



Arklow Bank Wind Park (ABWP) Phase 2

*Repeat Multibeam Survey (July-August 2020)
Marine Mammal Mitigation Report*

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Project Title:	Arklow Bank Wind Park (ABWP) Phase 2
Report Title:	Repeat Multibeam Survey (July-August 2020) Marine Mammal Mitigation Report
Document reference:	18086-R-001-01
Client:	Sure Partners Limited
Ultimate Client:	SSE Renewables

Document Control

Revision	Date	Authored:	Checked:	Approved:
00	19/08/2020	Hannah Keogh	David O'Sullivan	David O'Sullivan
01	03/09/2020	Hannah Keogh	David O'Sullivan	David O'Sullivan

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List of Abbreviations

ABWP	Arklow Bank Wind Park
BEP	Best Environmental Practice
EPS	European Protected Species
HRS	High Resolution Survey
HRB	High Resolution Bathymetric
IA	Investigation Area
JIP	Joint Industry Programme
MBES	Multibeam Echosounder
MMO	Marine Mammal Observer
MZ	Mitigation Zone
NPWS	National Parks and Wildlife Service
OWF	Offshore Wind Farm
SAC	Special Area of Conservation
SPL	Sound Pressure Level

1 Introduction

1.1 Project Overview

Sure Partners Limited commissioned repeat High Resolution Bathymetric (HRB) surveys of 4 Investigation Areas (IA's), at neap tidal periods specified, across the proposed Arklow Bank Wind Park (ABWP) Phase 2 and associated cable route. The current ABWP Phase 1 is a fully operational site comprising 7 x 3.6 MW turbines, located approximately 10 km off the east coast in the Irish Sea. The Phase 2 lease area lies in a north south orientation between 10 and 15 km off the coastline of Arklow, County Wicklow.

As part of the project consenting requirements an experienced Marine Mammal Observer (MMO) was provided to conduct marine mammal mitigation for the geophysical acoustic operations associated with the survey. Observations were conducted on-board the dedicated survey vessel, AMS Panther. National Parks and Wildlife Service (NPWS) of the Department of Arts, Heritage and the Gaeltacht 'Guidance to Manage the Risk to Marine Mammals from Man-made Sound Sources in Irish Waters' (NPWS, 2014) was implemented in accordance with the 'Arklow Bank Wind Park Geophysical and Geotechnical Survey Noise Risk Assessment' (RPS, 2018), which outlined industry best practice approach to mitigate against any possible disturbance to marine mammals.

A multibeam echosounder (MBES) was employed for the bathymetric survey. Potential impacts of these systems on cetaceans vary depending on the following: the sound propagation characteristics of the environment into which it is introduced, its intensity, frequency, duration and distance from biological receptors.

1.2 Survey Area

The Arklow Bank is a shallow water sandbank in the Irish Sea, 13km to the east of Arklow, County Wicklow. The Arklow Bank is approximately 27km long and 2.5km wide. Water depths vary between 2m and 25m, although there are areas which have water depths of less than 1m. The existing turbines are located towards the centre of the sandbank, with water depths varying between 2m and 5m (Lowest Astronomical Tide (LAT)).

There are no designated conservation sites for marine mammals in the immediate vicinity of the works. Therefore, there will be no direct impacts on any protected sites associated with the works, however there is potential for qualifying interests and features associated with Rockabill to Dalkey Island SAC (and sites further afield, see Figure 1) to be present in the survey area. A known haul-out and pupping site for grey seal exists at Brides Head, County Wicklow.

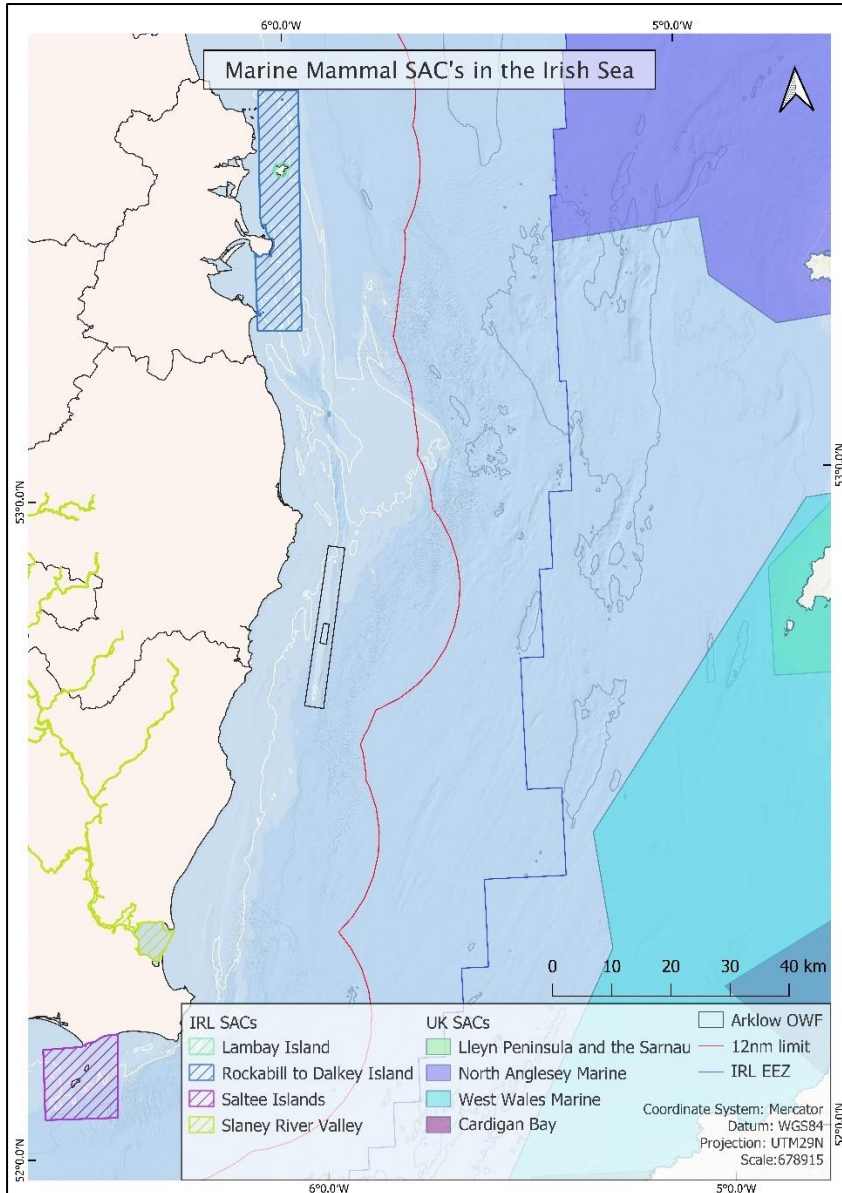


Figure 1 SACs with marine mammals as features of interest in the Irish sea.

1.3 Marine Mammals and Underwater Noise

The addition of noise into the marine environment and its impact on marine mammals, which use sound for navigating, feeding and mating, is a key topic of concern. Cetaceans (whales, dolphins and porpoises) are particularly sensitive to underwater noise. The effects of noise can include death or serious injury and/or physical injuries that can have longer term consequences for the animal such as hearing sensitivity and behavioural effects such as the displacement from an area (Temporary Threshold Shift (TTS) and Permanent Threshold Shift (PTS)).

Possible effects of underwater noise on marine mammals in general can be broadly summarised into the following categories:

- Physical injury and/or death
- Auditory damage (temporary or permanent)
- Behavioural
- Chronic/stress
- Indirect effects

The onset of TTS and PTS in marine mammals can be attributed from impulsive noise (e.g. boomer, sparker) and non-impulsive noise (e.g. sonar-based survey equipment, vessels, drilling). The sound emitted by man-made sources may induce TTS or PTS in an animal in two ways; unweighted peak Sound Pressure Levels (SPL peak) and marine mammal hearing-weighted Sound Exposure Levels (SEL). In order to provide a conservative assessment, the industry guidelines provided by US National Marine Fisheries Service (NMFS, 2018) recommend adopting both metrics as a dual noise criteria approach. Table 1 outlines the thresholds for marine mammals exposed to impulsive and non-impulsive underwater noise.

Table 1 Summary of acoustic thresholds for marine mammals for impulsive and non-impulsive sound (NMFS, 2018).

Hearing group	Parameter	Impulsive sound				Non-impulsive sound		
		PTS	TTS	Strong disturbance	Mild disturbance	PTS	TTS	Disturbance
Low-frequency (LF) cetaceans	SPL peak, unweighted	219	213	-	-	-	-	-
	SEL, LF weighted	183	168	-	-	199	179	-
	RMST90	-	-	160	140	-	-	120
Mid-frequency (MF) cetaceans	SPL peak, unweighted	230	224	-	-	-	-	-
	SEL, MF weighted	185	170	-	-	198	178	-
	RMST90			160	140	-	-	120
High-frequency (HF) cetacean	SPL peak, unweighted	202	196	-	-	-	-	-
	SEL, HF weighted	155	140	-	-	173	153	-
	RMST90	-	-	160	140	-	-	120
Phocid pinnipeds (PW)	SPL peak, unweighted	218	212	-	-	-	-	-
	SEL, PW weighted	185	170	-	-	201	181	-
	RMST90	-	-	160	140	-	-	120

Peak sound pressure level (SPL peak) has a reference value of 1 μPa , and weighted cumulative sound exposure level (SEL) has a reference value of $1\mu\text{Pa}^2\text{s}$. The subscript associated with cumulative sound exposure level thresholds indicates the designated marine mammal auditory weighting function (LF, MF, and HF cetaceans, and PW pinnipeds) and that the recommended accumulation period is 24 hours.

Southall et al. (2007) classified cetacean and seal species into functional hearing groups based on similarities in known or expected hearing capabilities (Table 2). The hearing weighting function is designed to represent the bandwidth for groups of marine mammals within which acoustic exposures can have auditory effects.

Table 2 Functional marine mammal hearing groups and estimated auditory bandwidth, adapted from Southall *et al.* (2007) and NMFS (2018).

Marine Mammal Hearing Group	Generalised Hearing Range according to Southall et al. (2007)	Generalised Hearing Range according to NMFS (2018)
Low-frequency cetaceans	7 Hz to 22 kHz	7 Hz to 35 kHz
Mid-frequency cetaceans	150 Hz to 160 kHz	150 Hz to 160 kHz
High-frequency cetaceans	200 Hz to 180 kHz	275 Hz to 160 kHz
Pinnipeds (in water)	75 Hz to 75 kHz	-
Pinnipeds (in water)	-	50 Hz to 86 kHz

Low frequency cetaceans include baleen whale spp.; Mid frequency cetaceans include bottlenose dolphin; High frequency cetaceans include harbour porpoise; Pinnipeds include grey and harbour seals.

1.4 Marine Species Legislation

All species of cetacean (whale, dolphin and porpoise) and otter occurring in Irish waters are listed in Annex IV of the EC Habitats Directive (92/43/EEC) as European Protected Species (EPS) which require a strict protection regime across their entire natural range within the EU, both within and outside Natura 2000 sites.

Grey seal, harbour seal, bottlenose dolphin and harbour porpoise are listed under Annex II of the EC Habitats Directive (92/43/EEC) as species of Community Interest, whose conservation requires the designation of Special Areas of Conservation (SACs), these sites must be managed in accordance with the ecological requirements of the species.

The European Communities (Birds and Natural Habitats) Regulations 2011-2015 transpose the EC Habitats Directive (92/43/EEC) into Irish law. Regulation 51(2) prohibits the following in relation to cetaceans (Annex IV sp.):

- All forms of deliberate capture or killing of specimens of those species in the wild.

- The deliberate disturbance of those species particularly during the period of breeding, rearing, hibernation and migration.
- The deterioration or destruction of breeding sites or resting places of those species.

Under Wildlife Acts 1976 to 2018, any species listed under the Fifth Schedule, including cetaceans and seals, is protected from injury, disturbance or damage to breeding and resting sites.

1.5 Best Industry Practice

Best Environmental Practice (BEP) was employed following NPWS Guidelines which involved the use of a qualified and experienced MMO.

1.6 Mitigation Requirements

According to *Arklow Bank Wind Park Geophysical and Geotechnical Survey-Noise Risk Assessment* produced (RPS, 2018) and current recommendations from *Guidance to Manage the Risk to Marine Mammals from Man-made Sound Sources in Irish Waters Guidelines* (NPWS, 2014) the following mitigation requirements were fulfilled during operations according to BEP:

- Pre-start monitoring: geophysical survey operations shall not commence if marine mammals are detected within a 350 m radial distance of the vessel. The 350 m monitoring distance proposed is conservative and adequately accounts for the maximum likely zone of influence for injury which is 130 m.
- Survey operations shall only commence in daylight hours where effective visual monitoring within a 350 m radial distance of the vessel by the MMOs 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 has been completed.
- This prescribed Pre-Start Monitoring shall be subsequently followed by a Ramp-Up Procedure which will include continued monitoring by the MMO.
- Ramp-up procedure: prior to commencing survey operations a ramp-up procedure for a period of 4 minutes shall be carried out, where the peak sound pressure level from the source exceeds 170dB re: 1 μ Pa @ 1m.
- Breaks in sound output: If there is a break in sound output for a period greater than 30 minutes then pre-start monitoring and ramp-up procedure will be undertaken in full.
- Once operations begin, there is no requirement to halt or discontinue the procedure.

*The multibeam echosounder (MBES) equipment on this survey was not capable of undertaking the ramp-up procedure and therefore this did not take place. We note this situation is accounted for in the guidance (NPWS, 2014) in section 4.3.4 (ii) 7. (a).

Detailed methods on how these mitigation requirements were fulfilled by the MMO are provided in section 2.4 Mitigation Procedure.

1.7 Marine Mammal Sensitivities

Information on marine mammal abundance and distribution comes from a range of resources, including estimates of cetacean abundance in European Atlantic waters in summer 2016 from the SCANS-III aerial and shipboard surveys (Hammond *et al.*, 2017), dedicated and opportunistic sightings surveys (e.g. Irish Whale and Dolphin Group) and various research papers.

Two species of pinnipeds, grey seal (*Halichoerus grypus*) and harbour seal (*Phoca vitulina*) and one species of cetacean, harbour porpoise (*Phocoena phocoena*) were most likely to be encountered during the geophysical survey. A summary of each species considered is provided below.

1.7.1 Pinnipeds (Seals)

Harbour seal (*Phoca vitulina*)

Harbour seal, often called ‘common seal’ is the smaller of two species of true seal (Phocidae) that commonly breed around the coasts of Britain and Ireland. Harbour seals come ashore in sheltered waters typically on sandbanks and in estuaries, but also in rocky areas. They give birth to their pups and mate during May-July approximately. Peak moulting takes place between approximately August-September. Foraging takes place 40-50km around their haul-out sites (SCOS, 2017.) They are vulnerable to disturbance at pupping/moulting stages in the life cycle. This species is present at Slaney River Valley SAC and Lambay Island SAC as a feature of interest.

Morris & Duck (2019) reported a nationwide population estimate of 4,007 for harbour seals in a 2017/2018 aerial survey, an increase compared to 3,489 counted in 2011/2012 (Duck and Morris, 2013) and 2,955 counted in 2003 (Cronin *et al.* 2004). No harbour seals or haul out sites were identified in the County Wicklow region during the above-mentioned surveys. It is not thought that this species pups/moults in the vicinity of the survey works.

Grey seal (*Halichoerus grypus*)

As one of the rarer seal species, its world population is estimated at just 350,000 to 400,000 individuals (SNH, 2017). Grey seals come ashore on remote islands, sandbanks and rocky coastlines to give birth to their pups. The breeding season occurs between approximately August - December. Mating also takes place at breeding sites or in the water nearby. Moulting takes place between approximately December - April. Foraging can take place 100km to several hundred kilometres offshore (SCOS, 2017). Individual mature grey seals of both sexes usually show high site fidelity and may return to within 10–100m of individual breeding locations (Pomeroy *et al.*, 2000). They are vulnerable to disturbance at pupping/moulting stages in the life cycle. A known pupping site is located 19km from the survey area at Brides Head, Co. Wicklow. This species is present within Lambay Island SAC and Saltee Islands SAC as a feature of interest.

Morris & Duck (2019) reported a nationwide population estimate of 3,698 grey seals in 2017/2018 compared with 2,964 counted in 2011/2012 and 1,309 counted in 2003.

1.7.2 Cetaceans (Whales, Dolphins and Porpoises)

Harbour porpoise (*Phocoena phocoena*)

The harbour porpoise is the most widespread and abundant cetacean species in Irish waters (Berrow, 2001). It has been recorded off all coasts and over the continental shelf but is thought to be most abundant off the southwest and east coasts. Highest relative abundance of harbour porpoises were recorded in the Irish Sea during the summer months (Wall *et al.*, 2013). SCANS-III data (Hammond *et al.*, 2017) demonstrate harbour porpoise abundance to be estimated at 8,320 (CV= 0.28; 95% CI: 4,643-14,354) in the Irish Sea. This species is present within the Rockabill to Dalkey Island SAC, and a number of sites in UK waters as a feature of interest.

Bottlenose dolphin (*Tursiops truncatus*)

Bottlenose dolphins occur off all Irish coasts with inshore animals moving around the entire Irish coastline and between the UK and Ireland (Wall *et al.*, 2013). They can also occur offshore, often in association with other cetaceans. Most offshore animals probably represent a separate population, although some inshore dolphins may move offshore during the winter months (Reid, *et al.*, 2003). SCANS-III data (Hammond *et al.*, 2017) demonstrate bottlenose dolphin abundance to be estimated at 288 (CV= 0.57; 95% CI: 0-664) in the Irish Sea. This species is present as a feature of interest in a number of sites in UK waters.

Minke whale (*Balaenoptera acutorostrata*)

Minke whales are the smallest and most frequently sighted whales in Irish inshore waters (Berrow *et al.*, 2010). They occur off all coasts including the Irish Sea and over the continental shelf. Wall *et al.*, (2013) reported that minke whales were present in the Irish Sea from late April through to early August but were largely absent for the rest of the year, with highest relative abundance recorded off the south and south-west coasts in the Autumn. SCANS-III data (Hammond *et al.*, 2017) demonstrate minke whale abundance to be estimated at 603 (CV= 0.62; 95% CI: 134- 1,753) in the Irish Sea.

Short-beaked common dolphin (*Delphinus delphis*)

Common dolphins are Ireland's most widespread and abundant dolphin species and occur off all Irish coasts and over the continental shelf. Wall *et al.*, (2013) reported highest relative abundances off the south and southwest coasts and in low densities from late spring to mid-autumn in the Irish Sea and were found to be largely absent during the winter months. No sightings of common dolphin were observed by SCANS-III in the Irish Sea, however the Irish Whale and Dolphin Group sightings and strandings schemes report a number of sightings and strandings along the east coast of Ireland.

Risso's dolphin (*Grampus griseus*)

Risso's dolphin are generally found in deep water habitats along shelf slopes, however in Ireland they can be found along inshore shelf slopes and in coastal waters. Risso's dolphins have been recorded in Irish Waters from April to November, with sightings peaking during the summer months (Wall *et al.*, 2013). SCANS-III data (Hammond *et al.*, 2017) demonstrate Risso's dolphin abundance to be estimated at 1090 (CV= 0.69; 95% CI: 0- 2,843) in the Irish Sea.

2 Methods

2.1 Survey Vessels

Survey work was completed on-board the survey vessel, AMS Panther (see Table 3 and Plate 1).

Table 3 Summary of vessel specifications for the AMS Panther

Vessel Name	AMS Panther
Call Sign	2EHC2
MMSI	235085036
Year Built	2011
Length overall	17m
Breadth	6m
Max Draft	10m



Plate 1 Survey vessel AMS Panther

2.2 High Resolution Survey Equipment

Only one piece of High-Resolution Survey (HRS) equipment was required during the bathymetric survey:

- Norbit iWBMS multibeam echo-sounder (MBES) was mounted on either side of the vessel at 0.8 and 1.1m below the water line and operated between 360-440 kHz, with Sound Pressure Levels (SPL) of 220 dB re 1 μ Pa (peak), and Sound Exposure Levels (SEL) at 180 dB re 1 μ Pa^{2.5}. It was not possible according to the operational parameters of the MBES to carry out a ramp-up/soft start procedure of acoustic output.

2.3 Mitigation Team

The AMS Panther operated on a 12-hour basis with a dedicated MMO based onboard to provide mitigation for operations throughout daylight hours. Acting as consultant to the client at all times, the MMO liaised directly with the survey team and vessel contractors with regards to the NPWS Guidelines. It was the MMO's responsibility for ensuring that the contractors were aware of their commitment to the latest NPWS Guideline procedures.

2.4 Mitigation Procedure

The latest NPWS Guidelines 'Guidance to manage the risk to marine mammals from man-made sound sources in Irish waters' (NPWS, 2014) was utilised during operations. The guidelines, specifically in relation to this project, are summarised below:

2.4.1 Pre-Start Monitoring

Sound producing activities should not be commenced during periods of darkness, poor visibility (such as fog), or during periods when the sea state is not conducive to visual mitigation (above Sea State WMO 4), as there is a greater risk of failing to detect the presence of marine mammals. The Mitigation Zone (MZ) should be monitored visually by MMOs for a minimum of 30 minutes prior to a ramp-up of equipment.

2.5 Mitigation Zone

The Mitigation Zone or Monitoring Zone (MZ) is the body of water surrounding the location of the noise source, which the observer monitors visually for the presence of marine mammals before and during operations. The extent of this zone represents the distance at which a marine mammal could still be exposed to sound levels capable of causing disturbance or injury. A MZ with a 350m radius for marine mammals from the sound source was adopted in accordance with *Arklow Bank Wind Park Geophysical and Geotechnical Survey-Noise Risk Assessment* produced (RPS, 2018).

2.5.1 Delay if marine mammals detected within mitigation zone

Sound producing activities should not be commenced if marine mammals are detected within the mitigation zone or until 30 minutes after the last visual detection. The MMO should track any marine mammals detected and ensure they are satisfied the animals have left the mitigation zone.

2.5.2 Ramp-up Procedure

A ramp-up is the gradual increase of power or intensity incrementally over a set time period, until full operational power or intensity is achieved. The ramp-up duration should be a period of 20 minutes for HRS equipment where the output peak sound pressure level exceeds 170 dB re: 1µPa @1m.

In all cases the delay between the end of ramp-up and the start of a survey line or station must be minimised to prevent unnecessary high-level sound introduction into the environment. Once the ramp-up procedure commences there is no requirement to halt or discontinue the procedure at night-time, nor if weather or visibility conditions deteriorate nor if marine mammals occur within the mitigation zone.

2.5.3 Break in sound output

If there is a break in sound output for a period of 30 minutes (e.g., due to equipment failure, shut-down, survey line or station change) then all Pre-start Monitoring and a subsequent Ramp-up Procedure must be undertaken.

2.6 Visual Observation

Visual observations were undertaken on board the survey vessel to support all survey works. The MMO must be confident that there were no marine mammals within the MZ prior to commencement of operations and must be aware of any marine mammals within the surrounding area outside the MZ. NPWS Guidelines recommend that as a minimum, 30 minutes of pre-start monitoring prior to operations commencing should be conducted in favourable conditions. MMO effort continued after the dedicated pre-watch, even though operations were considered continuous, in order to assess marine mammal distribution and behaviour towards the operations, and in the event of a breakdown or stop to operations.

2.6.1 Observation Platform

Observations were carried out from a platform ~3m above sea level which offered a 360-degree view. The MMO maintained visual observations during daylight hours. Bearings and distances to sightings were recorded using reticular binoculars, and in combination with a distance stick. Data were collected using standard JIP22 deck forms. Environmental data were recorded every hour and when weather and/or activity changed.

2.6.2 Equipment

The MMO was equipped with:

- Opticron Marine2 7x50 binoculars (7x Magnification, 50mm Objective Lens Diameter)
- Range finding distance stick
- Handheld GPS
- Outdoor clothing and PPE
- JIP22 deck forms

3 Results

3.1 Operations

Over the course of the 21 days of survey work, 159hrs 31mins of acoustic output was generated. Full details of operations can be found in the Appendices.

3.2 Observation Effort

A dedicated MMO was based on the observer platform of the AMS Panther to provide mitigation throughout operational hours. 133hrs 22mins of visual monitoring effort was conducted over the course of 21 days. Pre-start monitoring was carried out prior to operations commencing. Twenty-six pre-watches were carried out in total. The MMO was on effort watch for an average of 6hrs 21mins a day to provide full marine mammal mitigation during operational hours. Full details of monitoring effort can be found in the Appendices.

3.3 Weather Conditions

For the majority of monitoring effort, weather conditions were considered favourable for marine mammal observation as sea state was recorded as glassy for 15%, choppy for 20% and 65% as slight i.e. Beaufort Sea state 3. Swell was recorded as low (<2m) for the entirety of monitoring effort. Visibility was good (>5km) for 82%, moderate (1-5km) for 14% and poor (<1km) for 4% of monitoring effort. Sun glare was recorded as 31% no glare, 40% strong, 7% variable and 22% weak.

Northerly winds followed by north-easterly winds were the most distributed wind directions recorded throughout the survey, at 16.1% and 15.5%, respectively. North-westerly winds of Beaufort 4 were the most frequently recorded direction and force throughout the survey (see Figure 2).

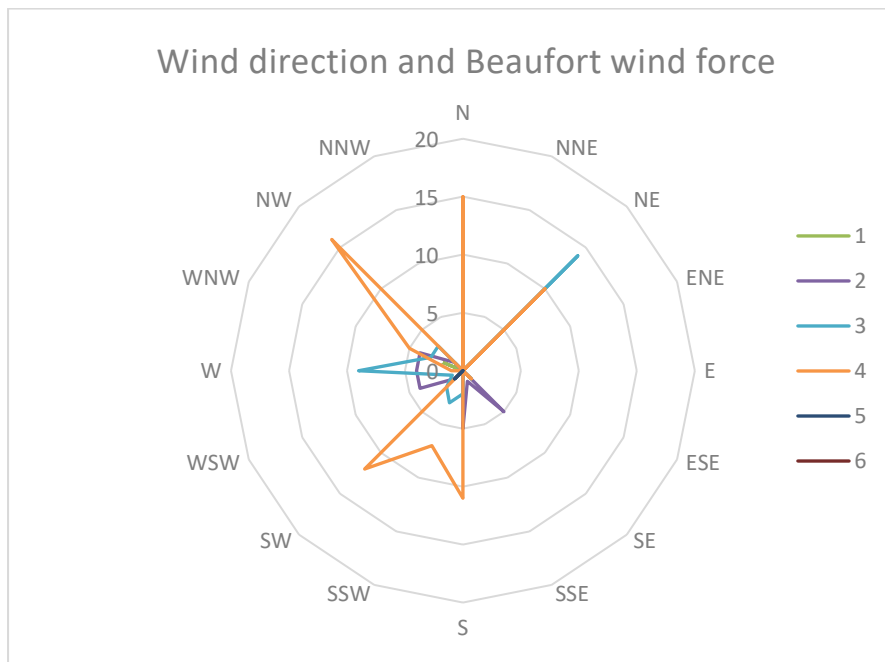


Figure 2 Wind direction and Beaufort wind force

3.4 Marine Mammal and Fauna Sightings

A total of 70 sightings were recorded during MMO observations throughout the geophysical survey. Harbour porpoise sightings accounted for 73% (n=51), grey seal 21% (n=15) and other species for 6% (n=4).

Of the 70 sightings, 83% (n=58) of sightings were observed when equipment was operating, and 17% (n=12) when equipment was non-operational. According to NPWS Guidelines (2014), if an animal enters the mitigation zone during operations a shut-down requirement is not necessary since operations are said to be continuous once started.

On two occasions groups of harbour porpoise consisting of one adult and one juvenile were observed. Juveniles were observed travelling in close proximity to the adult, exhibiting synchronized surfacing. Harbour porpoise behaviours included slow swim, fast swim, milling, porpoising, possible foraging (variable directions) and resting/logging at the surface. No orientation responses or behaviour responses were observed from the animals towards the vessel, whether operations were at full power or not operational. Grey seal behaviours included bottling, slow swim, milling, feeding at the surface and observation of the vessel.

On the 9th of August, a leatherback turtle (*Dermochelys coriacea*) was observed during a survey of Investigation Area 1 (IA1), in 4m of water. Houghton *et al.* (2006) found that distinct coastal jellyfish aggregations in the Irish Sea provide important foraging habitat for leatherbacks in coastal waters however providing the actual estimate of leatherback turtles in Irish waters is difficult as their numbers may be extremely low. According to Dow Piniak *et al.* (2012) leatherback turtles appear to have a relatively narrow, low-frequency range of hearing sensitivity. Results showed that leatherback sea turtle hatchlings are able to detect sounds underwater and in air, responding to stimuli between 50 and 1200 Hz in water and 50 and 1600 Hz in air, with maximum sensitivity between 100 and 400 Hz in water (84 dB re: 1 µPa-rms at 300 Hz) and 50 and 400 Hz in air (62 dB re: 20 µPa-rms at 300 Hz).

Jellyfish abundance was high throughout the survey period, with observations of *Cyanea capillata* and *Aurelia aurita*. One ocean sunfish (*Mola mola*) was also observed in IA1.

Marine fauna sightings data is summarised in Table 4 and the distribution of these sightings is visually represented in Figure 3. A full list of sightings, operational and effort data, and a list of observed sea birds are provided in the Appendices.

Table 4 Summary of marine fauna sightings

Species (Common)	Total Observations	Group Size	Number of Individuals	Number of Adults	Number of Juveniles
Harbour porpoise	51	1-2	64	62	2
Grey seal	15	1	15	15	-
Seal sp.	1	1	1	-	-
Sunfish	1	1	1	-	-
Shark spp.	1	1	1	-	-

Leatherback turtle	1	1	1	-	-
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There was a total of 70 observations of marine fauna, and 83 individuals observed during the repeat multibeam survey.



Plate 2 Harbour porpoise (top left), leatherback turtle (top right), grey seal (bottom left) and ocean sunfish (bottom right) Photos by Hannah Keogh

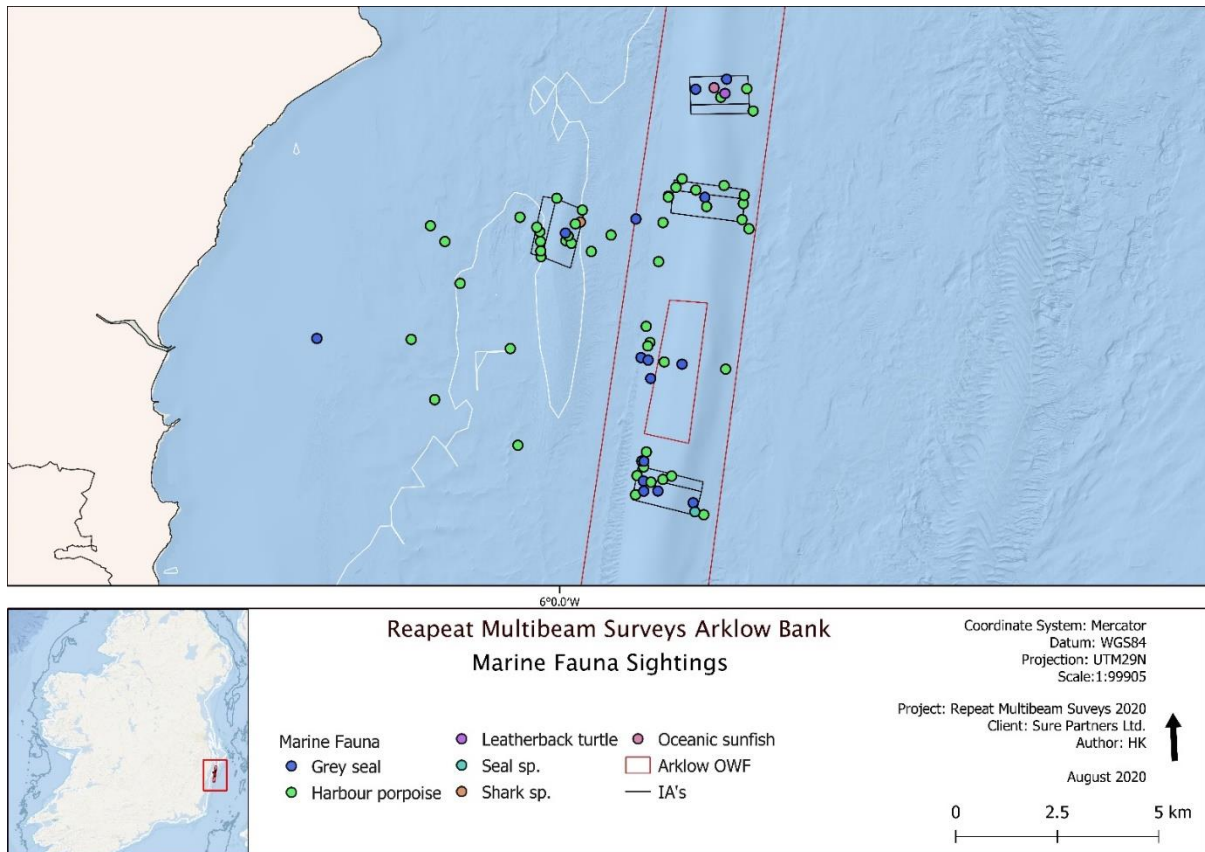


Figure 3 Distribution of marine fauna sightings during the repeat multibeam survey of the Arklow Bank

3.5 Marine Mammal Delays and Mitigation

Survey operations were delayed on one occasion as a result of a marine mammal present within the 350m MZ. Total time delay due to marine mammal activity was 32 minutes for the overall survey. Delays are not inclusive of mandatory 30-minute pre-watch, or time from the MMO's initial go ahead to actual start of operations.

On the 20th of July, a grey seal (sighting no. 21) was observed bottling and milling within the MZ prior to the start of operations (see Table 5). The MMO advised the survey team to relocate the vessel while delaying operations for 32 minutes.

Table 5 Summary of delays to operations due to marine mammals within the MZ

Date	Time of sighting (UTC)	Time of Delay (hr:min)	Description of delay	Start of operation (UTC)	Sighting Reference Number	Closest Distance of Approach to Noise Source (m)
20/07/2020	9:02 - 09:04	00:32	Relocation of vessel and delay	09:36	21	300

4 Discussion

4.1 Marine Mammals

A total of 70 sightings were recorded during MMO observations throughout the survey. Harbour porpoise and grey seal were the most abundant species observed. Sightings were observed while operations were at full power and non-operational. Sightings of marine mammals were not specific to one particular area or depth and ranged throughout the survey areas.

Given the high frequencies (360 - 440 kHz) and high attenuation rate of the MBES device used during the survey; it is generally believed that this device is inaudible to marine mammals associated with the investigation areas. According to Deng *et al.* (2014) no marine species are believed to be functionally sensitive to sounds above 200 kHz. However, research further presented by Deng *et al.* (2014) suggests while the operating frequency (at 200 kHz) of sonar equipment is above the hearing range of marine mammals, their operation also incidentally generates sub-harmonic sounds at lower output frequencies that falls within the functional hearing range of high frequency odontocetes and thus elicit a behavioural reaction or perhaps affect their hearing over small ranges. Further research into sub-harmonic frequencies of sonar equipment is required. Lower output frequency, higher output power and complex nature (multi directional sound beams) MBES systems have the potential to disturb and cause behavioural triggers such as mass strandings in cetaceans. In a report by Southall *et al.* (2013) demonstrated a MBES system operating at 12 kHz, along with some other confluence of environmental, physical habitat and behavioural factors, was considered most plausible and the likely initial behavioural trigger of a mass stranding event of 100+ melon-headed whales (*Peponocephala electra*) northwest of Madagascar.

It can be concluded, at this time, that use of this device at high frequencies presents a negligible risk of injury to marine mammals. However, depending on the operating frequency, swath width, environmental conditions and SPL levels of such impulsive noise emissions, induced TTS (temporary threshold shift), PTS (permanent threshold shift) and behaviour change effects in both cetaceans and pinnipeds is possible. Due to this sound exposure it is concluded that following NPWS Guidelines (2014) should continue to be enforced for BEP on both this and future geophysical surveys.

4.2 Mitigation Procedures

Procedures were underpinned by the recommended NPWS Guidelines (2014). These procedures were suitable for the operations being undertaken and provided a suitable level of protection whilst not being overly restrictive on operations. Weather conditions for operations were equally as limiting as those required for visual observations. There was no delay to operations as a result of observations not being able to be undertaken. The ability to relocate the vessel to an area free of marine mammals before the start of acoustic operations allowed also for the added avoidance of marine mammals within the MZ.

4.3 Issues with Compliance

There were no breaches in compliance with NPWS Guidelines during the project with all necessary delays observed by the operations team, and who should be commended for their cooperation and flexibility.

4.4 Recommendations

The following recommendations are made following the findings of this report and marine mammal observation undertaken on the survey:

- Marine mammal mitigation strategies should be included as conditions within licencing on a case by case basis.

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6 Appendices

6.1 Appendix 1 Summary of marine fauna sightings during the repeat bathymetry survey

Sighting Reference Number	Date	Species (common)	Number of Individuals	Range of Animal	Bearing to Animal	Direction of Travel (compass points)	Mitigation (details)
1	10/07/2020	Shark sp.	1	150	270	n	None req'd
2	10/07/2020	HP	1	100	70	n	None req'd
3	11/07/2020	HP	1	300	85	n	None req'd
4	11/07/2020	GS	1	100	30	var	None req'd
5	11/07/2020	Sunfish	1	100	15	var	None req'd
6	11/07/2020	HP	2	500	290	ne	None req'd
7	11/07/2020	GS	1	200	90	n	None req'd
8	12/07/2020	HP	1	70	20	nw	None req'd
9	12/07/2020	GS	1	350	100	var	None req'd
10	13/07/2020	HP	2	100	330	n	None req'd
11	13/07/2020	HP	1	250	80	n	None req'd
12	13/07/2020	HP	1	500	260	n	None req'd
13	13/07/2020	HP	1	350	80	n	None req'd
14	13/07/2020	GS	1	200	60	-	None req'd
15	13/07/2020	HP	2	400	320	nw	None req'd
16	13/07/2020	HP	1	500	180	var	None req'd
17	14/07/2020	HP	1	75	50	se	None req'd
18	15/07/2020	HP	1	100	30	sw	None req'd
19	15/07/2020	HP	1	700	260	e	None req'd
20	15/07/2020	HP	2	500	270	sw	None req'd
21	20/07/2020	GS	1	300	180	-	Delay to ops starting-32 mins
22	20/07/2020	HP	1	300	90	sw	None req'd
23	20/07/2020	GS	1	150	135	-	None req'd
24	20/07/2020	HP	1	500	45	ne	None req'd
25	20/07/2020	HP	1	500	230	sw	None req'd
26	20/07/2020	HP	1	700	70	se	None req'd
27	20/07/2020	HP	1	400	90	s	None req'd
28	20/07/2020	HP	1	250	80	s	None req'd
29	20/07/2020	HP	1	700	350	var	None req'd
30	20/07/2020	HP	1	800	60	n	None req'd
31	21/07/2020	HP	1	300	100	n	None req'd
32	21/07/2020	GS	1	300	180	-	None req'd
33	21/07/2020	HP	1	50	180	w	None req'd
34	21/07/2020	GS	1	70	180	-	None req'd
35	21/07/2020	HP	1	500	100	n	None req'd
36	21/07/2020	HP	1	100	340	s	None req'd
37	21/07/2020	HP	2	150	260	s	None req'd

38	21/07/2020	HP	1	300	270	s	None req'd
39	24/07/2020	GS	1	200	315	-	None req'd
40	24/07/2020	HP	1	700	90	n	None req'd
41	24/07/2020	HP	1	500	60	n	None req'd
42	24/07/2020	HP	1	700	70	n	None req'd
43	24/07/2020	HP	1	300	120	e	None req'd
44	24/07/2020	HP	2	400	50	var	None req'd
45	24/07/2020	HP	2	250	290	s	None req'd
46	24/07/2020	HP	1	250	80	ne	None req'd
47	24/07/2020	HP	1	150	290	s	None req'd
48	24/07/2020	HP	2	150	310	var	None req'd
49	26/07/2020	HP	2	70	130	n	None req'd
50	26/07/2020	HP	1	150	280	n	None req'd
51	26/07/2020	HP	1	100	80	nw	None req'd
52	26/07/2020	HP	2	100	280	var	None req'd
53	28/07/2020	HP	1	70	280	ne	None req'd
54	28/07/2020	GS	1	150	270	-	None req'd
55	28/07/2020	GS	1	100	0	-	None req'd
56	29/07/2020	HP	2	250	90	s	None req'd
57	29/07/2020	HP	1	100	0	n	None req'd
58	29/07/2020	HP	2	100	70	s	None req'd
59	29/07/2020	GS	1	150	50	e	None req'd
60	07/08/2020	GS	1	260	200	s	None req'd
61	07/08/2020	HP	1	300	190	se	None req'd
62	07/08/2020	HP	1	250	180	w	None req'd
63	07/08/2020	GS	1	100	45	-	None req'd
64	08/08/2020	GS	1	100	90	s	None req'd
65	08/08/2020	HP	2	60	80	s	None req'd
66	09/08/2020	Leatherback turtle	1	30	270	w	None req'd
67	10/08/2020	HP	1	90	350	var	None req'd
68	12/08/2020	HP	1	200	140	sw	None req'd
69	12/08/2020	HP	1	500	180	w	None req'd
70	12/08/2020	Seal sp.	1	300	200	-	None req'd

6.2 Appendix 2 Summary of bird sightings during the repeat bathymetry survey

Species (common)
Northern Fulmar
Black guillemot
Common guillemot
Northern gannet
Manx shearwater
Black-legged kittiwake
Great Cormorant
Razorbill
Puffin
Herring gull
Greater black-backed gull
Barn Swallow
Sandwich tern
Little tern
Common tern
Common gull
Grey heron

6.3 Appendix 3 Marine Mammal Recording Form - Operations

Regulatory reference number	Ship/ platform name	Date	Reason for firing	Time soft start/ ramp-up began (UTC)	Time of full power (UTC)	Time of start of line (UTC)	Time of end of line (UTC)	Time of reduced output (UTC) (if relevant)	Time airguns/ source stopped (UTC)	Time pre-shooting search began (UTC)	Time search ended (UTC)	Was it day or night in the period prior to firing?	Was any mitigating action required?
LF100034	AMS Panther	10/07/2020			7:30	7:30	16:53		16:53	7:00	7:30	d	n
LF100034	AMS Panther	11/07/2020			6:00	6:00	15:37		15:37	5:30	6:00	d	n
LF100034	AMS Panther	12/07/2020			5:54	5:54	15:22		15:22	5:24	5:54	d	n
LF100034	AMS Panther	13/07/2020			9:13	19:13	11:34		11:34	8:40	9:13	d	n
LF100034	AMS Panther	13/07/2020			12:13	12:32	16:37		16:37	11:34	12:13	d	n
LF100034	AMS Panther	14/07/2020			6:40	6:52	16:39		16:39	6:10	6:40	d	n
LF100034	AMS Panther	15/07/2020			7:30	7:30	13:47		13:47	7:00	7:30	d	n
LF100034	AMS Panther	15/07/2020			15:04	15:04	16:46		16:46	14:30	15:04	d	n
LF100034	AMS Panther	16/07/2020			7:31	8:07	11:27		11:27	7:01	7:31	d	n
LF100034	AMS Panther	16/07/2020			12:11	12:11	12:39		12:39	11:40	12:11	d	n
LF100034	AMS Panther	20/07/2020			9:36	9:36	11:39		11:39	9:06	9:36	d	y
LF100034	AMS Panther	21/07/2020			9:30	9:30	12:20		12:20	9:00	9:30	d	n
LF100034	AMS Panther	21/07/2020			14:55	14:55	17:27		17:27	14:25	14:55	d	n
LF100034	AMS Panther	24/07/2020			5:35	5:55	14:20		14:20	5:05	5:35	d	n
LF100034	AMS Panther	25/07/2020			6:35	6:45	16:30		16:30	6:04	6:35	d	n
LF100034	AMS Panther	26/07/2020			9:05	9:07	15:50		15:50	8:36	9:05	d	n
LF100034	AMS Panther	28/07/2020			6:51	6:51	16:37		16:37	6:20	6:51	d	n
LF100034	AMS Panther	29/07/2020			6:40	6:40	16:47		16:47	6:10	6:40	d	n
LF100034	AMS Panther	06/08/2020			7:45	7:45	13:43		13:43	7:00	7:45	d	n
LF100034	AMS Panther	07/08/2020			5:48	5:48	9:45		9:45	5:17	5:48	d	n
LF100034	AMS Panther	07/08/2020			12:01	12:01	13:05		13:05	11:30	12:01	d	n
LF100034	AMS Panther	08/08/2020			5:42	5:42	14:15		14:15	5:12	5:42	d	n

LF100034	AMS Panther	09/08/2020	I		5:58	5:58	15:45		15:45	5:28	5:28	d	n
LF100034	AMS Panther	10/08/2020	I		7:41	7:41	11:35		11:35	7:10	7:41	d	n
LF100034	AMS Panther	11/08/2020	I		5:56	5:56	15:15		15:15	5:26	5:56	d	n
LF100034	AMS Panther	12/08/2020	I		5:47	5:47	12:28		12:28	5:17	5:47	d	n

6.4 Appendix 4 Marine Mammal Recording Form – Effort

Date	Visual watch or PAM?	Time of start of watch (UTC)	Time of end of watch (UTC)	Start position - degrees latitude	Start position - minutes latitude	Start position - north/south	Start position - degrees longitude	Start position - minutes longitude	Start position - east/west	Depth of water at start position (metres)	End position - degrees latitude	End position - minutes latitude	End position - north/south	End position - degrees longitude	End position - minutes longitude	End position - east/west	Depth of water at end position (metres)	Speed of vessel (knots)	Source activity	Wind direction	Wind force (Beaufort)	Sea state	Swell	Visibility (visual watch only)	Sun glare (visual watch only)
10/07/2020	v	6:12	7:13	52	47.788	n	6	5.019	w	21.5	52	49.877	n	5	56.871	w	28.0	16.0	n	ne	3	s	o	g	S
10/07/2020	v	7:13	7:15	52	49.877	n	5	56.871	w	28.0	52	49.302	n	5	57.109	w	19.1	1.0	n	Ne	4	c	o	g	s
10/07/2020	v	7:15	7:30	52	49.204	n	5	57.389	w	28.1	52	48.501	n	5	59.201	w	25.3	8.6	n	ne	4	c	o	g	S
10/07/2020	v	7:30	8:20	52	48.501	n	5	59.201	w	25.3	52	50.000	n	5	59.305	w	20.0	4.0	f	ne	4	c	o	g	S
10/07/2020	v	8:50	10:10	52	48.907	n	5	59.307	w	19.0	52	48.906	n	5	59.500	w	16.0	4.0	f	ne	4	c	o	g	s
10/07/2020	v	10:10	11:14	52	48.906	n	5	59.500	w	16.0	52	49.304	n	5	59.400	w	16.8	4.9	f	ne	4	s	o	g	V
10/07/2020	v	11:14	11:38	52	49.304	n	5	59.400	w	16.8	52	48.906	n	5	59.602	w	14.8	5.1	f	ne	4	s	o	g	V
10/07/2020	v	12:05	13:05	52	49.309	n	5	59.408	w	17.6	52	48.601	n	6	0.01	w	22.3	5.6	f	ne	3	s	o	g	V
10/07/2020	v	13:05	14:00	52	48.601	n	6	0.01	w	22.3	52	49.400	n	5	59.408	w	17.0	5.7	f	ne	3	s	o	g	V
10/07/2020	v	14:27	15:25	52	49.200	n	5	59.506	w	15.2	52	49.105	n	5	59.903	w	24.0	7.1	f	ne	3	s	o	g	N
10/07/2020	v	15:25	16:22	52	49.105	n	5	59.903	w	24.0	52	48.601	n	6	0.32	w	27.8	6.0	F	ne	3	s	o	g	N

10/07/2020	v	16:22	17:00	52	48.61	n	6	0.32	w	27.8	52	49.19	n	6	0.11	w	26.4	5.0	f	ne	3	s	o	g	n
11/07/2020	v	5:07	6:02	52	47.80	n	6	6.74	w	14.5	52	50.61	n	5	56.64	w	23.0	15.2	n	nw	2	s	o	g	S
11/07/2020	v	6:02	6:54	52	50.61	n	5	56.64	w	23.0	52	50.82	n	5	56.42	w	17.3	4.6	f	ne	3	c	o	g	s
11/07/2020	v	6:54	9:20	52	50.82	n	5	56.42	w	17.3	52	50.45	n	5	56.02	w	4.2	7.3	f	ne	3	s	o	g	s
11/07/2020	v	9:20	10:08	52	50.45	n	5	56.02	w	4.2	52	50.73	n	5	56.00	w	2.9	6.1	f	se	2	s	o	g	s
11/07/2020	v	10:08	10:39	52	50.73	n	5	56.00	w	2.9	52	51.00	n	5	55.45	w	25.2	3.6	f	se	2	g	o	g	v
11/07/2020	v	10:39	11:22	52	51.00	n	5	55.45	w	25.2	52	50.65	n	5	55.60	w	21.0		f	se	2	s	o	g	s
11/07/2020	v	12:20	13:30	52	50.53	n	5	55.73	w	16.3	52	50.68	n	5	55.89	w	4.9	4.5	f	se	2	s	o	g	s
11/07/2020	v	13:30	14:30	52	50.68	n	5	55.89	w	4.9	52	50.48	n	5	55.76	w	8.0	6.5	f	se	2	s	o	g	s
11/07/2020	v	14:30	15:36	52	50.48	n	5	55.76	w	8.0	52	50.44	n	5	50.27	w	11.3	1.3	f	se	3	s	o	g	v
12/07/2020	v	5:09	6:04	52	47.63	n	5	7.03	w	17.0	52	45.12	n	5	57.36	w	5.6	16.5	n	sw	4	s	o	g	w
12/07/2020	v	6:04	7:00	52	45.12	n	5	57.36	w	5.6	52	45.27	n	5	57.20	w	4.7	5.8	f	sw	4	s	o	g	n
12/07/2020	v	7:00	8:10	52	45.27	n	5	57.20	w	4.7	52	45.33	n	5	57.03	w	3.3	7.9	f	sw	4	s	o	g	w
12/07/2020	v	8:10	9:00	52	45.33	n	5	57.03	w	3.3	52	45.525	n	5	56.89	w	11.0	8.6	f	sw	4	s	o	g	w
12/07/2020	v	9:00	10:04	52	45.525	n	5	56.89	w	11.0	52	45.43	n	5	56.92	w	12.6	7.0	f	sw	4	s	o	g	w
12/07/2020	v	10:04	10:55	52	45.43	n	5	56.92	w	12.6	52	45.136	n	5	57.43	w		6.5	f	sw	4	s	o	g	w
12/07/2020	v	11:44	12:49	52	45.31	n	5	57.40	w	6.5	52	45.36	n	5	57.65	w	8.2	5.6	f	sw	4	c	o	g	n
12/07/2020	v	12:44	14:34	52	45.36	n	5	57.65	w	8.2	52	45.55	n	5	58.16	w	21.8	5.4	f	sw	4	s	o	g	w

12/07/2020	v	14:34	16:00	52	45.55	n	5	58.16	w	21.8	52	45.70	n	5	58.24	w	27.0	8.0	f	sw	4	s	o	g	w
13/07/2020	v	8:09	9:04	52	46.64	n	5	8.11	w	10.9	52	50.72	n	5	56.43	w	14.8	9.3	n	ssw	4	s	o	g	n
13/07/2020	v	9:04	10:20	52	50.72	n	5	56.43	w	14.8	52	50.56	n	5	56.12	w	7.3	6.6	f	ssw	4	c	o	g	w
13/07/2020	v	10:38	11:31	52	50.55	n	5	56.15	w	7.3	52	50.53	n	5	55.52	w	4.7	5.6	f	ssw	4	s	o	g	w
13/07/2020	v	11:38	12:24	52	50.51	n	5	55.57	w	21.5	52	46.32	n	5	57.83	w	21.5	4.5	n	ssw	4	c	o	g	n
13/07/2020	v	12:24	12:40	52	46.32	n	5	57.83	w	21.3	52	45.68	n	5	57.93	w		2.4	f	ssw	4	s	o	g	w
13/07/2020	v	13:14	14:12	52	45.63	n	5	58.00	w	19.8	52	45.75	n	5	57.33	w	6.2	5.6	f	ssw	3	s	o	g	w
13/07/2020	v	14:12	15:25	52	45.75	n	5	57.33	w	6.2	52	45.43	n	5	57.29	w	5.1	5.6	f	wsw	2	s	o	g	s
13/07/2020	v	15:25	16:37	52	45.43	n	5	57.29	w	5.1	52	45.52	n	5	58.49	w	34.7	3.0	s	wsw	2	s	o	g	w
14/07/2020	v	6:01	6:34	52	47.78	n	6	7.05	w	13.9	52	48.99	n	5	57.14	w	27.8	17.0	n	nw	3	s	o	g	s
14/07/2020	v	6:34	8:00	52	48.99	n	5	57.14	w	27.8	52	49.237	n	5	56.908	w	22.8	1.2	f	nw	3	s	o	g	s
14/07/2020	v	8:00	9:13	52	49.24	n	5	56.91	w	22.8	52	49.17	n	5	56.74	w	18.8	5.5	f	wnw	4	c	o	g	s
14/07/2020	v	9:13	10:13	52	49.17	n	5	56.74	w	18.8	52	49.05	n	5	56.35	w	11.3	7.5	f	wnw	4	c	o	g	n
14/07/2020	v	10:41	12:00	52	49.25	n	5	56.36	w	4.5	52	49.20	n	5	56.22	w		6.8	f	wnw	4	s	o	g	n
15/07/2020	v	6:38	7:30	52	47.56	n	5	7.49	w	14.6	52	50.18	n	5	55.40	w	27.4	15.0	n	w	3	s	o	g	n
15/07/2020	v	7:30	8:45	52	50.18	n	5	55.40	w	27.4	52	50.56	n	5	55.81	w	9.3	5.3	f	w	3	s	o	g	n
15/07/2020	v	8:45	9:33	52	50.56	n	5	55.81	w	9.3	52	49.45	n	5	56.72	w	19.0	6.0	f	w	3	s	o	g	n
15/07/2020	v	9:33	11:05	52	49.45	n	5	56.72	w	19.0	52	49.29	n	5	57.32	w	29.3	6.2	f	w	3	c	o	g	n

15/07 /2020	v	11:0 5	11:5 2	52	49.2 9	n	5	57.3 2	w	29.3	52	48.8 6	n	5	59.4 6	w	17.9	8.0	f	wnw	3	s	o	g	S
15/07 /2020	v	13:0 7	14:0 4	52	45.6 2	n	5	58.3 9	w	31.5	52	47.7 1	n	5	59.1 8	w	26.3	1.2	f	wnw	3	s	o	g	w
15/07 /2020	v	14:0 4	15:0 2	52	47.7 1	n	5	59.1 8	w	26.3	52	48.5 3	n	5	58.4 1	w	31.6	8.5	f	wnw	3	s	o	g	N
15/07 /2020	v	15:0 2	16:2 1	52	48.5 3	n	5	58.4 1	w	31.6	52	49.1 4	n	6	0.19	w	27.0	6.9	f	wnw	2	s	o	g	w
15/07 /2020	v	16:2 1	16:5 5	52	49.1 4	n	6	0.19	w	27.0	52	48.8 9	n	5	59.3 8	w	21.6	5.6	f	wnw	2	s	o	g	v
16/07 /2020	v	7:01	8:00	52	47.6 5	n	6	7.62	w	13.4	52	49.3 9	n	6	0.08	w	24.5	15.8	n	w	2	g	o	g	N
16/07 /2020	v	8:00	9:02	52	49.3 9	n	6	0.08	w	24.5	52	49.6 2	n	5	1.29	w	22.5	7.0	f	w	2	s	o	g	S
16/07 /2020	v	9:02	10:5 8	52	49.6 2	n	6	1.29	w	22.5	52	49.4 7	n	6	0.32	w	24.7	6.7	f	w	3	s	o	g	w
16/07 /2020	v	10:5 8	11:2 5	52	49.4 7	n	6	0.32	w	24.7	52	49.0 1	n	6	0.03	w	25.4	6.0	f	w	3	s	o	g	s
16/07 /2020	v	11:4 0	12:0 0	52	46.7 9	n	5	5:57. 158	w	4.1	52	46.9 9	n	5	56.1 6	w	34.0	5.2	n	w	3	s	o	g	s
16/07 /2020	v	12:0 0	12:4 5	52	46.9 9	n	5	56.1 6	w	34.0	52	47.2 7	n	5	57.9 6	w	32.7		f	w	4	c	o	g	w
16/07 /2020	v	8:36	9:19	52	47.6 4	n	6	7.73	w	12.5	52	47.3 2	n	5	57.8 2	w	32.7	10.6	n	n	2	g	o	g	s
20/07 /2020	v	9:19	10:2 3	52	47.3 2	n	5	57.8 2	w	32.7	52	49.3 4	n	5	57.2 1	w	36.0	5.5	f	n	2	g	o	g	S
20/07 /2020	v	10:2 3	11:2 1	52	49.3 4	n	5	57.2 1	w	36.0	52	50.3 7	n	5	55.2 8	w	24.7	5.8	f	n	2	g	o	g	S
20/07 /2020	v	11:2 1	11:2 7	52	50.3 7	n	5	55.2 8	w	24.7	52	50.6 1	n	5	56.0 8	w	7.1	5.7	f	n	2	g	o	g	s
20/07 /2020	v	11:2 7	11:3 3	52	50.6 1	n	5	56.0 8	w	7.1	52	50.5 9	n	5	55.9 1	w	5.4	4.5	f	n	2	s	o	g	S
20/07 /2020	v	13:5 5	14:2 1	52	48.1 3	n	5	56.7 1	w	4.4	52	50.4 9	n	5	57.3 8	w	29.0	0.5	n	se	4	s	o	g	S
21/07 /2020	v	9:02	10:1 9	52	47.7 2	n	5	7.60	w	12.0	52	49.1 9	n	5	57.3 4	w	29.5	16.5	n	ne	4	s	o	g	s

21/07/2020	v	10:19	11:21	52	49.19	n	5	57.34	w	29.5	52	49.26	n	5	57.21	w	30.2	10.0	f	ne	3	s	o	g	S
21/07/2020	v	11:21	11:49	52	49.26	n	5	57.21	w	30.5	52	50.57	n	5	55.67	w	18.4	8.1	f	ne	4	s	o	g	v
21/07/2020	v	14:25	15:17	52	47.68	n	5	7.76	w	13.0	52	50.65	n	5	56.25	w	9.5	15.7	n	s	2	g	o	g	s
21/07/2020	v	15:17	16:33	52	50.65	n	5	56.25	w	9.5	52	47.11	n	5	57.17	w	8.0	4.2	f	s	2	s	o	g	V
21/07/2020	v	16:33	17:33	52	47.11	n	5	57.17	w	8.0	52	49.17	n	5	56.49	w	12.3	5.5	f	s	2	s	o	g	S
21/07/2020	v	17:33	17:41	52	49.17	n	5	56.49	w	12.3	52	49.40	n	5	57.37	w	12.3	5.1	f	s	2	g	o	g	w
24/07/2020	v	5:05	5:53	52	47.65	n	5	8.02	w	12.5	52	48.35	n	5	59.54	w	17.3	8.1	n	wnw	2	g	o	m	s
24/07/2020	v	5:53	6:58	52	48.35	n	5	59.54	w	17.3	52	48.87	n	5	59.45	w	19.2	5.3	f	wnw	2	g	o	m	w
24/07/2020	v	6:58	7:58	52	48.87	n	5	59.45	w	19.2	52	49.06	n	5	59.40	w	17.2	6.5	f	wnw	1	g	o	g	s
24/07/2020	v	7:58	9:16	52	49.06	n	5	59.40	w	17.2	52	49.02	n	5	59.62	w	14.2	7.5	f	wnw	1	g	o	g	w
24/07/2020	v	9:16	10:22	52	49.02	n	5	59.62	w	14.2	52	49.02	n	5	59.79	w		5.1	f	s	2	g	o	g	S
24/07/2020	v	11:30	12:36	52	49.23	n	5	59.77	w		52	49.07	n	5	59.99	w	23.3	5.0	f	s	4	s	o	g	n
24/07/2020	v	12:36	13:40	52	49.07	n	5	59.99	w	25.3	52	48.90	n	6	0.18	w	27.9	6.0	f	s	4	c	o	g	n
25/07/2020	v	6:04	6:51	52	47.67	n	6	7.59	w	15.0	52	49.22	n	5	56.69	w	14.4	16.7	n	w	3	s	o	g	w
25/07/2020	v	6:51	7:23	52	49.22	n	5	56.69	w	14.4	52	50.52	n	5	56.70	w	24.0	5.9	f	w	3	c	o	g	s
25/07/2020	v	7:23	8:18	52	50.52	n	5	56.70	w	24.0	52	50.62	n	5	56.68	w	23.6	1.0	f	wsW	3	c	o	g	s
25/07/2020	v	8:18	9:38	52	50.62	n	5	56.68	w	23.6	52	50.55	n	5	56.52	w	22.1	6.5	f	wsW	2	s	o	g	s
25/07/2020	v	9:38	10:23	52	50.55	n	5	56.52	w	22.1	52	50.56	n	5	56.11	w	7.4	4.6	f	wsW	2	s	o	g	n

25/07/2020	v	10:23	11:09	52	50.56	n	5	56.11	w	7.4	52	50.53	n	5	56.16	w	9.5	6.0	f	sse	2	g	o	g	n
26/07/2020	v	8:36	9:07	52	45.85	n	5	58.03	w	25.2	52	45.75	n	5	58.17	w	25.0	1.7	n	sw	4	s	o	g	S
26/07/2020	v	9:07	10:15	52	45.75	n	5	58.17	w	25.0	52	45.77	n	5	57.82	w	15.6	6.0	f	sw	4	s	o	g	s
26/07/2020	v	10:15	11:15	52	45.77	n	5	57.82	w	15.6	52	45.62	n	5	57.46	w	10.2	5.0	f	sw	5	s	o	g	S
26/07/2020	v	11:15	11:46	52	45.62	n	5	57.46	w	10.2	52	45.69	n	5	57.40	w	7.0	5.9	f	ssw	4	s	o	g	s
26/07/2020	v	12:57	13:48	52	49.52	n	5	57.06	w	43.7	52	49.39	n	5	56.91	w		8.1	f	ssw	3	s	o	g	w
26/07/2020	v	14:17	15:07	52	49.36	n	5	56.74	w	18.6	52	49.32	n	5	56.65	w	16.0	5.3	f	ssw	3	s	o	g	s
26/07/2020	v	15:07	15:19	52	49.32	n	5	56.65	w	16.0	52	49.49	n	5	56.52	w	10.7		f	ssw	4	s	o	g	n
28/07/2020	v	6:02	6:58	52	47.46	n	6	7.39	w	15.0	52	45.55	n	5	56.76	w	24.5	6.6	n	nw	4	s	o	g	s
28/07/2020	v	6:58	8:00	52	47.46	n	6	7.39	w	24.5	52	45.19	n	5	57.04	w	3.8	4.0	f	nw	4	s	o	g	w
28/07/2020	v	8:00	9:49	52	45.19	n	5	57.04	w	3.8	52	46.20	n	5	57.66	w	14.2	6.0	f	wnw	4	c	o	g	s
28/07/2020	v	9:49	10:42	52	46.20	n	5	57.66	w	14.2	52	45.14	n	5	57.06	w	3.4	8.0	f	wnw	4	c	o	g	n
28/07/2020	v	10:42	11:40	52	45.14	n	5	57.06	w	3.4	52	45.08	n	5	57.21	w	4.2	6.3	f	nw	4	s	o	g	w
28/07/2020	v	12:17	14:15	52	45.26	n	5	57.55	w	8.3	52	45.47	n	5	57.54	w	7.4	5.5	f	nw	4	s	o	g	s
28/07/2020	v	14:15	15:00	52	45.47	n	5	57.54	w	7.4	52	45.38	n	5	57.23	w	5.1	7.7	f	sw	2	s	o	g	n
29/07/2020	v	6:06	7:35	52	47.63	n	6	7.59	w	13.5	52	49.40	n	5	55.64	w	28.4	15.6	n	w	2	g	o	g	s
29/07/2020	v	7:35	9:03	52	49.40	n	5	55.64	w	28.4	52	48.94	n	5	55.74	w	30.8	4.7	f	w	2	g	o	g	s
29/07/2020	v	9:03	10:29	52	48.94	n	5	55.74	w	30.8	52	49.40	n	5	56.19	w	6.8	6.5	f	sw	1	g	o	g	w

29/07/2020	v	10:29	11:30	52	49.40	n	5	56.19	w	6.8	52	47.17	n	5	57.79	w	29.0	6.5	f	s	3	s	o	g	s
29/07/2020	v	12:26	13:00	52	49.10	n	5	56.18	w	4.5	52	49.28	n	5	56.12	w	7.0	4.2	f	s	3	s	o	m	n
06/08/2020	v	7:00	8:12	52	47.81	n	6	7.96	w	10.6	52	49.80	n	6	6.61	w	3.0	15.0	n	s	4	g	o	g	n
06/08/2020	v	8:12	8:24	52	49.80	n	6	6.61	w	3.0	52	49.85	n	6	6.37	w	3.2	3.1	f	s	4	g	o	m	n
06/08/2020	v	8:45	9:45	52	49.85	n	6	6.37	w	3.2	52	49.80	n	6	6.61	w	4.2	4.0	f	s	4	s	o	g	n
06/08/2020	v	10:00	11:00	52	49.82	n	6	6.20	w	4.2	52	49.90	n	6	6.61	w	5.0	4.6	f	s	4	s	o	g	n
06/08/2020	v	11:00	12:00	52	49.90	n	5	6.61	w	5.0	52	49.39	n	5	56.91	w	6.2	5.0	f	s	4	s	o	g	n
07/08/2020	v	5:00	5:51	52	47.67	n	6	7.75	w	12.0	52	47.10	n	5	57.10	w	4.6	16.5	n	s	4	s	o	m	n
07/08/2020	v	5:51	6:35	52	47.10	n	5	57.10	w	4.6	52	45.25	n	5	56.93	w	3.8	6.0	f	s	4	s	o	m	n
07/08/2020	v	6:35	6:59	52	45.25	n	5	56.93	w	3.8	52	45.17	n	5	56.74	w	34.0	6.0	f	s	4	s	o	p	n
07/08/2020	v	7:43	8:04	52	49.20	n	5	56.61	w	14.9	52	49.35	n	5	55.19	w	36.0	5.3	f	s	4	s	o	p	n
07/08/2020	v	10:56	11:17	52	47.11	n	5	58.52	w		52	46.86	n	5	58.32	w	37.3	3.8	n	sw	3	s	o	p	n
07/08/2020	v	11:17	12:00	52	46.86	n	5	58.32	w	37.3	52	47.12	n	5	57.25	w	5.3	4.0	n	sw	3	s	o	g	n
07/08/2020	v	12:00	13:00	52	47.12	n	5	57.25	w	5.3	52	45.62	n	5	58.51	w	32.4	6.3	f	sw	4	s	o	p	w
08/08/2020	v	5:01	5:52	52	47.63	n	6	8.20	w	13.0	52	48.55	n	5	59.42	w	21.6	14.0	n	n	3	s	o	m	w
08/08/2020	v	5:52	6:50	52	48.55	n	5	59.42	w	21.6	52	49.31	n	5	59.19	w		5.3	f	n	3	c	o	g	s
08/08/2020	v	6:50	8:03	52	49.31	n	5	59.19	w		52	48.88	n	5	59.51	w	14.8	6.4	f	n	3	c	o	g	s
08/08/2020	v	8:03	10:00	52	48.88	n	5	59.51	w	14.8	52	48.85	n	5	59.78	w	17.0	5.5	f	ne	3	c	o	g	s

08/08 /2020	v	10:0 0	11:1 5	52	48.8 5	n	5	59.7 8	w	17.0	52	48.5 4	n	6	0.07	w	24.0	6.3	f	ne	3	c	o	g	s
08/08 /2020	v	12:4 2	14:0 4	52	49.3 1	n	5	59.9 2	w	25.6	52	49.2 5	n	5	59.8 5	w	24.2	7.2	f	ne	4	c	o	g	n
08/08 /2020	v	14:0 4	14:1 3	52	49.2 5	n	5	59.8 5	w	24.0	52	48.4 7	n	6	0.22	w	24.0	6.3	f	ne	4	c	o	g	s
09/08 /2020	v	5:01	5:28	52	47.6 5	n	6	8.07	w	12.0	52	50.1 7	n	5	57.8 7	w	31.9	9.7	n	n	4	g	o	m	n
09/08 /2020	v	5:28	6:04	52	50.1 7	n	5	57.8 7	w	31.9	52	50.5 3	n	5	36.6 9	w	24.0	13.0	f	n	4	c	o	m	n
09/08 /2020	v	6:04	7:14	52	50.5 3	n	5	36.6 9	w	24.0	52	50.8 4	n	5	56.5 2	w	20.2	6.3	f	n	4	c	o	m	n
09/08 /2020	v	7:14	8:20	52	50.8 4	n	5	56.5 2	w	20.2	52	50.5 1	n	5	56.2 0	w	9.3	6.1	f	n	3	c	o	g	n
09/08 /2020	v	12:5 0	13:5 8	52	50.6 4	n	5	55.7 9	w	8.6	52	50.4 5	n	5	55.9 2	w	4.6	6.3	f	ne	3	s	o	g	s
09/08 /2020	v	13:5 8	15:5 5	52	50.4 5	n	5	55.9 2	w	4.6	52	49.6 5	n	5	59.1 6	w		2.7	f	ne	3	s	o	g	v
10/08 /2020	v	6:41	7:40	52	47.6 5	n	6	8.07	w	8.0	52	49.3 4	n	5	56.4 4	w	6.2	6.0	n	nw	3	g	o	m	w
10/08 /2020	v	7:40	8:22	52	49.3 4	n	5	56.4 4	w	6.2	52	49.3 6	n	5	56.8 0	w	20.5	5.5	f	n	4	s	o	m	w
10/08 /2020	v	8:22	9:00	52	49.3 6	n	5	56.8 0	w	20.5	52	49.3 1	n	5	55.6 1	w	31.0	6.5	f	n	4	c	o	m	w
10/08 /2020	v	9:30	10:1 7	52	49.3 3	n	5	55.6 1	w	31.2	52	49.4 5	n	5	56.0 0	w	10.0	6.3	f	n	4	c	o	m	s
10/08 /2020	v	11:3 9	12:1 9	52	49.3 1	n	5	55.7 4	w	24.0	52	52.0 0	n	5	55.9 2	w		6.0	n	n	4	s	o	m	n
11/08 /2020	v	5:01	6:03	52	47.6 5	n	6	7.95	w	11.6	52	48.8 8	n	5	55.6 8	w	35.6	13.8	n	n	4	s	o	m	n
11/08 /2020	v	6:03	7:14	52	48.8 8	n	5	55.6 8	w	35.6	52	49.1 6	n	5	55.9 9	w	11.0	5.5	f	n	4	s	o	g	s
11/08 /2020	v	7:14	8:50	52	49.1 6	n	5	55.9 9	w	11.0	52	49.1 5	n	5	56.3 6	w	8.4	6.1	f	n	4	s	o	g	s
11/08 /2020	v	8:50	9:54	52	49.1 5	n	5	56.3 6	w	8.4	52	49.4 1	n	5	56.2 6	w		5.5	f	n	4	s	o	p	s

12/08/2020	v	5:03	5:46	52	47.4 4	n	6	7.78	w	12.7	52	44.8 2	n	5	57.0 2	w	22.7	15.2	n	n	4	g	o	m	n
12/08/2020	v	5:46	6:24	52	44.8 2	n	5	57.0 2	w	22.7	52	45.5 0	n	5	56.9 0	w	9.5	5.6	f	n	4	s	o	m	w
12/08/2020	v	6:24	7:35	52	45.5 0	n	5	56.9 0	w	9.5	52	45.4 5	n	5	57.0 7	w	4.5	5.9	f	n	3	s	o	m	w
12/08/2020	v	7:35	8:37	52	45.4 5	n	5	57.0 7	w	4.5	52	45.2 4	n	5	57.3 9	w	6.3	2.4	f	n	4	s	o	m	n
12/08/2020	v	8:37	9:01	52	45.2 4	n	5	57.3 9	w	6.3	52	45.5 2	n	5	57.3 5	w	6.8	6.5	f	n	4	s	o	g	n

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