Annexed Species		
Annex II Species	**Otter (*Lutra lutra*) [1355]**	
	Attribute: Distribution **Target:** No significant decline	Standard Otter survey technique normally applied to riverine rather than purely marine sites. Current range in Western RBD estimated at 70% (Bailey and Rochford 2006). No decline in overall distribution expected.
	Attribute: Extent of terrestrial habitat **Target:** No significant decline	Area mapped to include 10 metre buffer above HWM on shoreline. HWM on shoreline is against the rock wall of the existing harbour park. Since the land above this rock wall is open dry spoil and bare ground (ED2), this terrestrial habitat is of low potential for Otter. 0.58 ha will be lost . A further 0.67 ha will be created by the new land reclamation area. Thus, the development will result in an increase in the total area of the type of terrestrial habitat that is currently available to Otter in the harbour park phase I.
	Attribute: Extent of marine habitat **Target:** No significant decline	Area mapped based on evidence that Otter tend to forage within 80 m of shoreline (HWM). 4.21 ha will be lost table 3.14). A further 16.04 hectares (table 3.14) will be created adjacent to new land reclamation area. Thus, the development will result in an increase in the total area of the type of marine habitat (*i.e.* within 80 m of shoreline) that is currently available to Otter in the harbour park area.
	Attribute: Extent of freshwater (river) habitat **Target:** No significant decline	Proposed development will not affect extent of freshwater habitat.

Table EIS(A) 7.22 Attributes and Targets to provide for Favourable Conservation Condition of Relevant Qualifying Interests of cSACs

<table>
<tr><th colspan="3">Attributes and Targets to Provide for Favourable conservation Condition of Relevant Qualifying Interests of cSACs</th></tr>
<tr><th>Attributes</th><th>Targets</th><th>Comment on Potential Impact on Attribute/Target</th></tr>
<tr><td colspan="3">Annexed Species</td></tr>
<tr><td>Annex II Species</td><td colspan="2">Otter (Lutra lutra) [1355]</td></tr>
<tr><td></td><td>Attribute: Extent of freshwater (lake/lagoon) habitat
Target: No significant decline</td><td>Proposed development will not affect extent of freshwater habitat.</td></tr>
<tr><td></td><td>Attribute: Couching sites and holts
Target: No significant decline</td><td>No known sites/holts will be affected.</td></tr>
<tr><td></td><td>Attribute: Fish biomass available
Target: No significant decline</td><td>Resident freshwater fish, anadromous and catadromous fish are not expected to be affected. No significant effects expected on coastal fish prey species (e.g. rockling and wrasse), except loss of 24.8 ha (5B of table 3.14) of shallow subtidal habitat at development site (excluding 2.1ha of intertidal). This is 0.25% of the total designated subtidal area. Probable minor but indeterminate negative impact.</td></tr>
<tr><td></td><td>Attribute: Barriers to connectivity
Target: No significant increase</td><td>Otter will regularly commute across stretches of open water up to 500m wide. The development will lengthen some potential commuting routes (e.g. from river mouth to Renmore Lough) but no complete barriers will be formed. No significant loss of connectivity.</td></tr>
<tr><td>Impacts during Construction Phase</td><td colspan="2">There will be direct disturbance within 76.6 ha (5B+5C of table 3.14) of subtidal habitat (excluding 2.1ha of intertidal) as a result of the proposed development and disturbance in the wider area around this, although the available area of terrestrial habitat and subtidal foraging area within 80 metres of the shoreline will be increased.
There is potential for physical damage and/or disturbance to be caused to individuals by noise/vibration/shock waves during blasting, dredging and pile driving operations during construction.
There is potential for disturbance to feeding by individuals as a result of suspended solids generated during the construction works. There is also potential for negative impacts due to pollution from work areas during construction.</td></tr>
</table>

Table EIS(A) 7.22 contd/. Attributes and Targets to provide for Favourable Conservation Condition of Relevant Qualifying Interests of cSACs

Attributes and Targets to Provide for Favourable conservation Condition of Relevant Qualifying Interests of cSACs	
Attributes / **Targets**	**Comment on Potential Impact on Attribute/Target**
Annexed Species	
Annex II Species	**Otter (*Lutra lutra*) [1355]**
Impacts during Operational Phase	There will be the loss of 24.8ha (5B of table 3.14) of shallow subtidal habitat at development site (excluding 2.1ha of intertidal), although the available area of terrestrial habitat and subtidal foraging area within 80 metres of the shoreline will be increased. There is potential for physical damage and/or disturbance to be caused to individuals by noise/vibration/shock waves during regular maintenance dredging. There is potential for disturbance to feeding by individuals as a result of suspended solids generated during regular maintenance dredging.
In Combination Effects	An assessment of previous works completed at the Galway Harbour Enterprise Park has identified loss of suitable habitat for Otter of a total extent of 5.52ha.
Proposed Mitigation	Exclusion of drilling, blasting and pile driving during the hours of darkness. Limiting individual sizes of blasting charges. Infill/reclamation area lined with geotextile membrane to minimize impacts from suspended solid run off. Environmental Management Framework including measures on the storage and disposal of oily wastes, maintenance procedures for machinery etc, monitoring of levels of suspended solids and best practice with respect to the pouring of concrete.
Level of Residual Impact	The permanent loss of 24.8ha (5B of table 3.14) of shallow subtidal habitat at development site (excluding 2.1ha of intertidal), and disturbance within an area of a further 51.8ha (5C of table 3.14) of subtidal habitat equates to a residual negative impact on one of the targets and attributes of otter, a qualifying interest of the Galway Bay Complex cSAC and Lough Corrib cSAC. Similarly, a previous historic loss of *ca* 16 ha associated with previous development within the Galway Harbour Enterprise Park has resulted in cumulative impacts associated with the development (Drg. 2139-2118 for Habitat Map of Lands pre 1990). This is considered to be a negative impact on one of the conservation objectives of the Natura 2000 site. The level of residual impact is not considered to be significant, as the habitats present are extensive in the surrounding area and usage of the site by otter was recorded but not extensive, however, a measure of the level of impact is difficult to assess in the context of the overall Natura 2000 site and is therefore considered indeterminate. ***On the basis of the precautionary principal this effect is therefore considered significant.***

Table EIS(A) 7.22 contd/. Attributes and Targets to provide for Favourable Conservation Condition of Relevant Qualifying Interests of cSACs

Attributes and Targets to Provide for Favourable conservation Condition of Relevant Qualifying Interests of cSACs		
Attributes	**Targets**	**Comment on Potential Impact on Attribute/Target**
Annexed Species		
Annex II Species	**Harbour seal (*Phoca vitulina*) [1365]**	
	Attribute: Access to suitable habitat **Target:** Species range within the site should not be restricted by artificial barriers to site use.	The proposed development will alter potential commuting routes for this species in the river mouth area, but the proposed development will not constitute an effective barrier to the movement of this species.
	Attribute: Breeding behaviour **Target:** Conserve breeding sites in a natural condition.	Haul out sites where pups are born will not be affected. Mating occurs in water with male visual and vocal displays (probably lekking) occurring near to haul out sites. These areas will not be affected by the proposed development.
	Attribute: Moulting behaviour **Target:** Conserve moult haul-out sites in a natural condition.	Moult haul-out sites will not be affected by proposed development.
	Attribute: Resting behavior **Target:** Conserve resting haul-out sites in a natural condition.	Resting haul-out sites will not be affected by proposed development.
	Attribute: Disturbance **Target:** Human activities should occur at levels that do not adversely affect the harbour seal population at the site.	Important breeding sites will not be affected by the development. Smaller non-breeding haul-outs are at distance from development footprint. No significant disturbance effects expected post-construction.
	Attribute: Loss of foraging habitat **Target:** No decline, subject to natural processes.	Loss of 26.93 ha (8B of table 3.14) of shallow subtidal habitat and intertidal at development site. This is 0.25% of the total designated subtidal area. Probable minor but indeterminate negative impact.

Table EIS(A) 7.23 Attributes and Targets to provide for Favourable Conservation Condition of Relevant Qualifying Interests of cSACs

Attributes and Targets to Provide for Favourable conservation Condition of Relevant Qualifying Interests of cSACs		
Attributes	**Targets**	**Comment on Potential Impact on Attribute/Target**
Annexed Species		
Annex II Species	**Harbour seal (*Phoca vitulina*) [1365]**	
Impacts during Construction Phase	There will be direct disturbance within 76.6ha (5B+5C of table 3.14) of subtidal habitat (excluding 2.1ha of intertidal habitat) (and disturbance in the wider area around this) as a result of the proposed development. There is potential for physical damage and/or disturbance to be caused to individuals by noise/vibration/shock waves during blasting, dredging and pile driving operations during construction. Research from the U.K. suggests that there is the potential for seals to be killed by ducted propellers if barges etc. with this propeller type are used in the construction works and perform manoeuvres while either static or moving slowly (*i.e.* while still operating the propeller/propellers). Examination of seal corpses found in the U.K. (eastern Scotland, north Norfolk and Strangford Lough) has led researchers (Thompson *et al*., 2010) to believe that the seal had been killed by being drawn through ducted or cowled ship propellers, such as fixed Kort or Rice nozzles, or ducted azimuth thrusters. Indications are that these accidents are unlikely to have happened as a result of casual collisions. The workers have theorised that the seals were killed after being attracted to the vicinity of the propellers, either as a result of concentrations of prey fish close to vessels, or as an inappropriate response to the acoustic output of the propellers. This type of propeller is common in tugs, construction vessels and construction barges and is used when such vessels are either manoeuvring slowly, or trying to maintain position. This situation could occur for long periods during the construction phase. It should be possible to specify that vessels used by contractors are fitted with grilles or guards to prevent seals being pulled through the ducts. However, there is no way of stopping vessels fitted with such propellers from using the port of Galway and (if the mechanism is as the Sea Mammal Research Unit have posited) speed limits would not have any effect on the impact. It is worth stating that: (1) no dead seals with similar injuries have been found in Galway Bay (2) the impact, as suggested by the report, is theoretical in nature and may not actually exist, (3) it is not possible knowing if the port development will lead to an increase in the use of these types of propeller, or if the use of these types of propeller will change over time even if the development does not go ahead. There is potential for disturbance to feeding by individuals as a result of suspended solids generated during the construction works. There is also potential for negative impacts due to pollution from work areas during construction.	

Table EISA 7.23 contd/. Attributes and Targets to provide for Favourable Conservation Condition of Relevant Qualifying Interests of cSACs

<table>
<tr><th colspan="3">Attributes and Targets to Provide for Favourable conservation Condition of Relevant Qualifying Interests of cSACs</th></tr>
<tr><th>Attributes</th><th>Targets</th><th>Comment on Potential Impact on Attribute/Target</th></tr>
<tr><td colspan="3">Annexed Species</td></tr>
<tr><td>Annex II Species</td><td colspan="2">Harbour seal (Phoca vitulina) [1365] contd/..</td></tr>
<tr><td>Impacts during Operational Phase</td><td colspan="2">There will be a loss of 26.93 ha (8B of table 3.14) of potential sub-tidal and intertidal foraging habitat.
There is potential for physical damage and/or disturbance to be caused to individuals by noise/vibration/shock waves during regular maintenance dredging.
There is potential for disturbance to feeding by individuals as a result of suspended solids generated during regular maintenance dredging.
Research from the U.K. suggests that there is the potential for seals to be killed by ducted propellers if the volume of shipping traffic with this propeller type that is either static or moving slowly while still operating propellers is increased as a consequence of the development.</td></tr>
<tr><td>In Combination Effects</td><td colspan="2">An assessment of previous works completed at the Galway Harbour Enterprise Park has identified loss of suitable habitat for Harbour Seal of a total extent of 35.51 ha (8A+8B of table 3.14)</td></tr>
<tr><td>Proposed Mitigation</td><td colspan="2">Blasting, drilling and pile driving will be carried out during daylight hours and at low tide.
This blasting schedule will coincide with the time when the maximum number of seals are hauled out of the water and will thus be less at risk from blasting activities.
The individual sizes of blasting charges will be limited to minimize the size of the area of the zone of potential effect from any individual blast event.
If barges with ducted propellers are used during the construction stage and these are likely to be making the types of manoeuvres mentioned above, the fitting of acoustic deterrent devices (ADDs) to them will be considered or vessels will be fitted with mesh screens at the ends of the ducts to prevent seal entry to ducts.
Infill/reclamation area lined with geotextile membrane to minimize impacts from suspended solid run off.
Environmental Management Plan including measures on the storage and disposal of oily wastes, maintenance procedures for machinery etc, monitoring of levels of suspended solids and best practice with respect to the pouring of concrete.</td></tr>
<tr><td>Level of Residual Impact</td><td colspan="2">Behavioural effects as a response to the construction phase are considered likely to arise, but significant effects will be mitigated by proposed mitigation measures. The permanent loss of 26.93ha (8B of table 3.13) of subtidal and intertidal habitat and disturbance within an area of 76.6ha of subtidal habitat (excluding intertidal) equates to a residual negative impact on one of the targets and attributes of Harbour Seal, a qualifying interest of the Galway Bay Complex cSAC. Similarly, a previous historic loss of 8ha associated with previous development within the Galway Harbour Enterprise Park has resulted in combination effects associated with the development. This is considered to be a negative impact on one of the conservation objectives of the Natura 2000 site. The level of residual impact is not considered to be</td></tr>
</table>

	significant as the habitats present are extensive in the surrounding area and usage of the site by Harbour Seal was recorded but not extensive, however, a measure of the level of impact is difficult to assess in the context of the overall Natura 2000 site and is therefore considered indeterminate. ***On the basis of the precautionary principal this effect is therefore considered significant.***

Table EIS(A) 7.23 contd/. Attributes and Targets to provide for Favourable Conservation Condition of Relevant Qualifying Interests of cSACs

Attributes and Targets to Provide for Favourable conservation Condition of Relevant Qualifying Interests of cSACs		
Attributes	**Targets**	**Comment on Potential Impact on Attribute/Target**
Annexed Species		
Annex II Species	**Salmon (*Salmo salar*) [1106]**	
Impacts during Construction Phase	There will be direct disturbance within 76.6ha (5B+5C of table 3.14) of subtidal habitat (excluding 2.1ha of intertidal habitat) (and disturbance in the wider area around this) as a result of the proposed development. There is potential for physical damage and/or disturbance to be caused to individuals during blasting, dredging and pile driving operations during construction.	
Level of Residual Impact	No change to previous conclusion: No significant residual impact is predicted.	

Table EIS(A) 7.24 Attributes and Targets to provide for Favourable Conservation Condition of Relevant Qualifying Interests of cSACs

Attributes and Targets to Provide for Favourable conservation Condition of Relevant Qualifying Interests of cSACs		
Attributes	Targets	Comment on Potential Impact on Attribute/Target
Annexed Species		
Annex II Species	**Sea lamprey (*Petromyzon marinus*) [1095]**	
Impacts during Construction Phase	There will be direct disturbance within 76.6ha (5B+5C of table 3.14) of subtidal habitat (excluding 2.1ha of intertidal habitat) (and disturbance in the wider area around this) as a result of the proposed development. There is potential for physical damage and/or disturbance to be caused to individuals by noise/vibration/shock waves during blasting, dredging and pile driving operations during construction.	
Level of Residual Impact	No change to previous conclusion: No significant residual impact is predicted.	

Table EIS(A) 7.25 Attributes and Targets to provide for Favourable Conservation Condition of Relevant Qualifying Interests of cSACs

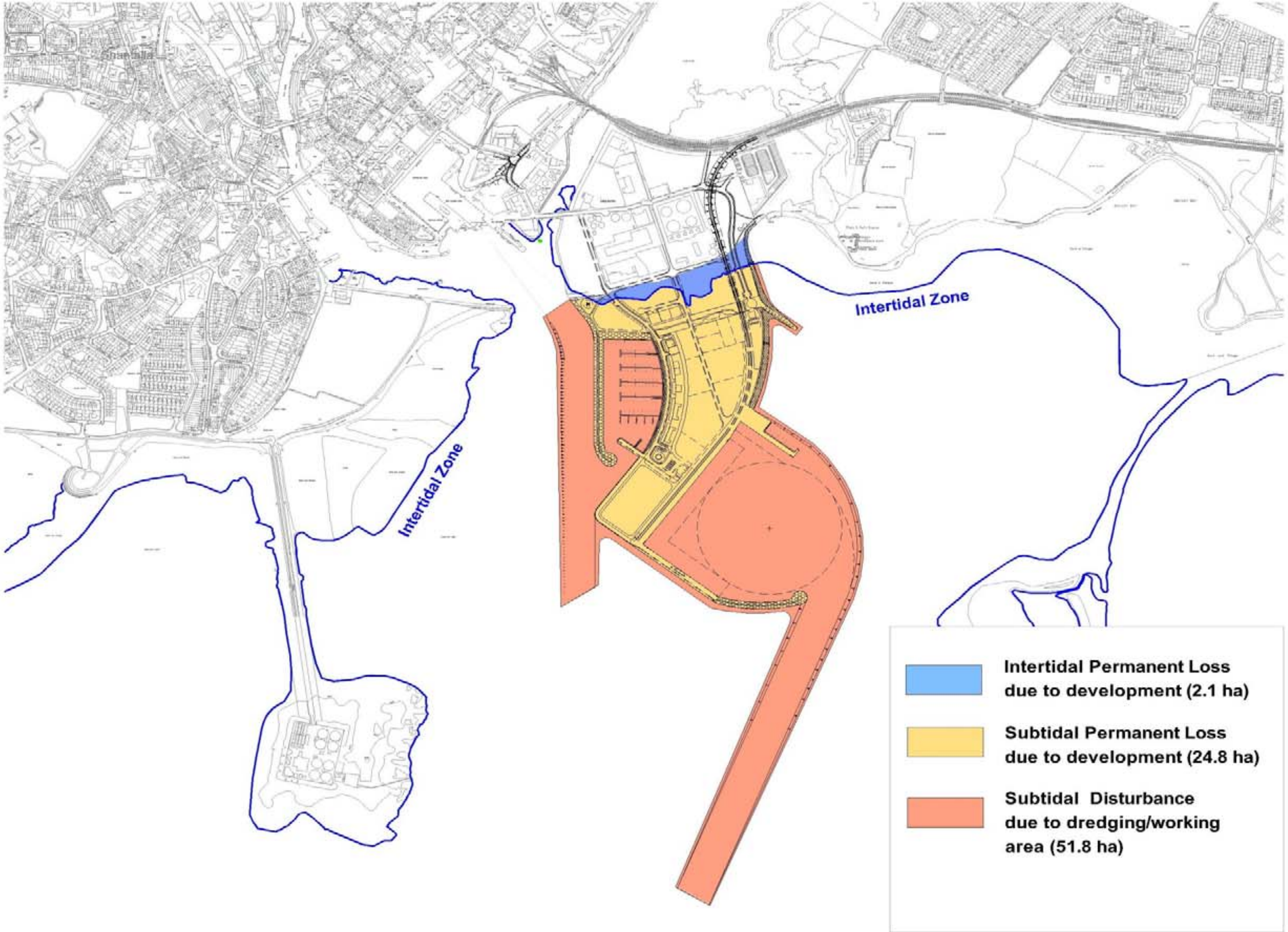


Figure EIS(A) 7.3 Birds, intertidal and subtidal losses

Birds Species Tables

A detailed analysis of the potential impacts on the conservation objectives of the special conservation interests of Inner Galway Bay SPA has been provided in Section 3.3.2.14 above, which has taken into account species species mitigation measures. Table 3.11 has therefore been replaced with the following summary table, which outlines the residual impacts on SCI species likely to result from the proposed development.

Attributes and targets to provide for favourable conservation condition of relevant Special Conservation Interests of SPA	
SCI Species	
Annex I species	**Great Northern Diver (*Gavia immer*) [A003]**
Level of Residual Impact	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 this very minor displacement impact will not cause any population-level consequences. 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. 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. ***Significant impacts on the SCI and conservation objectives of the SPA have therefore been excluded.***

Table EIS(A) 7.26 Attributes and targets to provide for favourable conservation condition of relevant Special Conservation Interests of SPA

Attributes and targets to provide for favourable conservation condition of relevant Special Conservation Interests of SPA	
SCI Species	
	Cormorant (*Phalacrocorax carbo*) [A017]
Level of Residual Impact	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 this very minor displacement impact will not cause any population-level consequences. 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. It is considered reasonable to conclude that this very minor displacement impact will not cause any population-level consequences. 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. 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. 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. ***Significant impacts on the SCI and conservation objectives of the SPA have therefore been excluded.***

Table EIS(A) 7.26 contd/.. Attributes and targets to provide for favourable conservation condition of relevant Special Conservation Interests of SPA

Attributes and targets to provide for favourable conservation condition of relevant Special Conservation Interests of SPA	
SCI Species	
	Grey Heron (*Ardea cinerea*) [A028]
Level of Residual Impact	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. Therefore, it is reasonable to conclude that this very minor displacement impact will not cause any population-level consequences. In addition, any displaced birds would have a high potential ability to use alternative terrestrial habitats in the vicinity of Inner Galway Bay. 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. ***Significant impacts on the SCI and conservation objectives of the SPA have therefore been excluded.***

Table EIS(A) 7.26 contd/.. Attributes and targets to provide for favourable conservation condition of relevant Special Conservation Interests of SPA

Attributes and targets to provide for favourable conservation condition of relevant Special Conservation Interests of SPA	
SCI Species	
	Light-bellied Brent Goose (*Branta bernicla hrota*) [A046]
Level of Residual Impact	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 this very minor displacement impact will not cause any population-level consequences. 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. ***Significant impacts on the SCI and conservation objectives of the SPA have therefore been excluded.***

Table EIS(A) 7.26 contd/.. Attributes and targets to provide for favourable conservation condition of relevant Special Conservation Interests of SPA

Attributes and targets to provide for favourable conservation condition of relevant Special Conservation Interests of SPA	
SCI Species	
	Wigeon (*Anas penelope*) [A050]
Level of Residual Impact	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 under-utilised habitats in the vicinity of Inner Galway Bay. Therefore, it is reasonable to conclude that this very minor displacement impact will not cause any population-level consequences. 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. ***Significant impacts on the SCI and conservation objectives of the SPA have therefore been excluded.***

Table EIS(A) 7.26 contd/.. Attributes and targets to provide for favourable conservation condition of relevant Special Conservation Interests of SPA

Attributes and targets to provide for favourable conservation condition of relevant Special Conservation Interests of SPA	
SCI Species	
	Teal (*Anas crecca*) [A052]
Level of Residual Impact	No significant residual impact is expected.

Table EIS(A) 7.26 contd/.. Attributes and targets to provide for favourable conservation condition of relevant Special Conservation Interests of SPA

Attributes and targets to provide for favourable conservation condition of relevant Special Conservation Interests of SPA	
SCI Species	
	Shoveler (*Anas clypeata*) [A056]
Level of Residual Impact	No significant residual impact is expected.

Table EIS(A) 7.26 contd/.. Attributes and targets to provide for favourable conservation condition of relevant Special Conservation Interests of SPA

Attributes and targets to provide for favourable conservation condition of relevant Special Conservation Interests of SPA	
SCI Species	
	Red-breasted Merganser (*Mergus serrator*) [A069]
Level of Residual Impact	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 this very minor displacement impact will not cause any population-level consequences. 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. 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. ***Significant impacts on the SCI and conservation objectives of the SPA have therefore been excluded.***

Table EIS(A) 7.26 contd/.. Attributes and targets to provide for favourable conservation condition of relevant Special Conservation Interests of SPA

Attributes and targets to provide for favourable conservation condition of relevant Special Conservation Interests of SPA	
SCI Species	
	Ringed Plover (*Charadrius hiaticula*) [A137]
Level of Residual Impact	No significant residual impact is expected.

Table EIS(A) 7.26 contd/.. Attributes and targets to provide for favourable conservation condition of relevant Special Conservation Interests of SPA

Attributes and targets to provide for favourable conservation condition of relevant Special Conservation Interests of SPA	
SCI Species	
Annex I species	**Golden Plover (*Pluvialis apricaria*) [A140]**
Level of Residual Impact	No significant residual impact is expected.

Table EIS(A) 7.26 contd/.. Attributes and targets to provide for favourable conservation condition of relevant Special Conservation Interests of SPA

Attributes and targets to provide for favourable conservation condition of relevant Special Conservation Interests of SPA	
SCI Species	
	Lapwing (*Vanellus vanellus*) [A142]
Level of Residual Impact	No significant residual impact is expected.

Table EIS(A) 7.26 contd/.. Attributes and targets to provide for favourable conservation condition of relevant Special Conservation Interests of SPA

Attributes and targets to provide for favourable conservation condition of relevant Special Conservation Interests of SPA	
SCI Species	
	Dunlin (*Calidris alpina alpina*) [A149]
Level of Residual Impact	No significant residual impact is expected.

Table EIS(A) 7.26 contd/.. Attributes and targets to provide for favourable conservation condition of relevant Special Conservation Interests of SPA

Attributes and targets to provide for favourable conservation condition of relevant Special Conservation Interests of SPA	
SCI Species	
Annex I species	**Bar-tailed Godwit (*Limosa lapponica*) [A157]**
Level of Residual Impact	No significant residual impact is expected.

Table EIS(A) 7.26 contd/.. Attributes and targets to provide for favourable conservation condition of relevant Special Conservation Interests of SPA

Attributes and targets to provide for favourable conservation condition of relevant Special Conservation Interests of SPA	
SCI Species	
	Curlew (*Numenius arquata*) [A160]
Level of Residual Impact	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 this very minor displacement impact will not cause any population-level consequences. 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. ***Significant impacts on the SCI and conservation objectives of the SPA have therefore been excluded.***

Table EIS(A) 7.26 contd/.. Attributes and targets to provide for favourable conservation condition of relevant Special Conservation Interests of SPA

<table>
<tr><th colspan="2">Attributes and targets to provide for favourable conservation condition of relevant Special Conservation Interests of SPA</th></tr>
<tr><td colspan="2">SCI Species</td></tr>
<tr><td></td><td>Redshank (Tringa totanus) [A162]</td></tr>
<tr><td>Level of Residual Impact</td><td>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 this very minor displacement impact will not cause any population-level consequences.

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.

Significant impacts on the SCI and conservation objectives of the SPA have therefore been excluded.</td></tr>
</table>

Table EIS(A) 7.26 contd/.. Attributes and targets to provide for favourable conservation condition of relevant Special Conservation Interests of SPA

Attributes and targets to provide for favourable conservation condition of relevant Special Conservation Interests of SPA	
SCI Species	
	Turnstone (*Arenaria interpres*) [A169]
Level of Residual Impact	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, while it is also possible that Turnstone will be able to use structures within the completed development. Therefore, the actual displacement impact is likely to be very minor and it is reasonable to conclude that this very minor displacement impact will not cause any population-level consequences. 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 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. ***Significant impacts on the SCI and conservation objectives of the SPA have therefore been excluded.***

Table EIS(A) 7.26 contd/.. Attributes and targets to provide for favourable conservation condition of relevant Special Conservation Interests of SPA

Attributes and targets to provide for favourable conservation condition of relevant Special Conservation Interests of SPA	
SCI Species	
	Black-headed Gull (*Chroicocephalus ridibundus*) [A179]
Level of Residual Impact	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 this very minor displacement impact will not cause any population-level consequences. 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. 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. ***Significant impacts on the SCI and conservation objectives of the SPA have therefore been excluded.***

Table EIS(A) 7.26 contd/.. Attributes and targets to provide for favourable conservation condition of relevant Special Conservation Interests of SPA

Attributes and targets to provide for favourable conservation condition of relevant Special Conservation Interests of SPA	
SCI Species	
	Common Gull (*Larus canus*) [A182]
Level of Residual Impact	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 this very minor displacement impact will not cause any population-level consequences. 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. 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. ***Significant impacts on the SCI and conservation objectives of the SPA have therefore been excluded.***

Table EIS(A) 7.26 contd/.. Attributes and targets to provide for favourable conservation condition of relevant Special Conservation Interests of SPA

Attributes and targets to provide for favourable conservation condition of relevant Special Conservation Interests of SPA	
SCI Species	
Annex I species	**Sandwich Tern (*Sterna sandvicensis*) [A191]**
Level of Residual Impact	The Sandwich Tern breeding colony is located at Illaunnaguroge in Corranroo Bay around 12 km from the GHE site. 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. 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. 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. 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. 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, it is highly unlikely that the habitat lost from the development of the GHEP was ever of significant importance to this species. ***Significant impacts on the SCI and conservation objectives of the SPA have therefore been excluded.***

Table EIS(A) 7.26 contd/.. Attributes and targets to provide for favourable conservation condition of relevant Special Conservation Interests of SPA

<table>
<tr><th colspan="2">Attributes and targets to provide for favourable conservation condition of relevant Special Conservation Interests of SPA</th></tr>
<tr><td colspan="2">SCI Species</td></tr>
<tr><td>Annex I species</td><td>Common Tern (Sterna hirundo) [A193]</td></tr>
<tr><td>Level of Residual Impact</td><td>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.

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 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.

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.

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 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.</td></tr>
</table>

	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. 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, it is highly unlikely that the habitat lost from the development of the GHEP was ever of significant importance to this species. 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. ***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.***

Table EIS(A) 7.26 contd/.. Attributes and targets to provide for favourable conservation condition of relevant Special Conservation Interests of SPA

Attributes and targets to provide for favourable conservation condition of relevant Special Conservation Interests of SPA		
	Attributes and targets	**Comment on Potential Impact on Attribute/Target**
Qualifying Interest Habitat	**Wetlands [A999]**	
	Attribute: Habitat Area **Target:** The permanent area occupied by the wetland habitat should be stable or not significantly less than the area of 13,267 ha, other than that occurring from natural patterns of variation.	Comment: Loss of 5.93 (6B of table 3.13) of wetland (intertidal) habitat i.e. 0.05% which is not considered significant.

Table EIS(A) 7.26 Attributes and targets to provide for favourable conservation condition of relevant Special Conservation Interests of SPA

7.8 MONITORING

7.8.1 Fish and Fisheries

No additional information.

7.8.2 Birds

No additional information.

7.8.3 Marine Mammals

Monitoring as per Kelp Marine Research report (EIS(A) 2.2) will be undertaken. This includes

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.

7.8.4 Marine Invertebrates

No additional information.

7.8.4.1 Intertidal benthos

No additional information.

7.8.4.2 Subtidal benthos

No additional information.

7.8.5 Marine chemistry

No additional information.

7.8.6 Marine Physics

No additional information.

7.8.7 Mitigation Measures

No additional information.

7.9 MITIGATION MEASURES PROPOSED

7.9.1 Summary of Mitigation Measures

No additional information

7.10 CONSTRUCTION MITIGATION

In addition to those previously proposed, mitigation measures as per Kelp Marine Research report (EIS(A) 2.2) will be undertaken. These include:

- 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.

7.10.1 Underwater Blasting, Pile Driving and Dredging

No additional information.

7.10.2 Impact of Blasting/Pile driving on Mammals

No additional information.

7.10.3 Suspended Solids and Construction/Operational Dredging

No additional information.

7.10.4 Potential Spillages

No additional information.

7.10.5 Use of Concrete

No additional information.

7.11 OPERATION MITIGATION

No additional information.

7.11.1 Lighting

No additional information.

7.11.2 Predation of Fish by Seals

No additional information.

7.11.3 Water Pollution and Increased Risk of Spillage when Operational

No additional information.

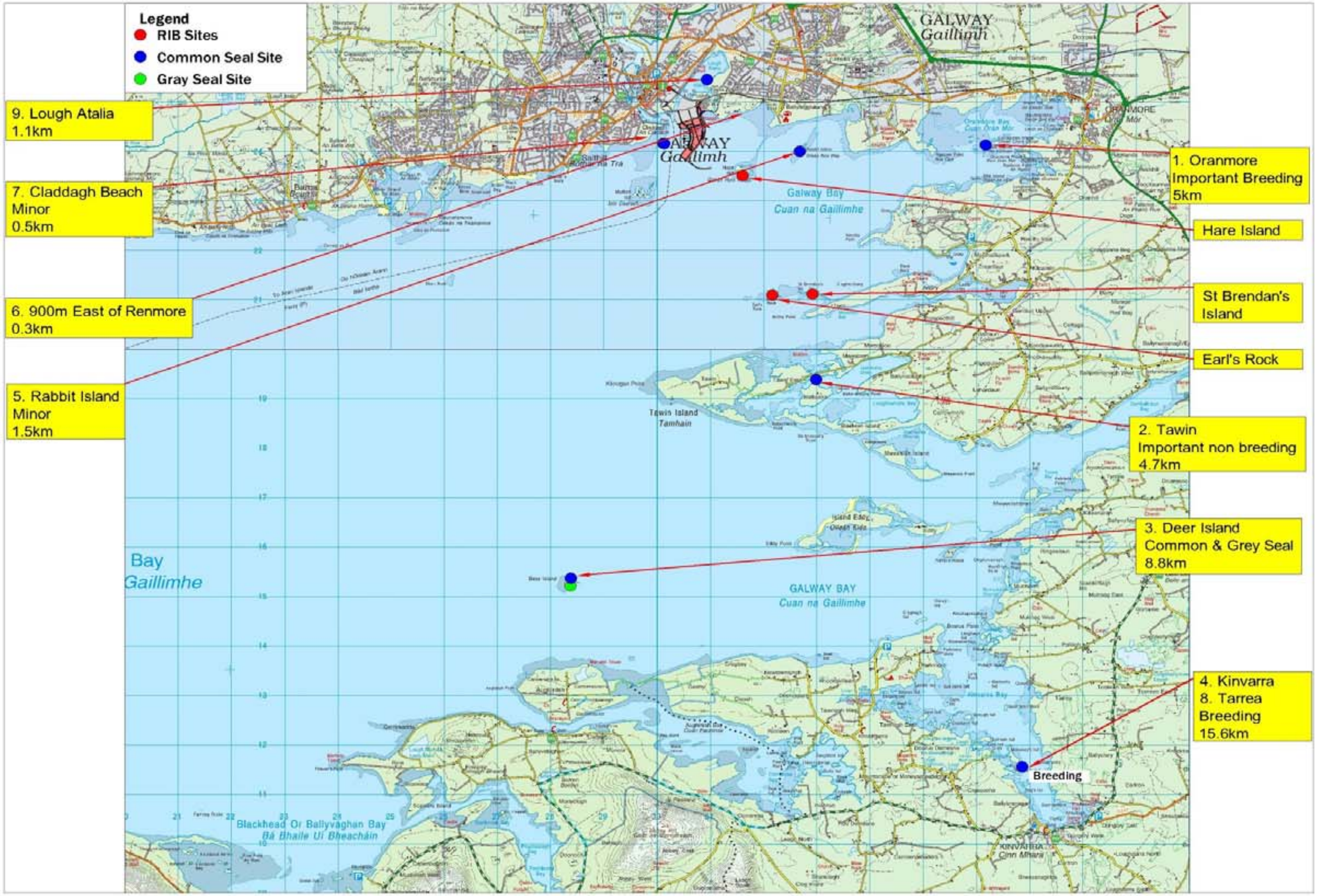
7.11.4 Depositing Maintenance Dredge Material

No additional information.

7.11.5 Contingency Plans

No additional information.

EIS(A) 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

EIS (A) 2.2 Kelp Report

- Risk Assessment for all Marine Mammals (Except Otter)
- Aquatic Habitat use of 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
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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 $\mu Pa^2 Hz^{-1}$ 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.

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Galway Harbour Company

Galway Harbour Extension

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

EIS(A) 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

EIS(A) 3.2 - Species Profiles by Dr. 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.

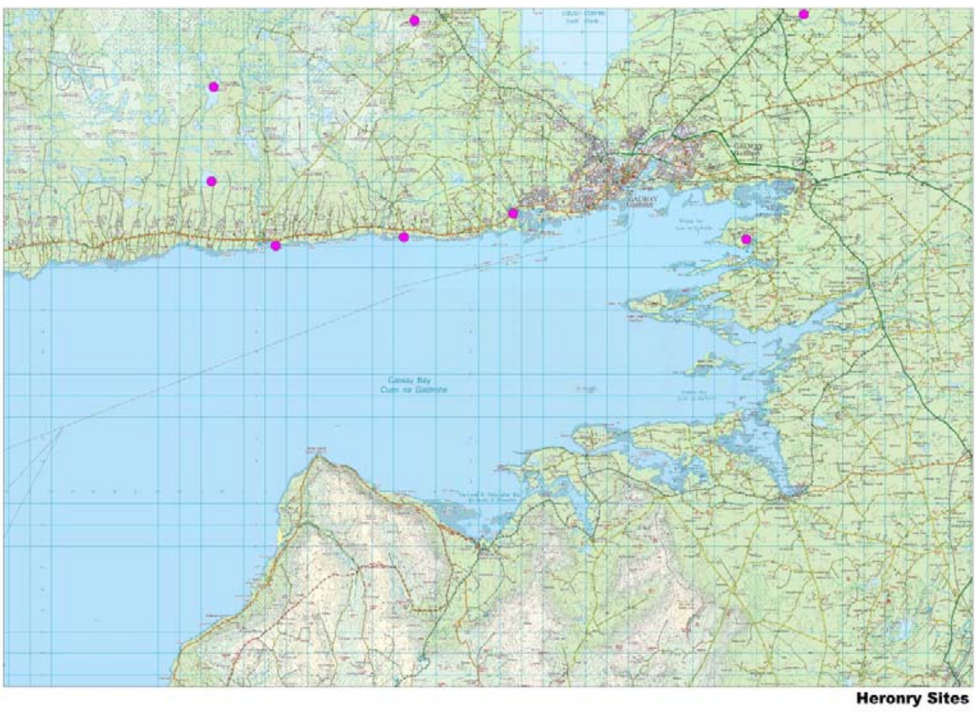

Figure NIS(A) Error! No text of specified style in document.**.1 Heronries around Inner Galway Bay**

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.

EIS(A) 3.3 - Bird Species Assessments by Dr. Tom Gittings

GALWAY HARBOUR EXTENSION:
SPECIAL CONSERVATION INTERESTS
SPECIES ASSESSMENTS

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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	GHE site	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

	Long-term trend		Short-term trend	
Species	**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

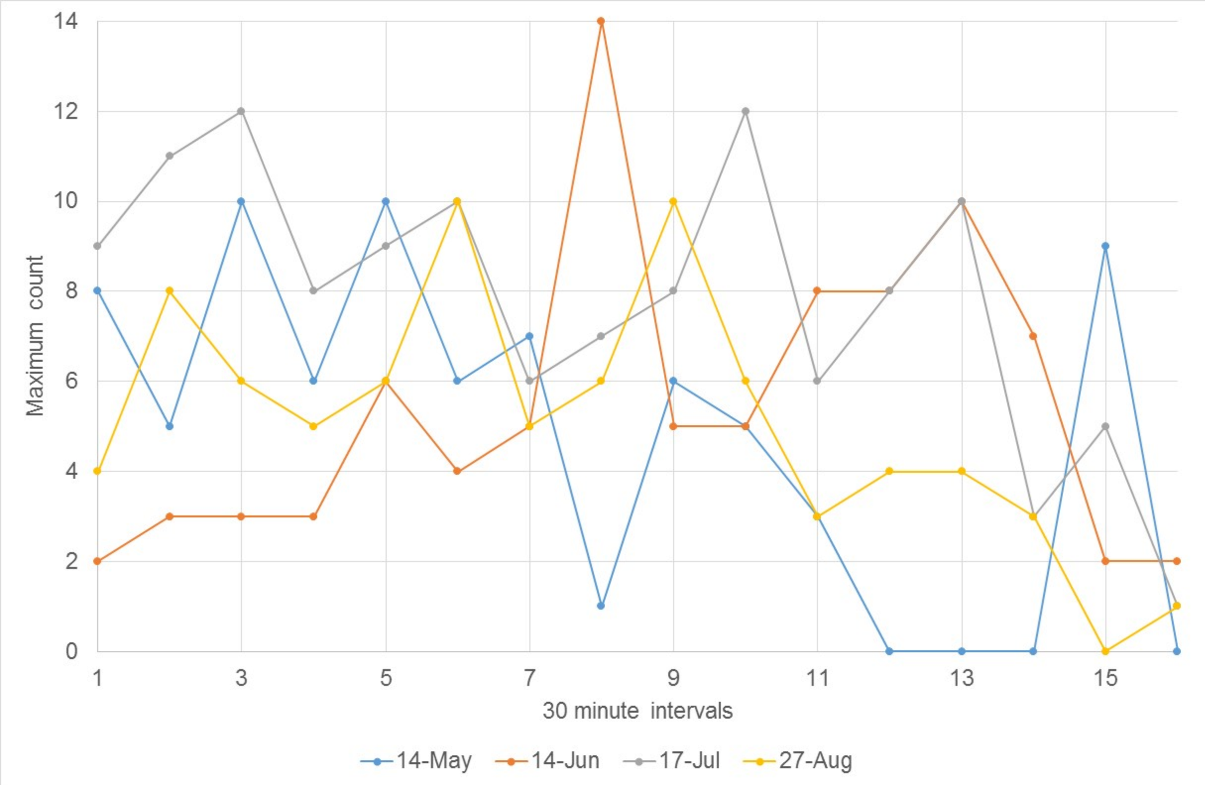
GHE development site may be more important as foraging habitat for the Mutton Island colony than indicated by the above percentages. Indeed, the mean foraging range reported by the individual studies reviewed in the seabird wikispace varies widely, with a minimum reported from a North American study 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				Renmore Beach			
	mean	SD	non-zero counts	% of I-WeBS	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.

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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

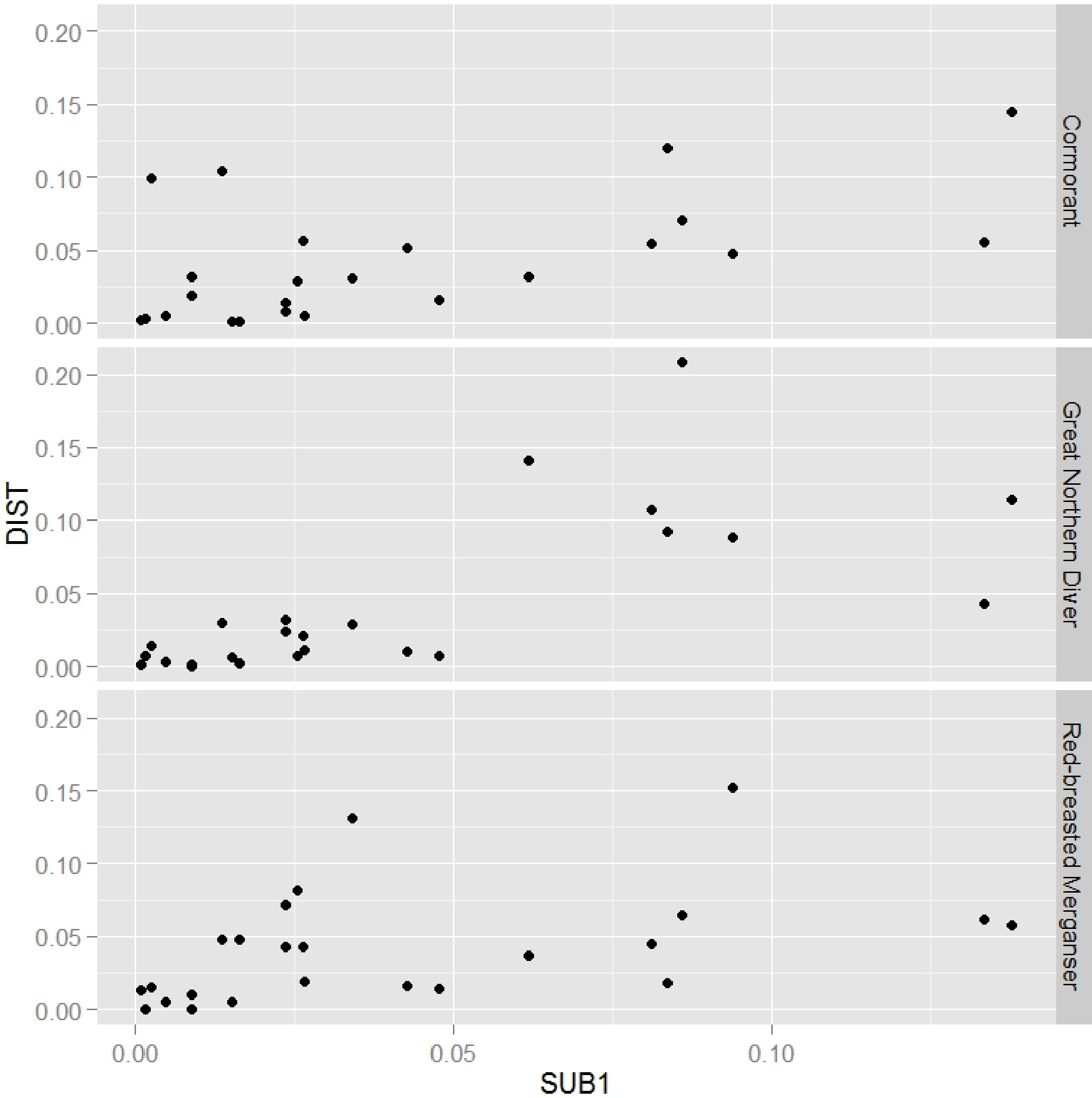
Species	**Shallow and moderately deep subtidal habitat**	**All subtidal habitat**
Red-breasted Merganser	0.431*	0.527**
Great Northern Diver	0.700***	0.797***
Cormorant	0.567**	0.538**

* $p < 0.025$, ** $p < 0.005$, *** $p < 0.0005$ (one-tailed tests, $n = 24$)

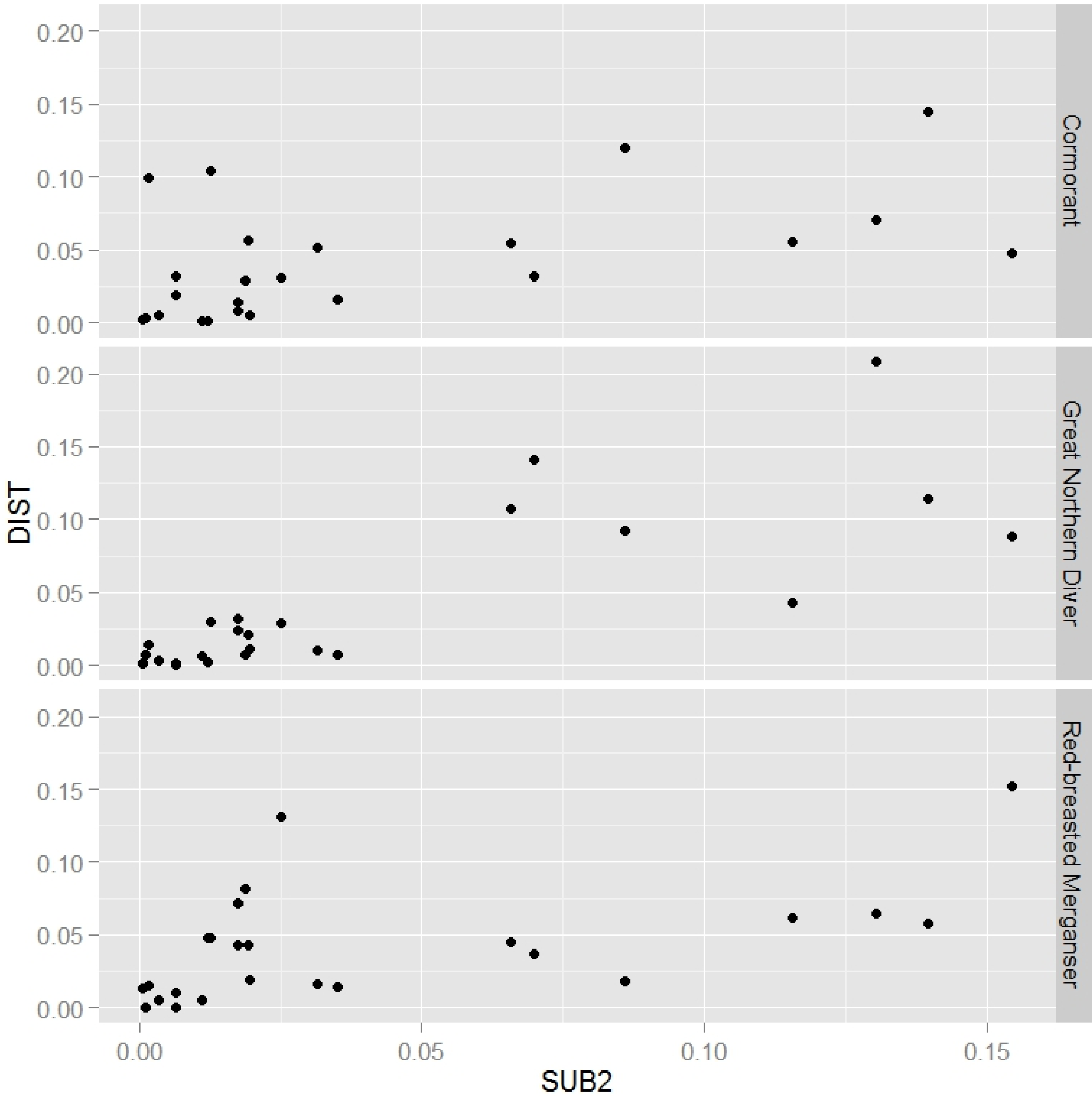
Table 14. Pearson's correlation coefficients between species distribution across subsites and availability of intertidal and shallow subtidal habitat

Species	**Intertidal zone**	**Intertidal and shallow subtidal zones**
Grey Heron	0.475*	0.554**
Curlew	0.606**	0.559**
Redshank	0.449*	0.414*

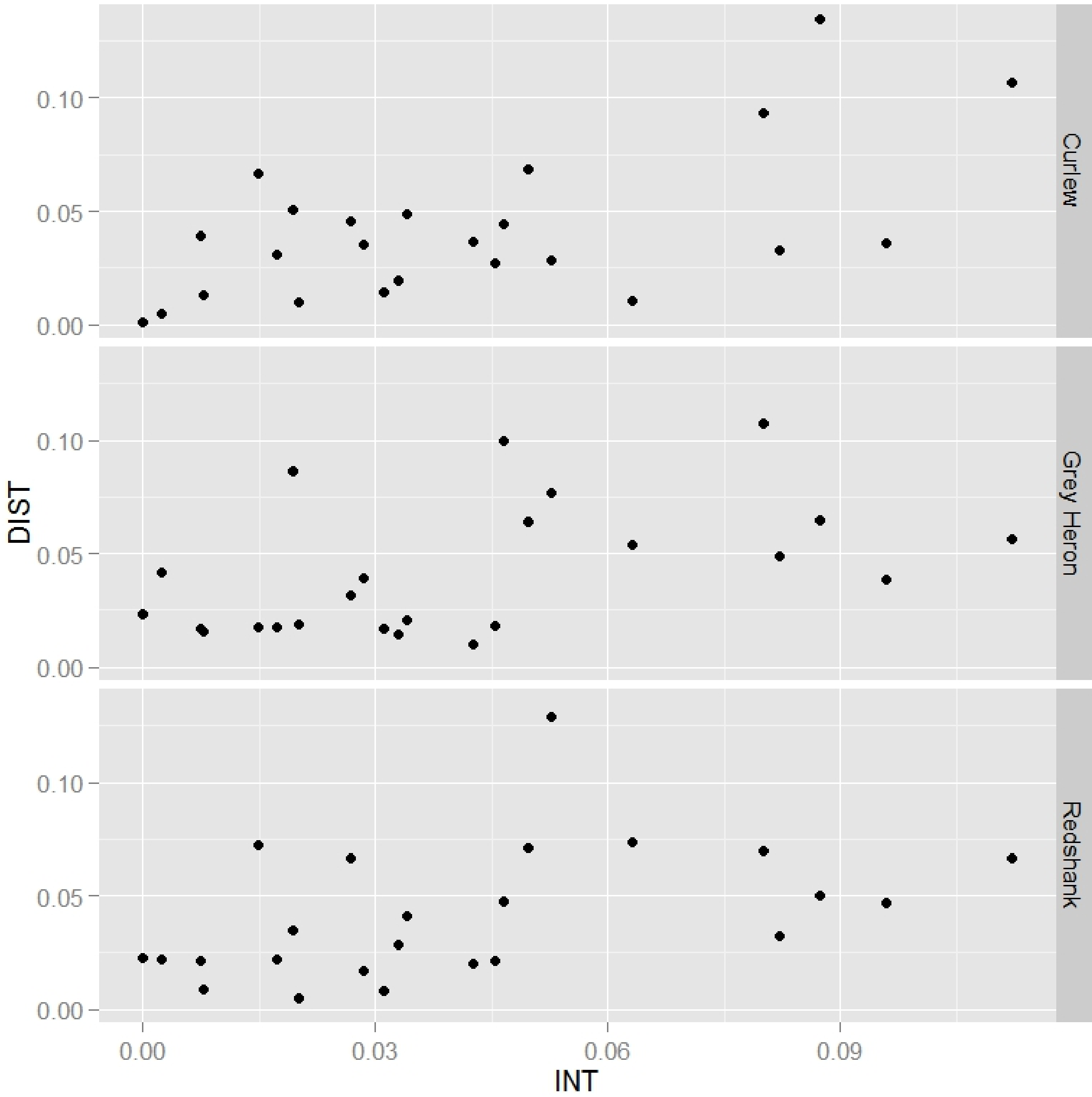
* $p < 0.025$, ** $p < 0.005$ (one-tailed tests, $n = 24$)



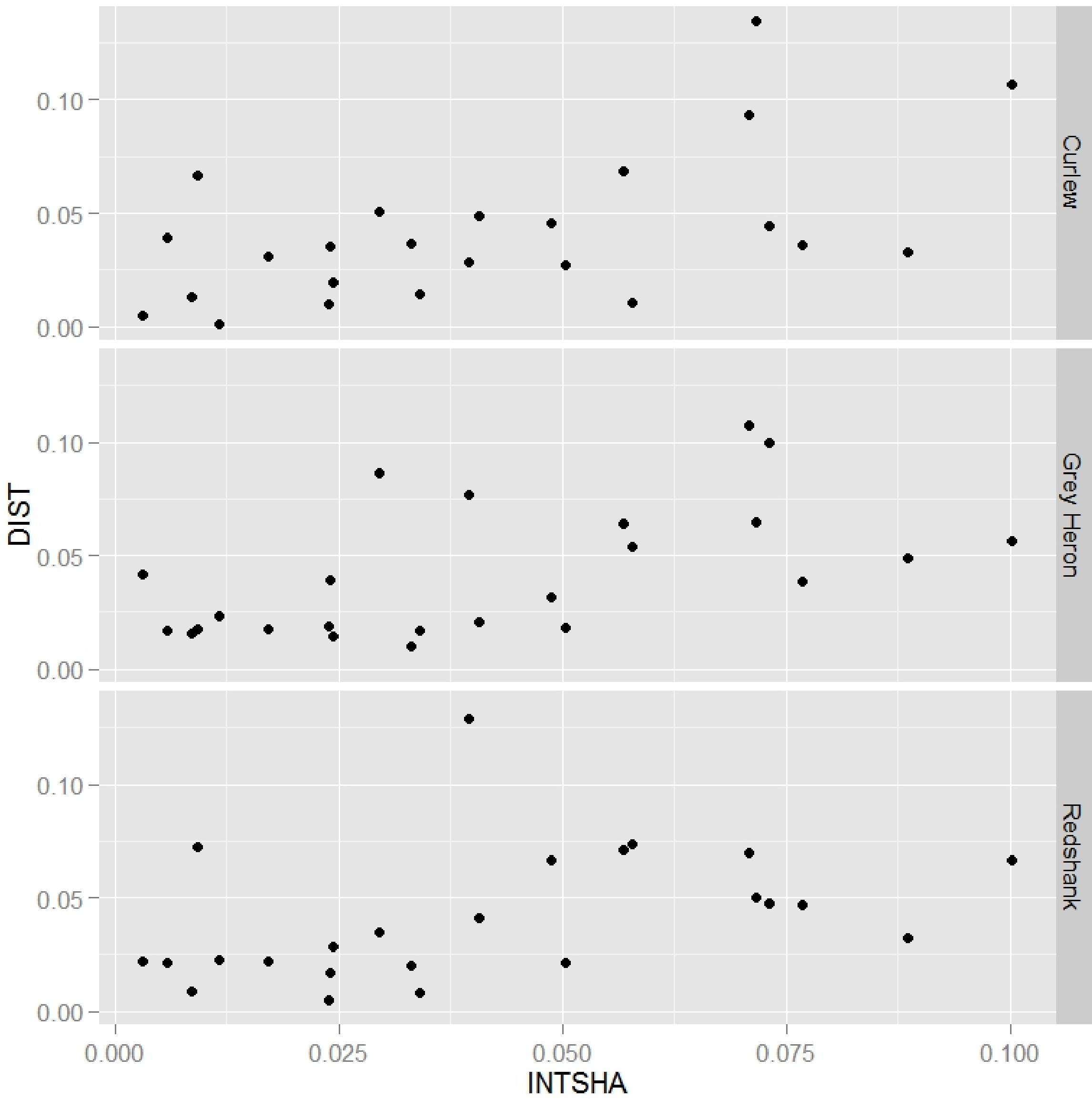
Text Figure A1. Relationship between species distribution among subsites (DIST) and availability of shallow and moderately deep subtidal habitat (SUB1)



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.

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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

Species	North Sea disturbance experiments Range of mean EDs (m)	n	Other studies 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).

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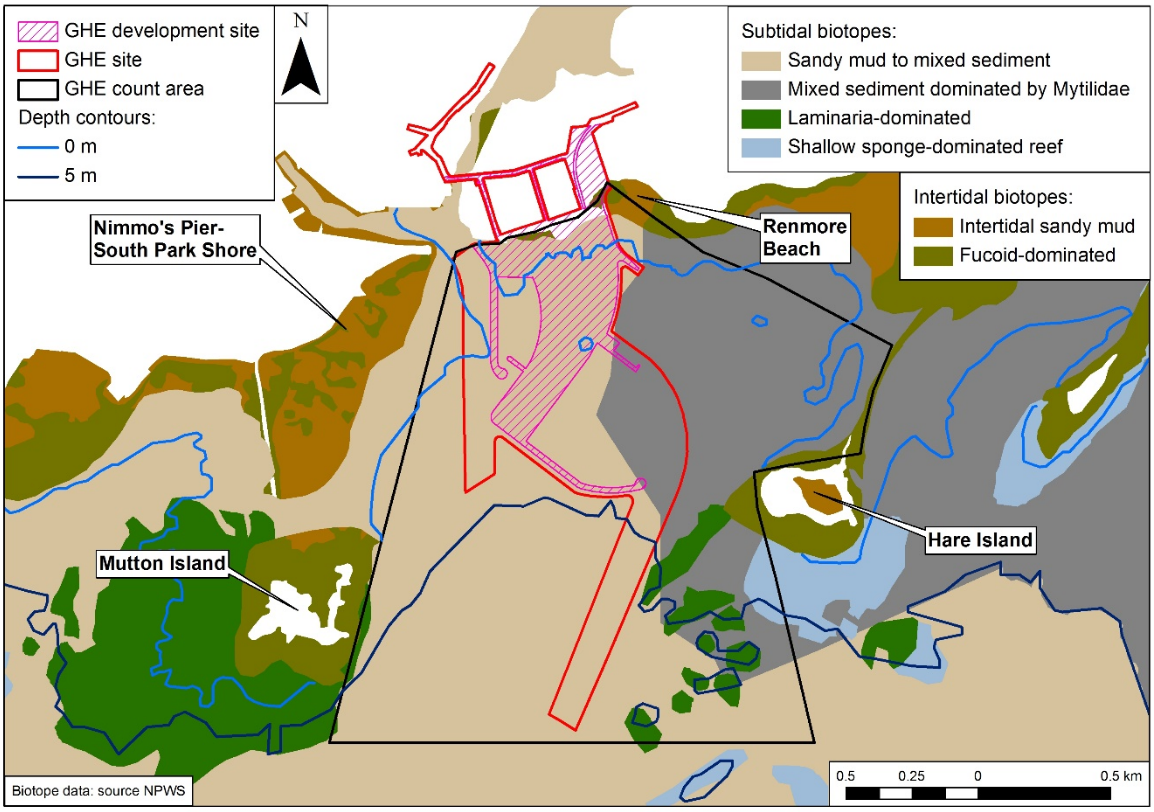

Figure 1. Areas referred to in this report

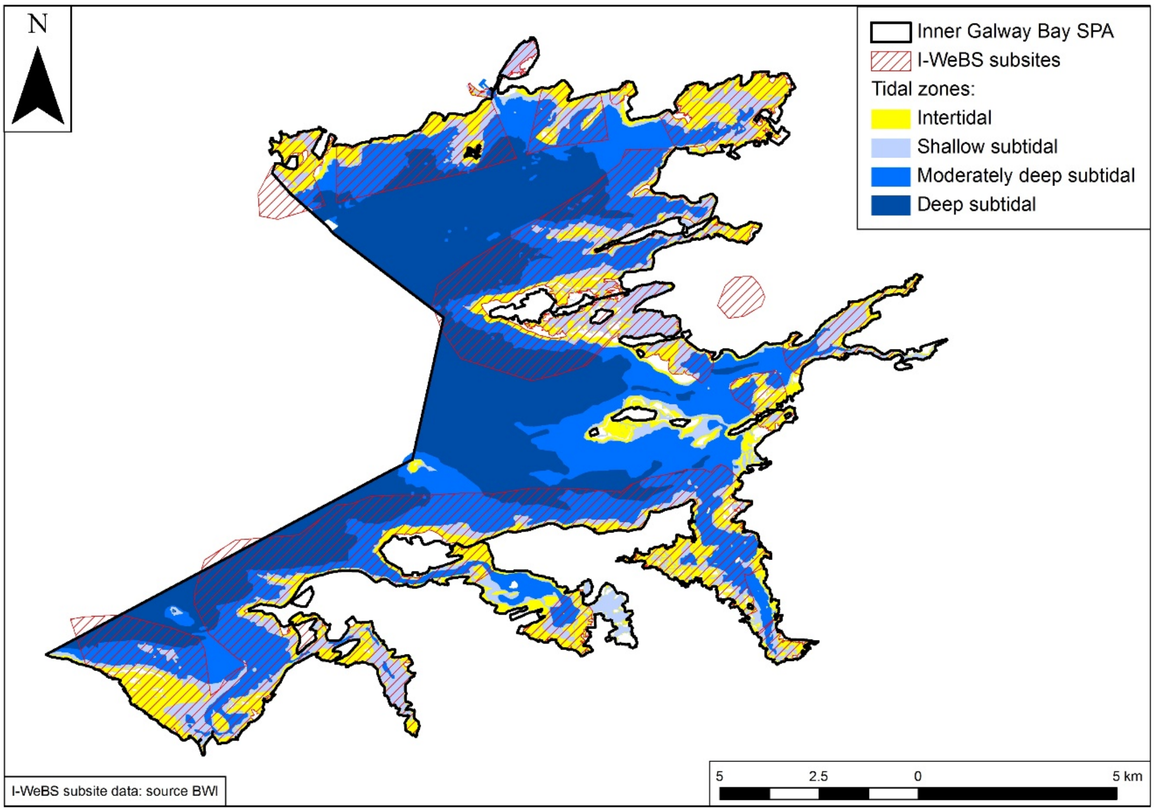

Figure 2. I-WeBS subsite coverage of the Inner Galway Bay SPA.

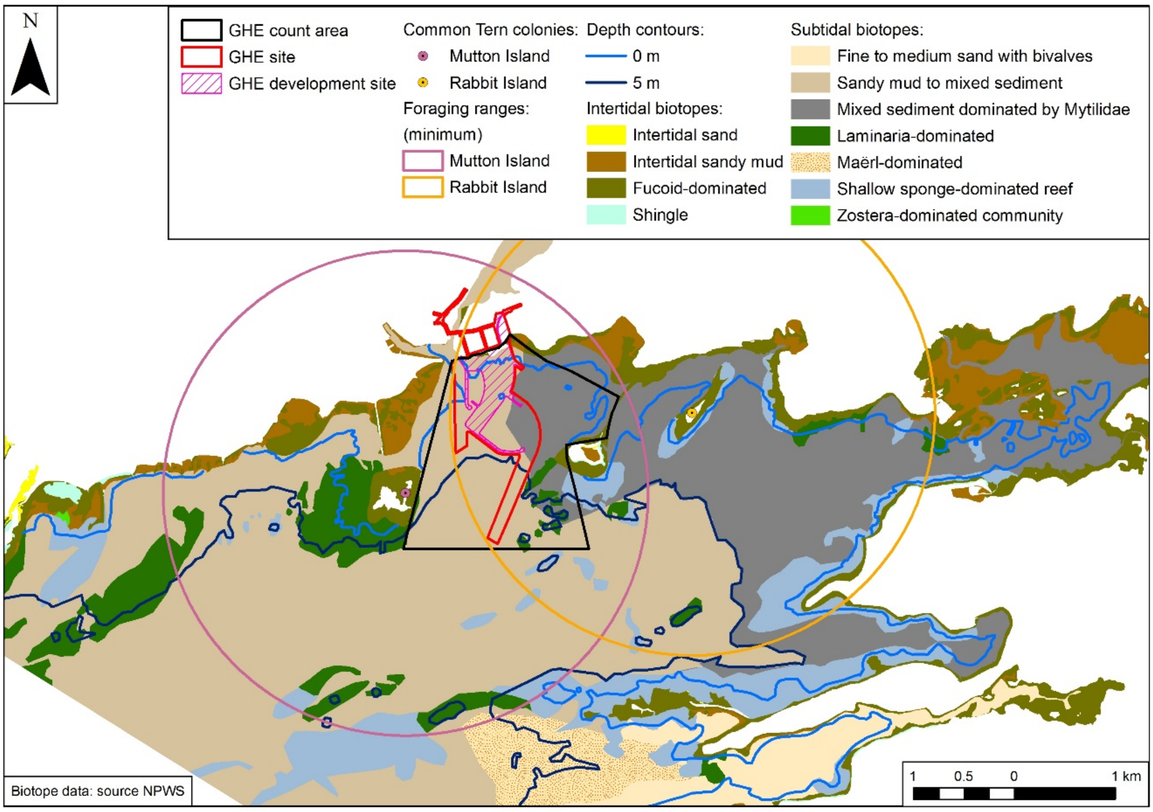

Figure 3. Biotopes and depth zones within the minimum foraging ranges of the Mutton Island and Rabbit Island Common Tern colonies

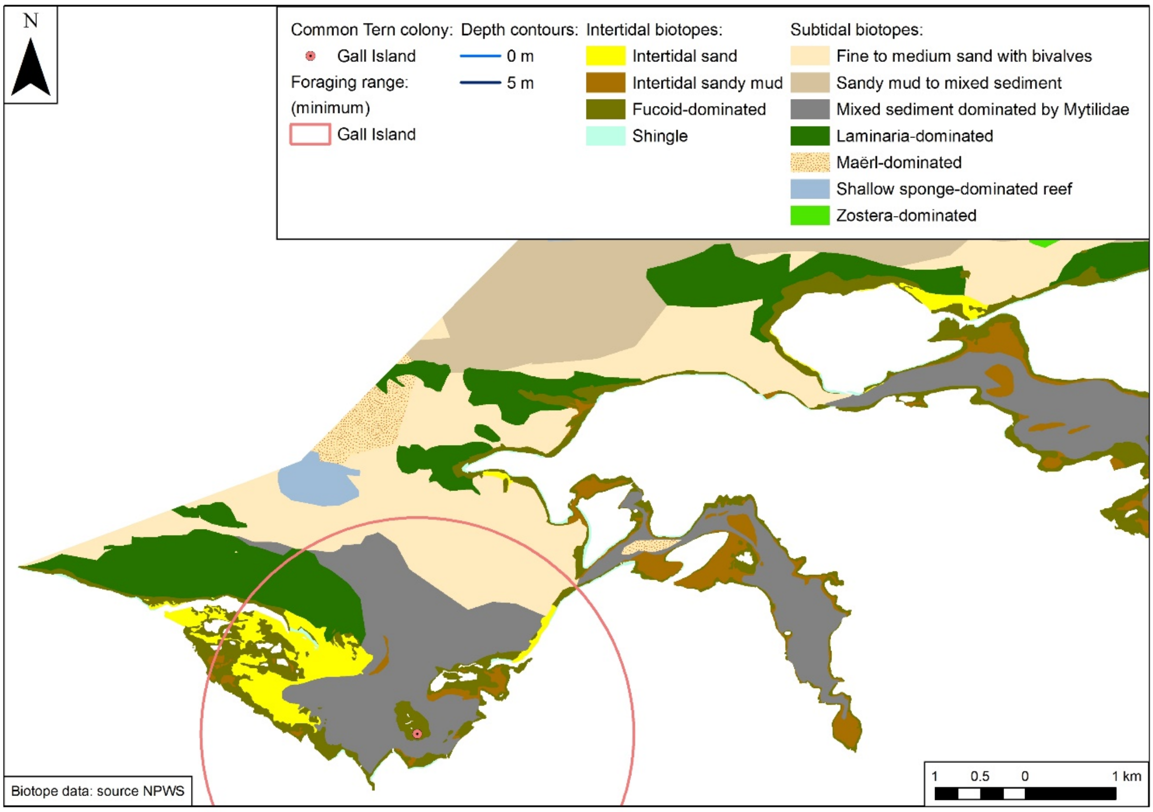

Figure 4. Biotopes and depth zones within the minimum foraging ranges of the Gall Island Common Tern colony