ANNEX IV SPECIES RISK ASSESSMENT OF MARINE SITE INVESTIGATIONS AT FOYNES ISLAND, CO LIMERICK

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1 | INTRODUCTION

The Irish Whale and Dolphin Group (IWDG) was contracted by RPS to carry out an Annex IV Species Risk Assessment of the proposed site investigations in association with the proposed new deep water terminal at Foynes Island (Figure 1). Annex IV species include cetaceans, marine turtle, otter and bats. Although not listed on Annex IV, we have included pinnipeds (seals) in this assessment as they frequently occur in waters adjacent to Foynes Island.

Figure 1: Location of Foynes Port and Foynes Island within the Shannon Estuary

1.1 | Proposed works

The Shannon Foynes Port Company (SFPC) has identified a number of key growth sectors for the port involving new berthing facilities, onshore infrastructure and the ability to accommodate larger vessels, to serve wider markets in an efficient and competitive manner. The development of a new Deepwater terminal adjacent to Foynes Port is currently under consideration. SFPC has recently concluded a feasibility study on the potential design options for a new deep water terminal at Foynes Island.

The proposed activity/works involve a **Marine Site Investigation** to support the planning and engineering design of the Foynes Island Deep Water Berth Development on Foynes Island. It is intended to perform both geophysical and geotechnical marine-based site investigation to inform the design of the proposed bridge crossing over to the South-East corner of Foynes Island from Foynes Port, construction of an access road across the island, construction of quay/marine infrastructure with associated quay furniture/services and development of a hardstanding hinterland area at the North-West edge of the Island. The surveys will entail the following activities:

- Standard methods of non-invasive acoustic based sensing will include the gathering of bathymetric, side scan sonar, sub-bottom profiler and magnetometer data.
- Standard methods of geotechnical investigation including deep boreholes (30-45m deep), shallow boreholes (5-10m deep). The boreholes are to be drilled firstly using cable percussive techniques. If rock is to be penetrated, then rotary drilling will follow on. For each borehole the footprint of the works on the foreshore will be four approximately 1 m^2 legs of the jack-up barge and the 200mm (8") temporary steel casing. The 200mm steel casing is the diameter of the borehole.
- Operation and manoeuvring of typical jack-up barge, survey vessels and floating pontoon equipment.

The borehole works will be carried out during two separate phases, pre-planning (phase 1 in Q1-Q2 2024) and post-planning (phase 2 in 2026). There will be a total of 79 boreholes in phase 1 and 84 boreholes in phase 2. The geophysical surveys will be undertaken in phase 1 (pre-planning).

1.2 | Environment

The location of the proposed site is within an area designated as Natural Heritage Area as well as being part of the River Shannon and Fergus Estuary SPA, and the Lower Shannon SAC. The receiving environment includes the benthos, the benthic, demersal and pelagic fish in the area, and the species listed on Annex IV including cetaceans, marine turtles, otter and bats. This report considers the risk to Annex IV species from the proposed site investigations with the addition of seals which are protected under the Wildlife Act and listed on Annex II of the EU Habitats Directive.

2 | METHODS

This risk assessment was based on original data collected by the IWDG in the Shannon Estuary since 1993 and a review of the available literature. Marine mammals and turtles are highly mobile and the potential for this development to impact on adjacent sites and important habitats at some distances from the development have been assessed.

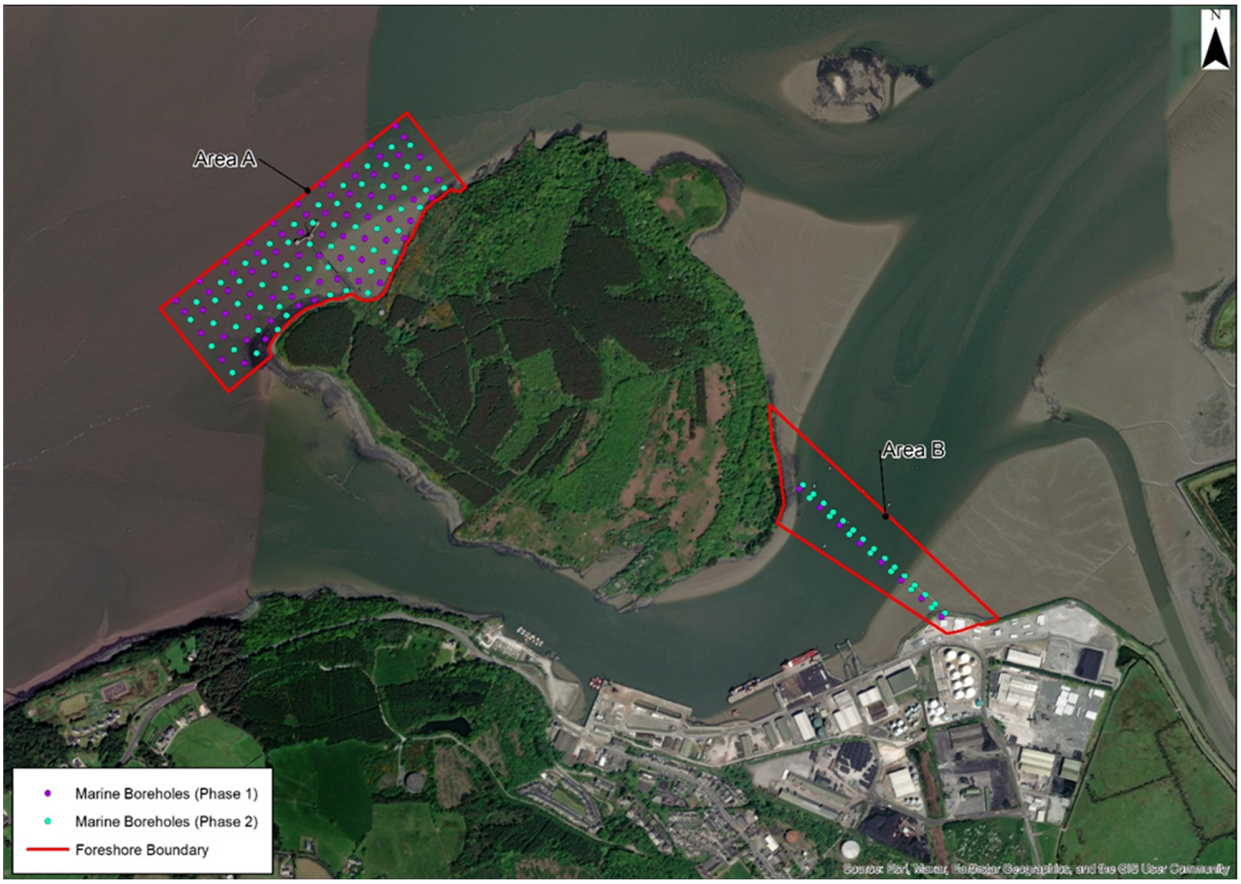

Figure 2: Proposed Site Investigations around Foynes Island, Co Limerick (geophysical surveys to occur within the red line boundary)

3 | LEGAL STATUS

Irish cetaceans (whales, dolphins and porpoises), pinnipeds, otter and Leatherback Turtle are all protected under national legislation and under a number of international directives and agreements which Ireland is signatory to. All cetaceans, as well as grey and harbour seals, are protected under the Wildlife Act (1976) and amendments (2000, 2005, 2010 and 2012). Under the act and its amendments it is an offence to hunt, injure or wilfully interfere with, disturb or destroy the resting or breeding place of a protected species (except under license or permit). The act applies out to the 12 nautical mile limit (nml) of Irish territorial waters.

All cetaceans, otter and Leatherback Turtle are protected under Annex IV of the EC Habitats Directive (92/43/EEC). The Directive lists Annex IV species of community interest 'in need of strict protection'. Pinnipeds are not listed on Annex IV but are listed on Annex II, which also includes the harbour porpoise (*Phocoena phocoena*), bottlenose dolphin (*Tursiops truncatus*), leatherback turtle (*Dermochelys coriacea*) and otter (*Lutra lutra*) which are of community interest and whose conservation requires the designation of special areas of conservation. The proposed development is wholly within the Lower River Shannon SAC which includes bottlenose dolphin and otter as qualifying interests.

Ireland is also signatory to conservation agreements such as the Bonn Convention on Migratory Species (1983), the OSPAR Convention for the Protection of the Marine Environment of the northeast Atlantic (1992) and the Berne Convention on Conservation of European Wildlife and Natural Habitats (1979).

Under the EU Marine Strategy Framework Directive with respect to maintaining good environmental status (GES), "*human activities should occur at levels that do not adversely affect the harbour porpoise community at the site*" and "*proposed activities or operations should not introduce man-made energy at levels that could result in a significant negative impact on individuals and/or the community of harbour porpoise within the site*". This refers to the "*aquatic habitats used by the species in addition to important natural behaviours during the species annual cycle*".

In 2007, the National Parks and Wildlife Service (NPWS) of the Department of Arts, Heritage and the Gaeltacht produced a '*Code of Practice for the Protection of Marine Mammals during Acoustic Seafloor Surveys in Irish Waters* (NPWS, 2007). These were subsequently reviewed and amended to produce '*Guidance to manage the risk to marine mammals from man-made sound sources in Irish waters*' (NPWS 2014). The guidelines recommend that listed coastal and marine activities be subject to a risk assessment for anthropogenic sound-related impacts on relevant protected marine mammal species to address any area-specific sensitivities, both in timing and spatial extent, and to inform the consenting process.

Once the listed activity has been subject to a risk assessment, the regulator may decide to refuse consent, to grant consent with no requirement for mitigation, or to grant consent subject to specified mitigation measures.

The Shannon dolphin population exhibits population structure which can be crudely described as comprised of "inner" and "outer" estuary dolphins. All individuals who have been sighted in the inner estuary have also been sighted in the outer estuary, suggesting the population mixes in this area. But many of the "outer" estuary dolphins have not been recorded in the inner estuary (Baker et al. 2018). Around 25% of the known population use the inner estuary all the time which has strong management implications as the degree of exposure to anthropogenic threats would be different for individuals of the inner and outer areas.

4 | BASELINE ENVIRONMENT

4.1 | Ambient Noise Levels

Ambient, or background noise, is defined as any sound other than the sound being monitored (primary sound) and, in the marine environment, is a combination of naturally occurring biological and physical sound sources including sediment transfer, waves and rain and that of a biological origin including fish, crustaceans and from marine mammals. The impact of noise created by human activity is strongly influenced by background or ambient noise, the impact is less in a noisy environment compared to a quiet environment and it's the intensity and frequency of this increased noise compared to the ambient levels at a site, which defines its impact. As ambient noise levels increase, the ability to detect a biologically important sound decreases. The point at which a sound is no longer detectable over ambient noise is known as acoustic masking. The range at which an animal is able to detect these signals reduces with increasing levels of ambient noise (Richardson *et al.* 1995). This is important when considering the impact of sound sources on marine mammals by the proposed works.

Ambient noise in the Shannon Estuary was measured by Beck et al. (2013) at two locations (Labasheeda Bay and Kilbaha Bay, County Clare) and reported a mean±SD noise levels in dB re 1 µPa of 100±7.5 which was 3 db lower than Galway Bay and 13 db lower than Dublin Bay. In the Shannon Estuary there were a limited number of shipping transits resulting in a lower variation while the level of large ships in the area maintained a constant shipping noise level.

4.2 | Marine Mammals

This risk assessment was based on original data collected by the IWDG and a review of the available literature. The IWDG have been working in the Shannon Estuary since 1993 (Berrow et al. 1997) and have a unique understanding of the use of the estuary by marine mammals. Most surveys have been carried out in the outer and mid estuary west of Tarbert, Co. Kerry but acoustic monitoring and recent boat-based surveys throughout the year of the inner estuary has improved our knowledge of the use of the inner estuary by dolphins and other marine mammals.

Reynolds (2020) published a list of mammal species recorded on Foynes Island since 1991. This included otter, long-eared bat and bottlenose dolphin. A number of marine mammal species have been recorded in the Shannon Estuary including grey and common seals and bottlenose dolphin. Although not strictly a marine mammal, otter also occur along the shores of the estuary and forage within the estuary. The Lower River Shannon SAC includes bottlenose dolphins and otter as qualifying interests.

4.2.1 Cetaceans

Bottlenose dolphin (Tursiops truncatus)

The Shannon Estuary is one of the most extensively study sites for bottlenose dolphins in Europe. Bottlenose dolphins are found throughout the estuary but regular concentrations occur off Kilcredaun Head in the outer estuary and Tarbert-Killimer which is associated with foraging behaviour. Most research and monitoring work has been carried out in the outer estuary as far upriver as Tarbert-Killimer with relatively less up river of Tarbert.

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<u>Abundance estimates</u>

The first robust abundance estimate of dolphins using mark-recapture modelling of photo-id data was carried out in 1997 by Ingram (2000). At least two surveys were carried out each month between April and September and one per month during winter (weather permitting). During 45 photo-identification boat surveys Ingram (2000) identified 53 individual dolphins with well-marked dorsal fins. This resulted in an estimate of 113±16 dolphins with a CV of 0.14 and 95% Confidence Intervals of 94-161 individuals.

Since this first study a number of abundance estimates have been carried out using mark-recapture modelling of photo-id data. These estimates ranged from a peak of 140±12 in 2006 to a minimum of 107±12 in 2010 but were quite consistent over the period 1997-2018 (Ingram 2000; Ingram and Rogan 2003; Englund et al. 2007; 2008; Berrow et al., 2010; Rogan et al. 2015: 2018). During an extensive period of photo-id in the Shannon Estuary between 2012 and 2015 (Baker et al. 2018), a discovery curve of individuals identified against the cumulative number of identifications reached a clear plateau suggesting all individuals present in the estuary were captured.

No new adults or juveniles were recorded during the 2015 field season (excluding additions of new born calves to the population) resulting in an estimated extant population of 145 individuals comprising 80 adults, 25 juveniles and 40 calves (Baker et al. 2018). Excluding dependent calves, 121 individuals were sighted, of whom 98% (n = 119) were sighted in multiple years (Baker et al. 2018). Concurrent with this four year study, in 2015 Rogan et al. (2015) estimated an abundance of 114±14 with 95% Confidence Intervals of 90-143, which fitted within the estimate by Baker et al. (2018). The most recent estimate was carried out between June and September 2022 by Berrow et al. (2022) who provided a final best estimate of 116 ± 9 with a CV 0.08 and 95% Confidence Intervals of 103 to 122.

As part of a population viability study, Blásquez et al. (2021) found a number of false positives in Rogan et al. (2015) dataset and provided a revised estimate of 93 ± 8.81 with a CV of 0.09 and 95% Confidence Intervals of 83-103, which would be the lowest abundance estimate published to date. A mark-recapture analysis was also carried out by Blásquez et al. (2021) on the IWDG photo-identification catalogue during the same time period, and an estimate of 136 ± 18.0, with a CV of 0.13 Confidence Intervals of 125-202 was calculated. Interestingly, the most recent abundance estimate from the Shannon Estuary in 2018 (Rogan et al. 2018) produced a very similar abundance (139 ± 15.23; CV = 0.11; 95% CI = 121 to 160) to that calculated using the IWDG photo-identification catalogue in 2015 (Blásquez et al. 2021). Since the first mark-recapture estimate in 1997, estimates have been largely consistent, suggesting the population is stable. However, a population viability analysis which was carried out on the latest data from the Shannon Estuary suggested that the dolphin population is vulnerable to even small increases in adult mortality, or a reduction in reproduction rates (Blásquez et al. 2021).

Static Acoustic Monitoring

Static Acoustic Monitoring (SAM) using C-PODs has been used off Foynes Island and once within the harbour to assess the use of the area by bottlenose dolphins (Table 1). CPODs were deployed off Foynes Island for a total of 1428 days between February 2009 and November 2014. Dolphin clicks were logged on 549 different days or 38.45 of days monitored (Carmen et al. 2021). A high proportion of clicks (64%) were detected at night but diel tidal and lunar cycles all had significant effects on detection rates. Autumn had the highest predicted foraging using stepwise models but tidal cycle and tidal phase were found to be significant factors influencing foraging at the site. The differences in predicted foraging between ebb, flood, slack high and slack low were rather small, with flood tides having the lowest foraging and spring tides predicting significantly higher foraging than neap tides and transitional phases. Finally, evenings have the highest significant odds of detecting foraging trains, followed by nights.

A total of 176 days were monitored at Foynes Jetty for bottlenose dolphins between 23 February and 25 October 2010. Over the monitoring period dolphins were detected on from 27 to 47% of days (mean = 34% of days). A total of 162 DPM were recorded with a mean on 0.87 DPM per day (Table 1). When recorded, there was only one encounter per day and the duration of encounters were short with only 6 (3.4%) greater than 4 minutes (Figure 3). When detected, there was only one encounter per day and the duration of encounters were very short with 76% of detections were at night. This suggests that dolphins are using Foynes more frequently at night, maybe as there is less human activity and thus are rarely observed.

Table 1: Comparison of results from relevant SAM studies in the Shannon Estuary

Period	Duration (days)	% of days with detections	Detection Positive Minutes	Mean DPM/day (dolphin)	Reference
Foynes Island Feb 2009 – Oct 2010 Nov 2011 - Nov 2012 Apr-Aug 2018 2009-2014	591 288 140 1,428	41 47 34 39	1,227 1266 114	- 4.4 0.8	O'Brien et al. (2013) O'Brien and Berrow (2012) O'Brien and Berrow (2017) Carmen et al. (2021)
Foynes Harbour Feb – Oct 2010	176	34	162	0.87	Berrow and O'Brien (2011)
Canon Island Apr-Aug 2018	140	4	9	0.06	O'Brien and Berrow (2018)

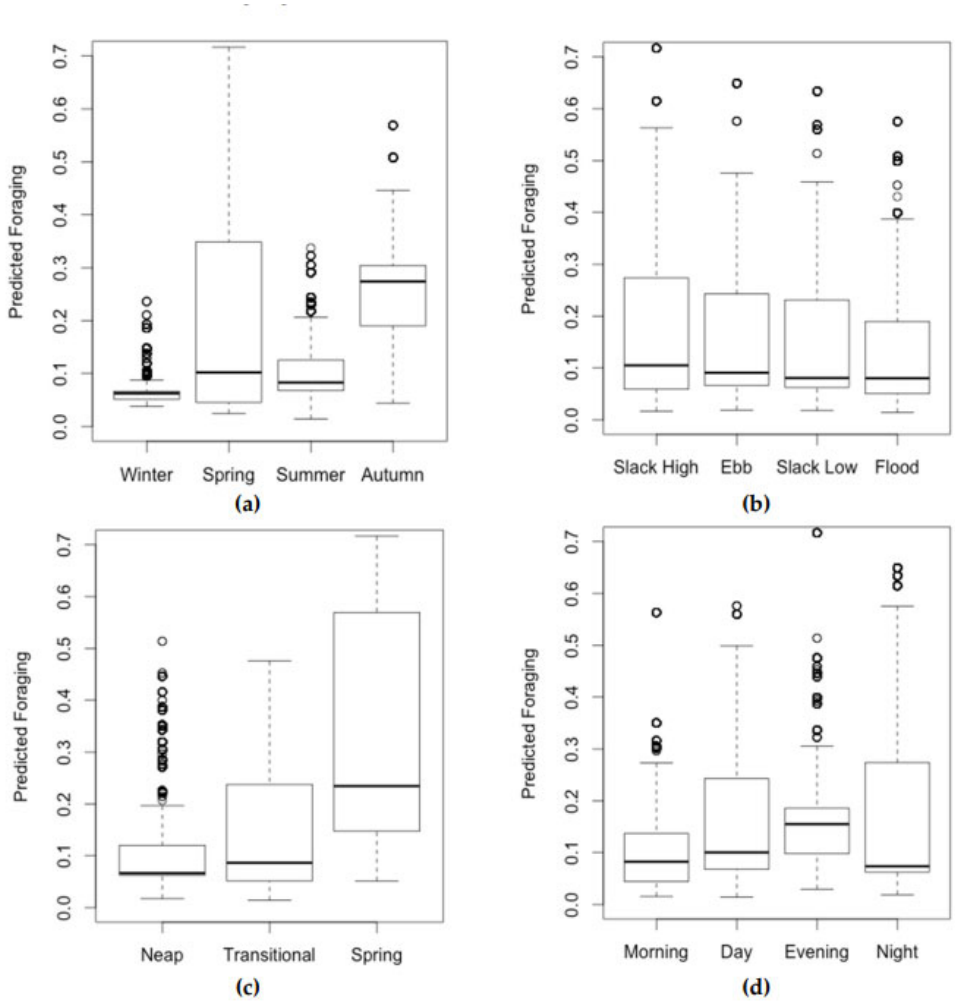

Figure 3: Predicted foraging at Foynes for the explanatory variables included in the best model: (a) Season; (b) Tidal Cycle; (c) Tidal Phase and (d) Diel Phase (from Carmen et al. (2021))

Harbour porpoise (Phocoena phocoena)

Harbour porpoise are the most widespread and abundant cetacean in inshore Irish waters, with highest abundances in the Irish Sea (Berrow *et al.* 2010). They are regularly reported at the mouth of the Shannon Estuary and occasionally within the outer estuary.

Recently O'Callaghan et al. (2021) reported on two sightings east of Scattery Island in the mid-estuary (Figure 4). These sightings are very unusual but this does demonstrate that they can on occasion venture up the estuary. There are no reports of sightings of harbour porpoise around Foynes Island but a porpoise stranded in moderate condition was reported on 9 August 2017 near the Foynes Yacht Club (O'Connell and Berrow, 2019).

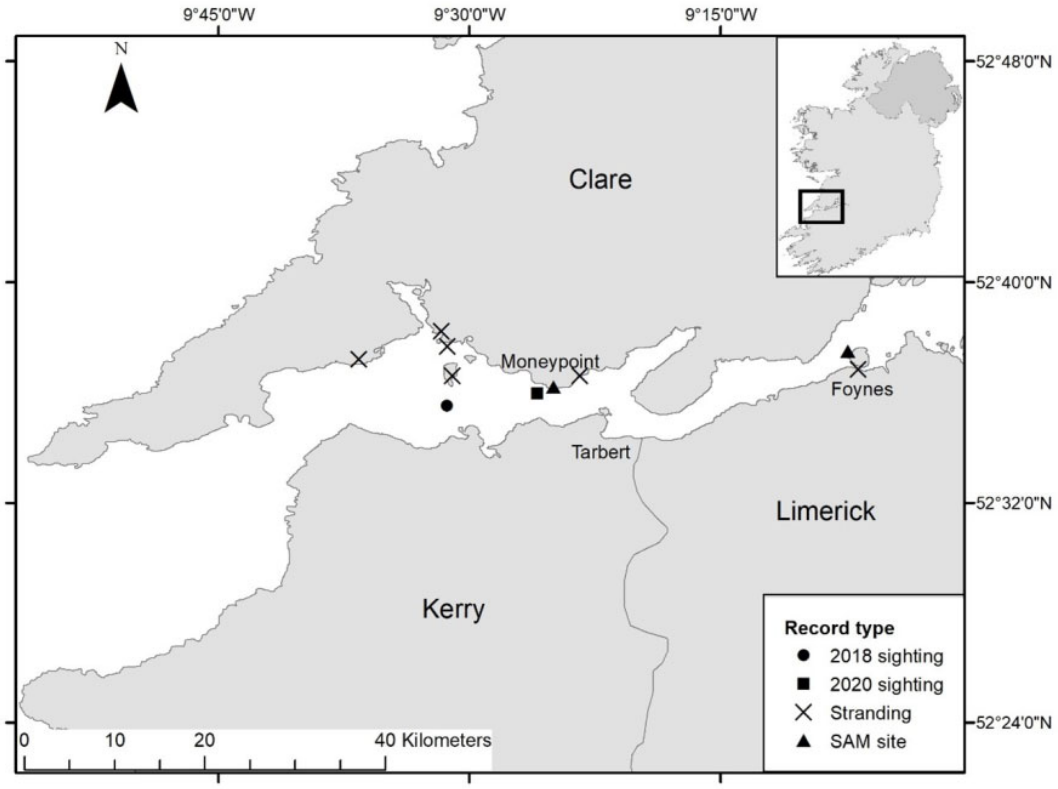

Figure 4: The location of Harbour Porpoise sightings, strandings and acoustic detections within the Inner Shannon Estuary from 1989-2020 (from O'Callaghan et al. 2021)

Common dolphin (Dephinus delphis)

Common dolphins are frequently recorded off the western seaboard of Ireland with peak counts during summer (Wall et al. 2013), including off Loop and Kerry Heads. Historically, they are rarely encountered in the Shannon Estuary but recently we have recorded common dolphins during the winter as far upriver as Tarbert. There is one stranding of a common dolphin on Saints Island in the mouth of the Fergus Estuary, east of Foynes Island but the carcass may have been brought in by the tide (**Figure 5**). The recent occurrence of common dolphins may be an artifact of increased survey effort during winter or part of a new trend.

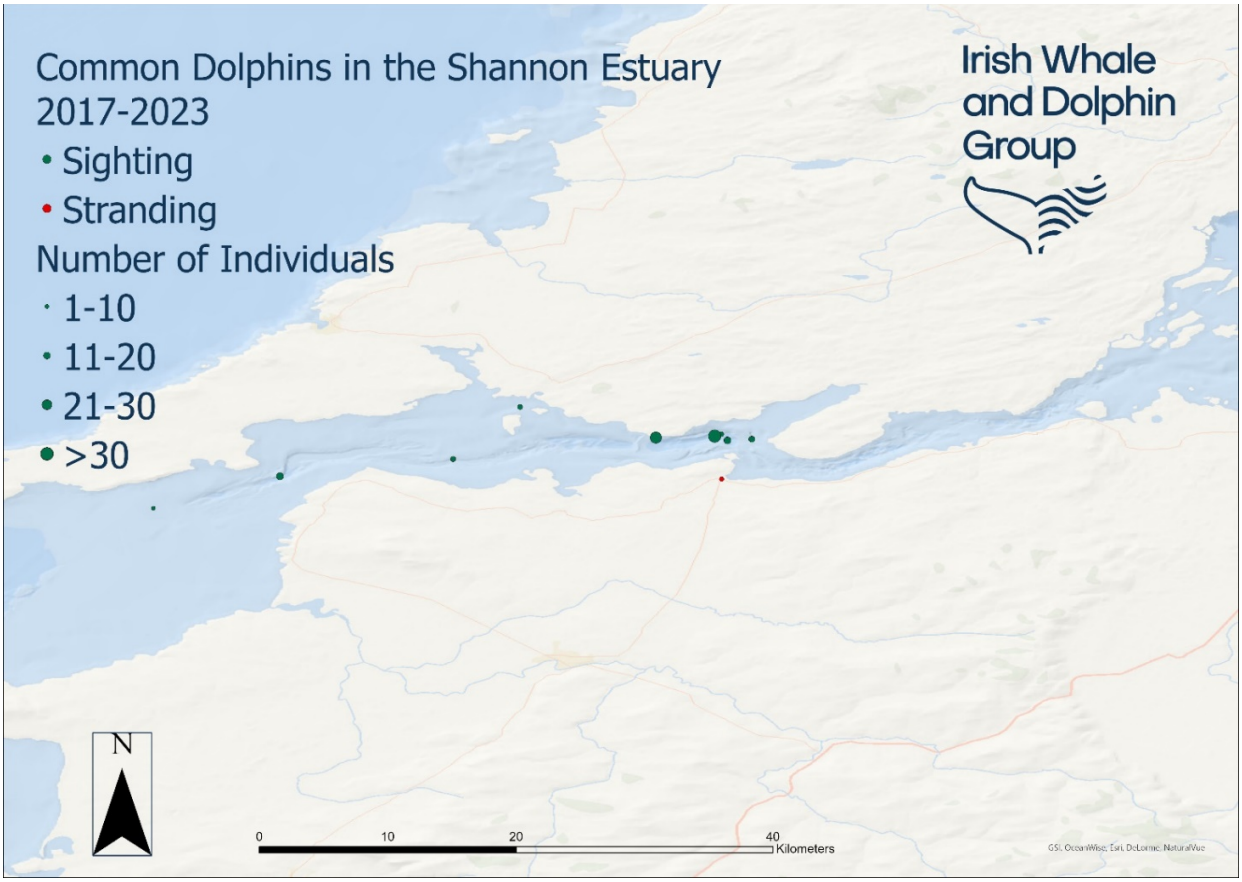

Figure 5: Location of recent common dolphin sightings within the Inner Shannon Estuary

4.3 | Other Annex IV species

Other Annex IV species of interest include marine turtles and bats. Data from the National Biodiversity Data Centre was also accessed (on 1 March 2023) to help inform this Annex IV assessment.

Five species of marine turtle have been recorded in Irish waters (King and Berrow 2009; Botterell *et al*. 2020) including: Leatherback (or Leathery) turtle (*Dermochelys coriacea)*, loggerhead (*Caretta caret*ta), Kemps Ridley (*Lepidochelys kempii*), Hawksbill (*Eretmochelys imbricata*) and green turtle (*Chelonia mydas*). Hawksbill and Green are very rare. Records of hard-shell turtles stranded in the UK, including loggerhead turtles and Kemp's Ridley turtles, have significantly increased over the last 100 years but with a notable decrease in records in the most recent years. The majority of records of hard-shell turtles were juveniles and occurred in the boreal winter months when the waters are coolest in the North-east Atlantic. In contrast to hard-shell turtles, leatherback turtles were most commonly recorded in the boreal summer months with the majority of strandings being adult sized, of which there has been a recent decrease in annual records (Botterell et al. 2020). All five species of marine turtles reported in Ireland are listed on Annex IV of the EU Habitats Directive.

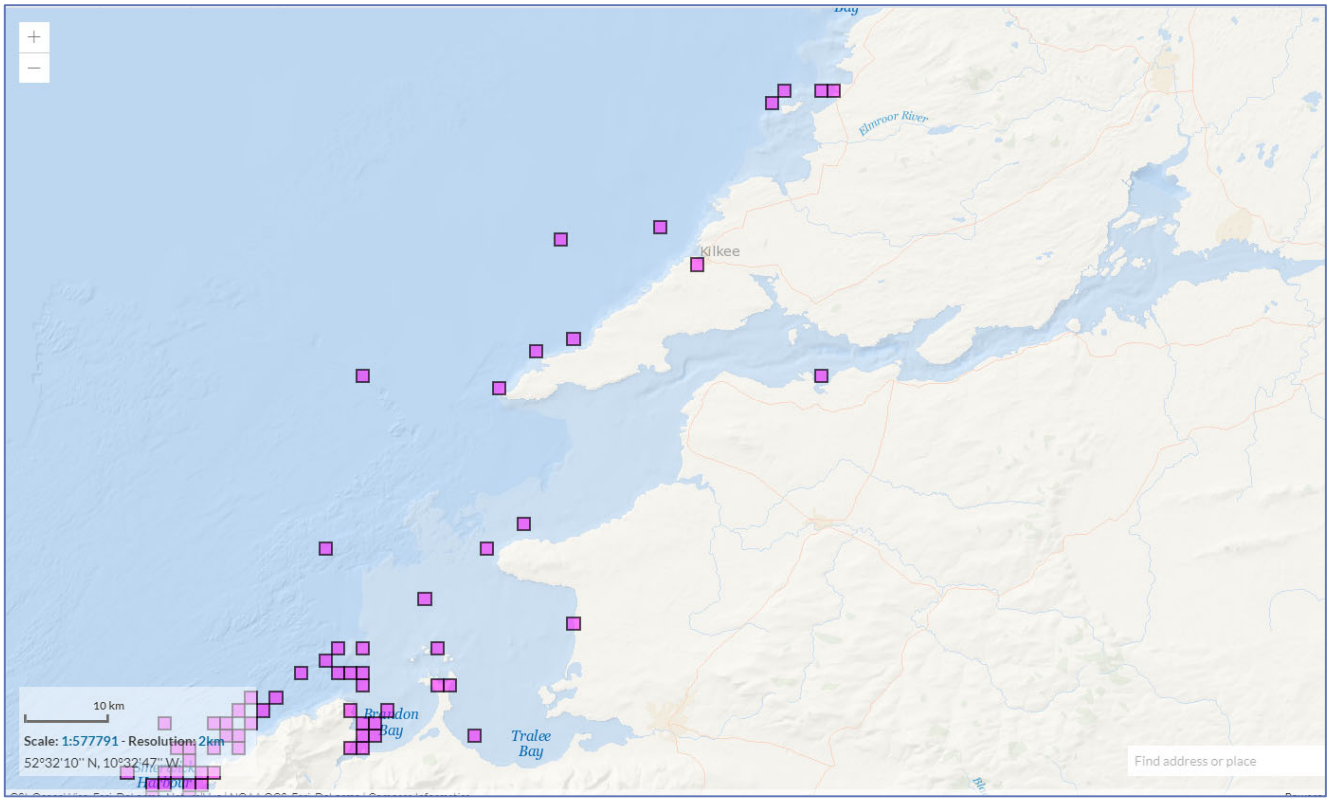

Figure 6: Map of leatherback turtle sighting records around the Shannon Estuary (map courtesy of the National Biodiversity Data Centre)

4.3.1 Leatherback turtle (Dermochelys coriacea)

Leatherback turtles are the largest extant sea turtle and have many unique anatomical and physiological adaptations (Doyle 2007). Leatherback turtles are reported regularly off north Kerry but there has been only one record within the Shannon Estuary (Figure 6), a historic record from July 1970 of indeterminate location (King and Berrow 2009).

4.3.2 Loggerhead turtle

Loggerhead turtles are stranded regularly in Ireland with records reported once every few years (King and Berrow, 2009; Doyle 2007; Marine Environmental Monitoring annual reports). They are very rarely sighted alive in Irish waters. A loggerhead turtle was recorded on 28 November 1998 stranded alive at Kilbaha, on Loop Head and taken for rehabilitation at Lahinch SeaWorld.

4.3.3 Kemp's Ridley turtle

Kemp's Ridley turtle are very rare in Irish waters with only 10 records on the NBDC database. However, one record was of a Kemp's Ridley turtle live stranded at Ballybunnion, Co. Kerry on 17 October 1992 and flown to the US for rehabilitation.

4.3.4 Otter (Lutra lutra)

Otters are widespread around the Irish coast and in the Shannon Estuary (Reid *et al.* 2013). Reynolds (2020) reported otter spraints as regularly recorded at the southern headland on Foynes Island at Bareen and are likely to occur all around the island but which is difficult to access from land to survey.

An otter survey of Foynes Port was carried out on 26 April and 3 June 2010 as part of the Foynes land Reclamation project (Berrow and O'Brien 2011), but no signs of otter presence were recorded. The lands at Durnish Island were surveyed again in August 2016 and at the East Jetty in July 2017 as part of the SFPC Capacity Extension Project. No signs of otter presence but they are considered likely to use the sites particularly the north of the Durnish lands. Records of otters from Foynes and adjacent mainland are presented below (Figure 7) and are likely to be present in most 10km^2 in the immediate area.

Figure 7: Map of otter records around Foynes (map courtesy of the National Biodiversity Data Centre)

4.3.5 Bats

All bat species in Ireland are protected under the EU Habitats Directive (92/43/EEC) and listed in Annex IV of this Directive. This Annex IV Species Risk Assessment has also considered the potential for any impacts from the proposed activities at the site on any of the ten species of bat that are confirmed as resident in Ireland (Kelleher and Marnell, 2006).

Reynolds (2020) reported bats were seen regularly at dusk but was not aware of any roosts on the island. With the exception of a sighting of a long-eared bat (*Plecotus auritus*) near the house on the east side of Foynes Island no other species has been confirmed present. The only bat records recorded adjacent to the site was the Sopano

pipistrelle bat (*Pipistrellus pygmaeus*) according to data supplied by the National Biodiversity Data Centre (accessed 1 March 2023) (Figure 8).

Figure 8: Map of soprano Pipistrelle bat distribution around Foynes Harbour (map courtesy of the National Biodiversity Data Centre)

4.4 | Non -Annex IV species but of conservation interest (ETP)

4.4.1 Basking shark (Cetorhinus maximus)

Basking sharks are frequently observed off the west coast of Clare and Kerry. Basking sharks are seasonally abundant on the surface during early spring and summer but may occur in continental shelf Irish waters throughout the year. There are no records of basking sharks in the Shannon Estuary (IWDG *unpubl. data*).

4.4.2 Pinnipeds

Grey and harbour seals are distributed around the entire Irish coast with grey seals being more abundant along the western seaboard (Cronin *et al.* 2004; O'Cadhla *et al.* 2007; O'Cadhla and Strong 2007). Common and Grey seals are occasionally reported hauled out east of Foynes Island on Sturamis Island and Beeves Rock upriver of Foynes Port. Although both species only occur in small numbers these seals are part of a much wider population.

5 | IMPACT ASSESSMENT

5.1 | Introduction

Site investigations will primarily lead to increased noise in the local marine environment. Noise associated with geophysical surveys will occur for 2 weeks and planned for Q2/2024. Noise associated with borehole investigations will be more prolonged and take 18 weeks in phase 1 in Q1-Q2/2024 and 16 weeks in phase 2 in (Q1 2026). Although this period is long drilling will not be continuous with periods of no noise production between drilling. Excess noise produced during drilling should attenuate quickly and only ensonify the local area in Foynes Harbour within Foynes Island. Surveys and drilling on the estuary side of Foynes Island will ensonify the estuary and could impact on bottlenose dolphins transiting the site. Disturbance may also occur due to increased vessel traffic associated with the site investigations.

The surveys will entail the following activities:

- Standard methods of non-invasive acoustic based sensing will include the gathering of bathymetric, side scan sonar, sub-bottom profiler and magnetometer data.
- Standard methods of geotechnical investigation including deep boreholes (30-45m deep), shallow boreholes (5-10m deep).
- There will be 79 boreholes in pre-planning (phase 1) and 84 boreholes in post planning (phase 2).
- Operation and manoeuvring of typical jack-up barge, survey vessels and floating pontoon equipment.

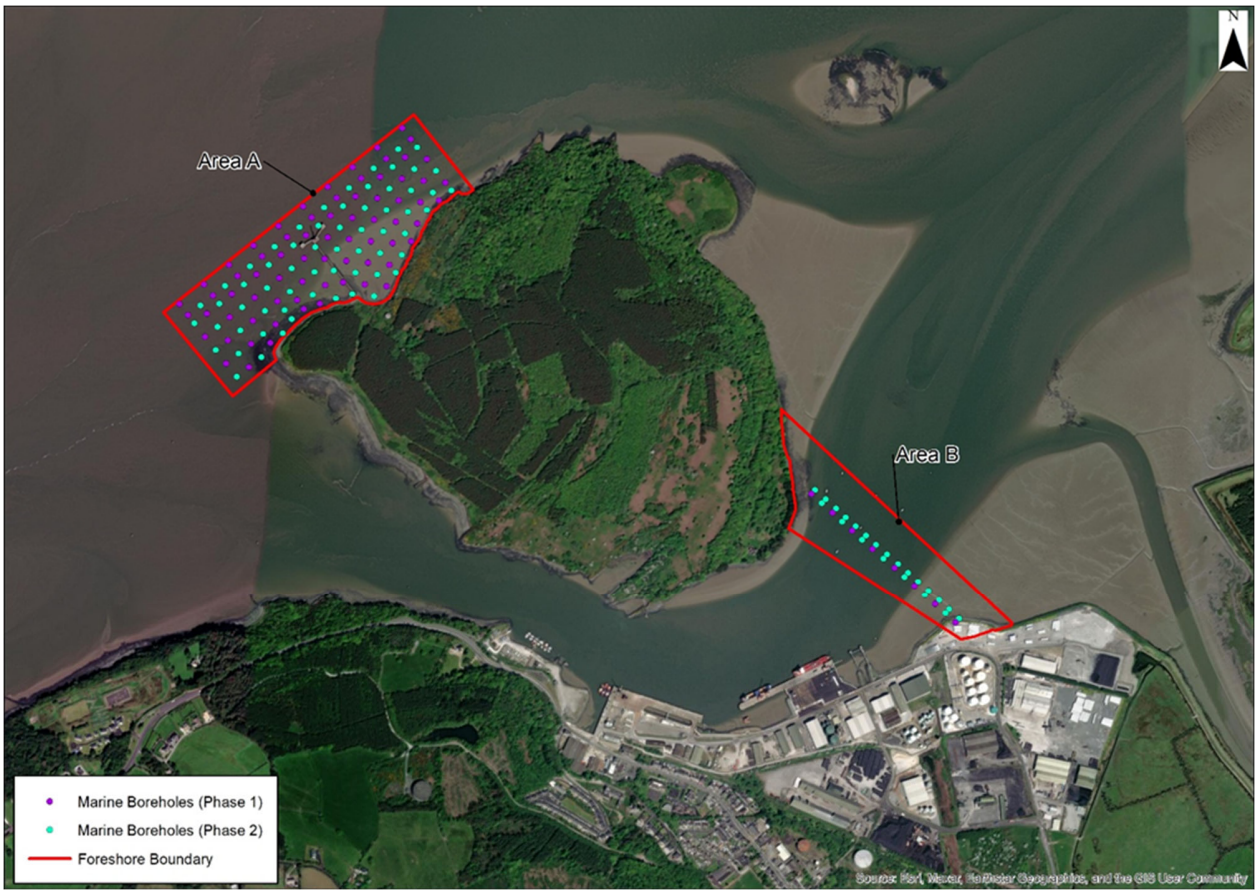

Figure 9: Proposed Site Investigations around Foynes Island, Co Limerick

Potential impacts on Annex IV species include localised disturbance, habitat degradation (e.g. decline in availability of potential prey), impulsive sound due to geophysical site investigations and continuous due to drilling and increased ambient noise due to increased vessel traffic. The marine section of the receiving environment is largely restricted to the northwest part of Foynes Island and a limited area across the island. Impacts in the wider estuary include the channel between Foynes and Cahiracon to the north and adjacent waters east and west depending on sound attenuation.

The potential effects of the proposed site investigations on Annex IV species was addressed by assessing the likelihood that these species would be exposed, or interact, with marine activities. Impacts assessed include likelihood of occurrence, and disturbance especially from noise emitted during site investigations and from extra marine activity. Acoustic disturbance includes the ability of the individual to detect increased noise levels over ambient levels, masking, Temporary Threshold Shift (TTS) and Permanente Threshold Shift (PTS) and behavioural impacts, i.e. resulting in a behavioural change by individuals.

5.2 | Description of Activities

5.2.1 Geophysical Surveys

Geophysical acoustic surveys in marine or coastal waters involve the systematic collection of information on the physical environment by means of sound signal production, reception, analysis and interpretation. Such techniques may be used, for example, to investigate bathymetry, to analyse the structure and composition of the seabed substrate, to explore extensively for and investigate subsurface geological structures or to survey specific targets (e.g., hydrocarbon reservoirs, wrecks, oceanographic features). Such methods commonly involve the use of ships or smaller vessels fitted with specialised equipment or from which such equipment can be deployed or towed. The level of environmental impact associated with this acoustic activity is variable depending on a number of factors including the type of the equipment being used, its sound signal and propagation characteristics, and the depth in which it is operating (NPWS 2014).

Geophysical surveys in coastal waters are commonly mobile, taking the form of a systematic series of survey lines within an overall target area. Depending on the location and scale of this area and the data objectives such acoustic surveys may require a period of hours, days or weeks, with many surveys being performed on a 24-hour basis once they have begun. These activities, particularly where accurate geophysical data are required via a deep acoustic penetration into the seafloor, in substantial water depths or at high resolutions, have the potential in many circumstances to introduce persistent pulse and/or non-pulse sound at levels that may impact upon marine mammal individuals and/or populations, constituting an important conservation risk (NPWS 2014).

Geophysical and geotechnical equipment produce a wide range of frequencies and source levels. MacGillivray *et al.* (2014) used modelling to explore the acoustic effects of marine survey sound sources on marine mammals. They reviewed the acoustic signatures of widely used equipment (see Table 2, reproduced from MacGillivray et al. (2014)). Sub-bottom profilers produced frequencies of 1-6 kHz at a source level of 200 dB re 1µPa @1m, while multibeam and side-scan sonar much higher frequencies of 200-230kHz at 218-229 dB re 1µPa @1m. The model indicated that odontocetes were most likely to hear sounds from mid-frequency sources (fishery, communication, and hydrographic systems), mysticetes from low-frequency sources (sub-bottom profiler and airguns), and pinnipeds from both mid- and low-frequency sources. High-frequency sources (side-scan and multibeam) generated the lowest estimated sensation levels for all marine mammal species groups.

Table 2: Selected Geophysical survey sources and their modelled specifications (reproduced from MacGillivray et al. (2014))

Table 1. Selected geophysical survey sources and their modeled specifications.

Type	Model	Frequency (kHz)	Beam width (−3 dB)	Beam orientation	Source level (rms dB re 1 μPa @ 1 m)	Rep. rate (/sec)	Pulse length (ms)
		Low-frequency (<10 kHz)					
Airgun array	Bolt 4×40 in^3	0.005-2 (pulse)	n/a	n/a	229[b]	0.1	100
Sub-bottom profiler	EdgeTech DW-106	1–6 (chirp)	28°–36° circular	vertical	200	15	33
		Mid-frequency (10 to 100 kHz)					
Communications transceiver	Simrad HiPAP 500 USBL	23	10° circular	2° from horizontal[a]	206	1	1000
Fish finding sonar	Simrad SX90	26	7° circular	2° from horizontal[a]	215	1	72
Hydrographic echosounder	Simrad EA500	38	7° circular	vertical	232	0.5	0.1
		High-frequency (>100 kHz)					
Multibeam echosounder	Simrad EM2000	200	150° × 1.5° rectangular	vertical	218	10	0.2
Side-scan sonar	EdgeTech 4500DF	230	50° × 0.15° rectangular	30° from horizontal	229	10	20

[a]Sonars with steerable beams were oriented toward the horizontal.
[b]Maximum source level in horizontal plane.

Side scan sonar, sub-bottom profiler and Magnetometer

Sub-bottom profilers are typically low to mid-frequency with high source levels and could impact on marine mammals (Table 3). Typical level magnitudes of Sub-Bottom Profilers used by IFREMER (2016) showed transmitted signals were quite homogeneous between constructors (Ixblue, Kongsberg, Knudsen). The peak levels of acoustic pressure were in the range 213 to 228 dB re 1µPa @1m. The FM signal features a long modulation typically of a few tens of ms with a relatively constant level in the frequency band. The typical pulse length was 80 ms, and the usable frequency band was between 1.8 and 5.3 kHz. The SPL (Sound Pressure Level) received is equal to 213 dB re 1µPa@1m with a pulse length of 80 ms, is 202 dB re 1 µPa².s @ 1m (IFREMER 2016).

Acoustic sources are prone to impact marine mammals when the values of SPL and SEL received by the marine mammals are above specific tolerance thresholds (depending on the signal type and frequency, and on marine mammal species). Southall et al. (2007) recommend a threshold of 215-230 dB re. 1µPa²×s. The results suggest that auditory damage is only likely if animals pass the transducer at close range and that the impact on marine mammals can be mitigated by implementing prior detection and shut down procedures.

Table 3: Typical sound characteristics of a range of sub-bottom profilers

(from https://www.federalregister.gov/documents/2015/06/30/2015-16012)

Model	High Frequency	Parametric or low Frequency	Source level primary	Source level parametric	
Atlas Parasound	18-33 kHz	0.5 to 6kHz	242/245dB	206/200 dB	Whale warning mode
Kongsberg SBP 120		2.5 to 7 kHz	220 dB		
Innomar SES-2000 Deep Parametric sub-bottom profilers	35 kHz	2, 3, 4, 5, 6, 7 kHz	244 dB		
Huntec boomer		0.5 to 8 kHz	205 dB		
Edgetech 512i		1 to 12 kHz	198 dB		
SIG '2 mille' mini-sparker		1 to 6 kHz	204 dB		
Arena Sub K-Chirp 3310		2 to 8 KHz	204 dB		
Applied Acoustics AA201 and AA301 boomer		1 to 6 kHz	212/215 dB		
Applied Acoustics Squid 500/2000 sparker		1 to 3.5 kHz	216/222 dB		
Applied Acoustics S-Boom		1 to 5 kHz	222dB approx.		

5.2.2 Boreholes

Both deep boreholes (30-45m deep) and shallow boreholes (5-10m deep) will be carried out. There will be 79 boreholes in phase 1 and 84 boreholes in phase 2. For each borehole the footprint of the works on the foreshore will be four approximately 1 m^2 legs of the jack-up barge and the 200mm (8") temporary steel casing. The 200mm steel casing is the diameter of the borehole. The boreholes are to be drilled firstly using cable percussive techniques. If rock is to be penetrated, then rotary drilling will follow on.

Borehole drilling is typically a source of low-frequency continuous noise at relatively low sound pressure levels (SPL). Recent measurements of geotechnical drilling in shallow waters (Huang Long-Fei et al. 2023) recorded an SPL of 155.9 dB re 1µPa rms @ 1 m at a peak frequency of 45 Hz. Sound measurements from a jack-up drilling boreholes in Australia showed a range of 142–145 dB re 1 µPa rms @ 1 m between 30 – 2000 Hz (Erbe &

McPherson 2017). Evans (1996 cited in Evans 2003) found SPLs of 59-127 dB re 1µPa rms @ 1 m at a peak frequency of 16Hz. Mitigation for drilling is provided for in the NPWS (2014) guidelines.

5.2.3 Increased vessel traffic

Increased vessel traffic during the site investigations is restricted to survey craft deployed during the geophysical surveys and a jack-up barge the site and will be an insignificant increase over existing vessel traffic. The presence of small vessels in the area may lead to a very localised increase in vessel traffic and associated noise. The presence of an additional small vessel and the associated noise produced, is very unlikely to have a significant impact on Annex IV species. As the likelihood of most Annex IV species, aside from bottlenose dolphin, being in the vicinity of the construction site is low there is an low risk of excessive sound exposure and impact.

5.3 | Impact Assessment

Although there are few empirical studies on the effects of geophysical and geotechnical techniques on pinnipeds or odontocetes (Richardson *et al.* 1995). Elevated noise from sub-bottom profilers could affect seals which are sensitive to a lower frequency ranges than odontocetes (Todd *et al.* 2015).

5.3.1 Bottlenose dolphins

MacGillivray et al. (2014) showed that low-frequency sources such as sub-bottom profilers were the most audible sources to large baleen whales. Mid-frequency sources (fisheries, communication, and hydrographic systems) were the most audible sources to odontocetes at ranges below 3km, but low-frequency sources began to dominate between 3 and 10 km. Low- and mid-frequency systems have similar estimated audibility for seals due to their broad hearing range. For all species, modelled sensation levels are lowest for the high-frequency sources (side-scan and multibeam), which operate at the upper limits of the audible spectrum. The estimated zone of audibility for all species is largest for the low-frequency sources (sub-bottom profiler), which propagate over longer distances relative to the rapidly attenuating high frequencies. Thus bottlenose dolphins if very close to the vessel during site investigations may lead to disturbance and at worse temporary threshold shift (TTS).

Mahon (2017) found an impact of drilling on land associated with erecting onshore wind turbines at Moneypoint, with an increase in whistles vocalisations during drilling, compared to when there was no drilling. What the implications of these findings are, and the impact on dolphins, is unclear but it does indicate an effect of drilling even when occurring on land adjacent to the estuary. Similar vibration and rotary drilling occurring in the actual marine environment will lead to increased noise levels compared to that recorded by Irwin-Carr (2021) and potentially to greater impacts.

5.3.2 Seals

Anderwald *et al.* (2013) found that grey seals showed some level of avoidance to high construction vessel traffic in Ireland but this study was in a relatively pristine environment. This exposure may lead to some chronic exposure to man-made noise, with which they tolerate. Ecological or physiological requirements may leave some marine mammals with no choice but to remain in these areas and continue to become chronically exposed to the effects of noise. In areas with repeated exposure, mammals may become habituated with a decline in avoidance responses and thus become less sensitive to noise and disturbance (Richardson *et al.* 1995). Reactions, when measured, have only occurred when received sound levels are well above ambient levels.

5.3.3 Otters

Otter are quite sensitive to low frequency sounds as their sensitivity range is low but they are less sensitive than marine mammals. They can therefore hear and are susceptible to the noise of shipping, geotechnical drilling, SBP and HESS. However only those individuals within the water will be exposed and then only when very close to the activities.

The presence of otters is assumed, but the proposed marine site investigations wouldn't have potential to give rise to any significant impacts to otter, as these areas are already subject to some levels of human disturbance and are part of much larger areas of suitable habitat for the species in the wider area, with coastal territories between 2km and 10km of shoreline. In addition otter are primarily nocturnal, although coastal otters certainly appear to be less so, and the works will take place during the day. The marine SI will have extremely limited potential to impact upon terrestrial resting and breeding locations for otter.

5.3.4 Bats

The area has low suitability for bats, due to the absence of preferred bat habitats (e.g., woodland, hedgerows, freshwater lakes and rivers) or roost sites. Considering the low suitability of the area for roosting, foraging or commuting bats, the site is considered to be of negligible value for bats. Based on these findings in relation to bats as it is concluded that the proposed works will have no impact on the terrestrial Annex IV species, bats.

5.3.5 Leatherback turtles

Leatherback turtles are unlikely to be disturbed by marine activities even if they were in the vicinity. However, the likelihood of marine turtles being in the area during operations is non-existent as the operations planned to occur in Q1 and Q2 2024.

5.4 | Identification of Relevant Natura 2000 sites with marine mammals as a qualifying interest

Marine mammals are highly mobile and range far outside those sites designated to protect them. Outside of the Lower River Shannon SAC, which has bottlenose dolphins as a qualifying interest and where the site investigations occur wholly within the site, the Blasket Islands SAC is the closest SAC where marine mammals are included as qualifying interests (Table 4).

Table 4: Special Areas of Conservation, which list marine mammals as a Qualifying Interest, within reasonable foraging range of Shannon Estuary

Site	Qualifying Interest			Distance to Foynes Island	
	Grey seal	Harbour seal	Harbour porpoise	nmls	km
Blasket Islands SAC (Site Code 002172)	X		x	67.5	125

The boundary of the Blasket Islands SAC is around 125km from Foynes Island, Although harbour porpoises are highly mobile and have been occasionally reported in the inner estuary (O'Callaghan et al. 2021), it is extremely unlikely they will be exposed to proposed works at Foynes Island and there will be no impact on the Conservation

Objectives of the Blasket Islands SAC. While grey seals have been reported in waters adjacent to Foynes Island and it is possible that these same individuals may breed in the Blasket Islands SAC, the mitigation proposed during potentially harmful activities will ensure any exposure will not lead to any impact and there will be no impact on the Conservation Objectives of the Blasket Islands SAC for grey seals.

5.4.1 Potential disturbance to life cycle

The proposed marine operations will not cause any adverse effects on Annex IV species in the area as the affected area is small and disturbance very local and of relatively short duration.

5.4.2 Cumulative Effects

Cumulative effects may occur if the proposed development time period overlaps with proposed site investigations or relevant activity downstream as noted in Table 5.

Table 5. Activities which may lead to Potential Cumulative Effects

Development	Location	Activities	Period	Distance from Foynes Island
Eirgrid Cross Shannon 400kV Electricity Cable	Moneypoint, Co Clare to Kilpaddoge, Co Kerry	Laying of 400 kV submarine cables across the Lower Shannon Estuary	2023/2024	19 km
Shannon Technology and Energy Park	Ardmore point. Co Kerry	Site investigations	None	22km
Atlantic Energy Hub	Moneypoint, Co Clare	Site investigations	None	22km
Clarus Offshore Wind Farm	Extends from Tarbert in the Lower Shannon Estuary to the Mouth of the Shannon and along the Co Clare Coastline to Doonbeg	Site investigations (subject to foreshore consent)	Programme 5 years post consent	17km
Illen Offshore Array	Extends from Kilpaddoge, Co Kerry in the Lower Shannon Estuary to the Mouth of the Shannon and seaward to the 12nm limit	Site investigations (subject to foreshore consent)	Programme 5 years post consent	19 km
Mainstream Renewable Power Ltd.	Extends from Tarbert in the Lower Shannon Estuary to the Mouth of the Shannon and northwards along the Co Clare Coastline to Doonbeg and southwards along the County Kerry Coastline to the south of Ballyheige Bay	Site investigations (subject to foreshore consent)	2023/2024 assuming foreshore consent	17km

Moneypoint Offshore Wind	Moneypoint Co Clare in the Lower Shannon Estuary through the Mouth of the Shannon and seaward to the 12nm limit	Site investigations (subject to foreshore consent)	None	22km
Rian Offshore Array Ltd.	Tarbert Co Kerry in the Lower Shannon Estuary through the Mouth of the Shannon and seaward to the 12nm limit	Site investigations (subject to foreshore consent)	None	17km

5.4.2 Conclusion

Mitigation for some Annex IV species will be required. The likelihood of bottlenose dolphin and to a lesser extent seals and otter occurring with the impact zone is high, especially during activity to the north of Foynes Island. It is likely any sound pressure from site investigations could impact on bottlenose dolphins and seals without mitigation. Although otters may occur in the area, risk exposure is extremely low as most noise will occur within the marine environment and activities will be carried out during the day. Mitigation is required to minimize impacts on these Annex IV species and the NPWS (2014) guidelines would apply during geophysical and geotechnical operations.

It is extremely unlikely that species such as marine turtles or basking sharks will be exposed to potential impacts as the likelihood of them being within the impacted area is extremely low. Although bats may occur in the area risk exposure is extremely low as most noise will occur within the marine environment and activities will be carried out during the day.

6 | MITIGATION MEASURES

Mitigation is required to minimize impact for some Annex IV species including bottlenose dolphin, seals and otter. We recommend implementation of the NPWS (2014) guidelines and limited static acoustic monitoring as outlined below.

6.1 | Marine Mammal Mitigation

The National Parks and Wildlife Service recommend a distance of 500m radial distance of the sound source in water depths of <200m (NPWS 2014) on commencement of drilling and 500m radial distance of the sound source with respect to geophysical surveys.

6.1.1 Guidance to Manage the Risk to Marine Mammals from Man-made Sound Sources in Irish Waters

The mitigation measures recommended by the NPWS are for the presence of a trained and experienced Marine Observer (MMO) to ensure a “buffer zone” is clear of marine mammals prior to the start of noise inducing activities. The proposed mitigation measures (Guidance to Manage the Risk to Marine Mammals from Man-made Sound Sources in Irish Waters) recommended by the Department of Arts, Heritage and the Gaeltacht in 2014 are designed to mitigate any possible effects. The following mitigation measures are proposed to minimise the potential impacts on marine mammals and to allow animals move away from the area of geophysical and geotechnical operations:

1. A dedicated, qualified and experienced Marine Mammal Observer will conduct a 30-minute watch for marine mammals within 500m prior to start-up of drilling and 1000m for geophysical surveys (Figure 10). If an Annex IV species (cetacean, marine turtle or otter) or seal is sighted within 500/1000m of the site, start-up must be delayed until the animal(s) is observed to move outside the mitigation zone or the 30 minutes has passed without the animal being sighted within the mitigation zone.
2. Multibeam, single beam, side-scan sonar and sub-bottom profiler surveys activities shall only commence in daylight hours where effective visual monitoring, as performed and determined by the MMO, has been achieved. Where effective visual monitoring, as determined by the MMO, is not possible the sound-producing activities shall be postponed until effective visual monitoring is possible.
3. Drilling activities shall only commence in daylight hours where effective visual monitoring, as performed and determined by the MMO, has been achieved. Where effective visual monitoring, as determined by the MMO, is not possible the sound-producing activities shall be postponed until effective visual monitoring is possible.
4. Once normal operations commence, there is no requirement to halt or discontinue the activity at night-time, nor if weather or visibility conditions deteriorate nor if marine mammals occur within a 500/1000m radial distance of the sound source, i.e., within the MZ.

10a.

10b. 

Figure 10: a) Proposed 500m mitigation zone around drilling and b) 1000m mitigation zone around geophysical and geotechnical activities proposed at Tarbert Island (as per NPWS (2014) guidelines)

6.1.2 Static Acoustic Monitoring

Static acoustic monitoring through the use of FPODs at Foynes jetty and a control site, will also be carried out prior to, and throughout site investigations, and for a period post surveys to ensure bottlenose dolphin activity at the site is not affected long-term and the presence of dolphins at the site returns to pre-site investigation levels.

7 | NPWS ASSESSMENT

1. **Do individuals or populations of Annex IV species occur within the proposed area?**
   Bottlenose dolphin are the most frequently recorded Annex IV species adjacent to the site. Otters, also occur at the site and bats forage within the site but marine turtles do not occur.

2. **Is the plan or project likely to result in death, injury or disturbance of individuals?**
   The activities proposed during site investigations are boring, side-scan sonar and sub-bottom profiler surveys. It is likely that noise generated will be capable of causing disturbance or temporary hearing injury to a marine mammal without mitigation.

   The project may cause injury and disturbance without the proposed mitigation, as impacts including noise associated with the project may travel a short distance potentially exposing a suite of Annex IV species to the activity. The risk of injury in the marine environment is considered high, but low for terrestrial Annex IV species.

3. **Is it possible to estimate the number of individuals of each species that are likely to be affected?**
   Abundance estimates for bottlenose dolphins within the Lower River Shannon SAC are available. The most recent estimate was carried out between June and September 2022 by Berrow et al. (2022) who provided a final best estimate of 116 ± 9 with a CV 0.08 and 95% Confidence Intervals of 103 to 122. However not all the Shannon dolphins use the inner estuary and is more likely a sub-set of 30-40 individuals may be exposed to site investigations. Seals occur in low numbers within the Shannon Estuary. Otters are also likely to occur in small numbers but there are no marine turtles.

4. **Will individuals be disturbed at a sensitive location or sensitive time during their life cycle?**
   The proposed geophysical works are scheduled to be carried out for 2 weeks during Q2/2024. Boring will take place over a 18 and 16 week period in Q1 and Q2/2024 and in Q1 2026. Bottlenose dolphins occur all year around with calving peaking late summer. Acoustic monitoring suggested autumn was the highest predicted foraging period at Foynes Island. Seals and otters also occur year round in small numbers.

5. **Are the impacts likely to focus on a particular section of the species' population, e.g., adults vs. juveniles, males vs. females?**
   Bottlenose dolphin calves may be exposed to site investigations if born towards the start of the summer. Immatures and dependant calves would also be exposed when occurring at Foynes Island.

6. **Will the plan or project cause displacement from key functional areas, e.g., for breeding, foraging, resting or migration?**
   The site, although regularly visited by bottlenose dolphins, is not a critical habitat. Acoustic evidence suggests that the proposed marine activities will not lead to any significant disturbance of Annex IV species known to occur in the area. Small numbers of grey seals may occur in the vicinity of the site but they are accustomed to human activities and are unlikely to be affected.

7. **How quickly is the affected population likely to recover once the plan or project has ceased?**
   Any disturbance occurring with the proposed mitigation in place would be short term and local to Foynes Island and not lead to any long terms impacts.

8 | RESIDUAL IMPACTS

There will be no residual impacts from the proposed marine operations on Annex IV species in the area.

9 | SUMMARY

Annex IV species do occur frequently in the area of interest, including the resident bottlenose dolphins, some seals and otters on the shore. No marine turtles occur at the site but bats will forage overhead. We recommend implementation of the NPWS (2014) mitigation guidelines which if implemented will result in no significant impacts on Annex IV species. Static Acoustic Monitoring for bottlenose dolphins before, during and after boring is also recommended to ensure mitigation results in no displacement of dolphins from the area.

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