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Measuring the effect of construction of two offshore wind farms in the Forth and Tay on marine mammals using passive acoustic monitoring

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1 Glossary

Term	Definition
AIC	Akaike Information Criterion, a model selection tool used to compare the quality of different statistical models for a given dataset
AIS	Automatic Identification System
Autocorrelation	In a statistical model, autocorrelation refers to the correlation of a variable with itself across different time lags or spatial positions. In time series or spatial data, the presence of autocorrelation indicates that observations are not independent, which can bias estimates and affect model validity if not accounted for.
Broadband recorder	Passive acoustic sensor configured to collect raw acoustic data and provide information on underwater noise and dolphin whistles. This project used LS1x sensors manufactured by Loggerhead Instruments or Sylence-LP sensors manufactured by RTSys.
Click logging device (CPOD/FPOD)	Cetacean Porpoise Detector or Full-waveform capture Porpoise Detector. The click logging devices (CPOD and FPOD, both manufactured by Chelonia Ltd) store instances of toothed whale echolocation clicks detected by the sensor using an on-board click detector.
DPH	Dolphin positive hour, hour with detected dolphin whistles and/or clicks
ECOMMAS	East Coast Marine Mammal Acoustic Study
EIA	Environmental Impact Assessment
Frequency band	A specific range of sound frequencies, defined by lower and upper limits, used to analyse and compare acoustic signals within that portion of the spectrum. Three bands are used in this study: 0.01 - 0.1 kHz, 0.1 - 1 kHz, 1-10 kHz, 10-48 kHz
FTRAG-MM	Forth and Tay Regional Advisory Group for Marine Mammals
GAM	Generalised Additive Models

Term	Definition
GAMM	Generalised Additive Mixed Models
IMO/MMSI	International Maritime Organization unique and permanent identification for a ship. Maritime Mobile Service Identity stays with the vessel as long as it is registered under the same entity or flag state
L_{10}, L_{50}, L_{90}	The sound pressure level that is exceeded for 10%, 50% or 90% of the measurement period respectively. L_{10} represents the higher noise levels, often associated with intermittent or louder events; L_{50} is the median sound level and L_{90} represents the quieter end of the distribution and is often used as an indicator of background or residual noise.
MD-SEDD	Marine Directorate - Science, Evidence, Data and Digital
Monitoring phase	Point in the monitoring period in relation to the start and the end of the construction period. Four phases were considered: pre-construction, during construction period with construction occurring that day, during construction period without construction occurring that day or post-construction.
Monitoring project	One of the three projects contributing to data collection: East Coast Marine Mammal Acoustic Study (ECOMMAS), Seagreen and Neart na Gaoithe (NnG).
Monitoring site	The site where noise and marine mammal detection devices were deployed.
NnG	Neart na Gaoithe (Offshore Wind Farm)
NnGOWL	Neart na Gaoithe Offshore Wind Limited
NOAA	National Oceanic and Atmospheric Administration
OSP	Offshore Substation Platform
OWF	Offshore Wind Farm
PAM	Passive Acoustic Monitoring
PEMP	Project Environmental Monitoring Programme
PPM	Porpoise positive minutes, number of monitoring minutes per hour with porpoise clicks detected.
PSD	Power Spectral Density
S36	Section 36 consent
SAC	Special Area of Conservation
SPL	Sound pressure level, a logarithmic measure of the effective sound pressure of a sound relative to a reference pressure, expressed in decibels (dB). The reference pressure is 1 µPa in water.
SSTA	Sea surface temperature anomaly
Study area	Forth and Tay region, between Eyemouth and Stonehaven, off the east coast of Scotland
SWEL	Seagreen Wind Energy Limited
SWH	Significant wave hight, a measure used as proxy for sea state in the modelling
WTG	Wind Turbine Generator

2 Executive Summary

Underwater noise generated during the construction of offshore wind farms can impact marine mammals, especially in the case of intense sound generation activities like impact pile driving. Two offshore wind farms off the east coast of Scotland used alternative pile installation techniques for wind turbine generator foundations such as drilling (Neart na Gaoithe Offshore Wind Farm, NnG) and suction caissons (Seagreen Offshore Wind Farm), while only the Offshore Substation Platform at the Seagreen Offshore Wind Farm was installed used impact pile driving.

A regional passive acoustic monitoring array was designed to investigate the variations in harbour porpoise and delphinid acoustic presence and underwater noise levels around the Forth and Tay areas, East coast of Scotland of the North Sea in relation to baseline and construction activities around these two offshore wind farms. The aim of this study was to relate any observed changes to a range of anthropogenic and non-anthropogenic factors and determine whether there were any significant changes in cetacean detections within the wind farm areas and adjacent waters pre, during and post-construction. This monitoring was a direct requirement as outlined in Project Environmental Monitoring Plan (PEMP) documents, which were prepared to address the specific requirements of the relevant conditions attached to the Section 36 (S36) consent and Marine Licences issued to NnG and Seagreen.

The PAM array consisted of 21 monitoring locations spread between Eyemouth and Stonehaven, off the east coast of Scotland. Passive acoustic data were collected between March 2019 and December 2024 using a combination of broadband recorders and echolocation click logging devices. Covariate data were collected for the monitored period to contextualize and interpret trends and patterns in cetacean presence observed in the Forth and Tay study area, and these were split into the following categories: spatial, temporal, underwater noise, physical, oceanographic, tidal variables, vessel traffic and those related to the construction of the NnG and Seagreen foundations. Response variables (cetacean acoustic presence) and covariate data were checked for missing values and prepared for model fitting. Separate statistical models were fitted for dolphins and porpoises using a range of Generalised Additive Models (GAM) and Generalised Additive Mixed Models (GAMM).

The results of this study indicated that both dolphins and porpoises were recorded at each monitoring site, with cyclical temporal patterns in acoustic presence particularly noted for porpoises. Underwater noise levels recorded during drilling and suction bucket caisson installation hours generally exhibited a 3-5 dB increase in the 0.1 – 1 kHz frequency range compared to non-construction days, whereas piling exhibited an 18 dB increase in the same frequency band. The models fitted for porpoises and dolphins highlighted that anthropogenic covariates (related to construction and vessel traffic) explained the lowest proportions of deviance in all the models and for both species groups, indicating that patterns in dolphin and porpoise presence and detections are primarily driven by natural and environmental variation at the spatial and temporal scales evaluated in this study. Construction activities at the two offshore wind farms did not have a discernible impact on dolphin and porpoise detections.

This study offers a rare, long-term, and spatially extensive analysis of the effects of offshore wind farm construction on marine mammals in the Forth and Tay region. Through six years of passive acoustic monitoring across 21 stations, we evaluated not only traditional piling activities, but also the comparatively under-studied drilling and suction bucket caisson installation methods. The inclusion of pre-, during-, and post-construction phases across two concurrently constructed wind farms allows for a more holistic understanding of potential impacts than most existing studies, which typically focus on single construction types in isolation over a shorter period of time. Monitoring at the regional scale identified that the effects of construction on both species were benign. Whilst many past studies on

the effects of noise focus on short term, localised effects, this study highlights the importance of data collection over longer time and wider space and consideration of broader scale impacts.

3 Introduction

3.1 Background

Underwater noise resulting from offshore wind farm development has been identified as a key factor influencing marine mammal responses during construction activities. It can lead to a range of effects, including auditory injury, habitat displacement, behavioural disturbance and acoustic masking.

Much of the concern around impacts on marine mammals stems from studies monitoring the effects of sounds generated during impact pile driving, where a hydraulic hammer drives piles into the seabed. This remains the most common foundation installation method in the offshore wind industry and one of the most intense, acute sources of underwater noise during construction. For over a decade, research has primarily focused on the impact of pile driving on sensitive marine mammal species in European waters, especially harbour porpoise (*Phocoena phocoena)* (van Geel et al. 2025). Studies have shown that harbour porpoises are displaced from the vicinity of piling events (Brandt et al. 2016, Brandt et al. 2018, Graham et al. 2019, Rose et al. 2019, de Jong et al. 2022, Rumes et al. 2022, van Geel et al. 2023, Benhemma-Le Gall et al. 2024, Rose et al. 2024). In contrast, evidence of impact piling effects on dolphin species is more limited. For example, a study in the Moray Firth observed minor changes in bottlenose dolphin presence during pile driving, though there was no indication of complete avoidance of the area (Graham et al., 2017).

Given an increased general concern about the impacts during construction, it is important to consider how, with technological advancements, there has been significant development in the design of offshore wind farm foundation structures, installation technologies, and equipment and alternatives to impact piling installation methods: such as vibratory piling, suction bucket caissons, and drilling (Jiang 2021, Guan et al. 2022, Huang et al. 2023, Meng et al. 2025). Compared to studies from impact piling, little is known about the effect of such alternative installation methods on marine mammals.

Sound generated by these alternative techniques differ in character from sound generated by conventional impact pile driving (Guan et al. 2022). Suction bucket caisson foundations are often described as "*almost silent*" but there is a lack of publicly available information reporting an acoustic signature during their installation (Cathie 2019, ter Horst and D'Aspremont 2023). The frequency and characteristics of noise generated during drilling are influenced by the drilling method, the equipment used, and the geological properties of the seafloor. The technique referred to in this report involves the use of rotating drill rods to bore into the seabed. It is expected to produce continuous, non-impulsive noise with past studies reporting a dominant 45 Hz tonal peak and irregular broadband energy extending beyond 1 kHz (Huang et al. 2023).

Given that both alternative installation methods are less common than impact pile driving, their potential effects on marine mammals remain less studied and are not yet as well understood. To date, no research has been conducted on the effects of suction bucket caisson installation on marine mammal presence and behaviour. Information on the disturbance effects of drilling is limited, and the majority of the research available is focussed on baleen whales (e.g. a study by Blackwell et al. (2017) showed changes in calling behaviour of bowhead whales during drilling activities). Research on porpoise responses to drilling remains inconclusive, as existing studies have difficulty isolating the extent to which other noise sources may have contributed to any observed effects (Bach et al. 2010, Martin et al. 2024).

3.2 Marine Mammal monitoring around the Forth and Tay

This report summarises marine mammal monitoring undertaken around two offshore wind farms: Neart na Gaoithe Offshore Wind Farm (henceforth referred to as NnG) and Seagreen 1 Offshore Wind Farm (hereafter referred to as Seagreen). This monitoring was a direct requirement as outlined in Project Environmental Monitoring Plan (PEMP) documents, which were prepared to address the specific requirements of the relevant conditions attached to the Section 36 (S36) consent and Marine Licences issued to NnG and Seagreen. The overall objective of the PEMPs is to outline the environmental monitoring of the projects required under their respective S36 Consent and Marine Licence conditions.

The majority of the foundations were installed using non-impact piling methods: at Seagreen, Wind Turbine Generators (WTG) jackets were secured using suction bucket caissons, while at NnG, pin piles were installed through drilling. Impact piling was limited to the installation of a single Offshore Substation Platform (OSP) at the Seagreen site, where 12 pin piles were driven to support a jacket foundation.

In discussion with the FTRAG-MM, it was agreed that given the spatial proximity of the Seagreen and NnG projects and the temporal overlaps in their construction phases, monitoring would be undertaken on a regional, rather than project-specific basis. The objectives and approach to the monitoring were presented to and agreed with the FTRAG-MM[1][2]. Monitoring and analysis therefore seek to understand the impacts on marine mammal activity in the wider Forth and Tay area. This is because at the regional scale, there are many anthropogenic activities underway (e.g. shipping, fisheries) alongside noise-generating OWF construction activity (which could include drilling, piling, pile installation, jacket installation etc.).

3.3 Objectives and approach

This study details the process and findings from PEMP objective. Given these, the objectives of the study were:

1. To characterise baseline and installation technique-related changes in underwater noise.
2. To characterise baseline levels of detections of vocalising marine mammals and determine whether there are any significant changes in these detections within the wind farm areas and adjacent waters pre, during and post-construction (the monitoring aim was therefore to inform whether construction activities cause significant changes in detections of marine mammals).
3. To relate any observed changes to a range of anthropogenic (level of underwater noise, construction related, vessel traffic) and non-anthropogenic factors (spatial, temporal, oceanographic, physical, tidal).

In this study we present the results from six years passive acoustic (PAM) and underwater noise monitoring of marine mammals in the Forth and Tay region, Scotland.

[1] https://marine.gov.scot/?q=data/ftrag-passive-acoustic-monitoring-methodology-overview-april-2021

[2] https://marine.gov.scot/sites/default/files/ftrag_minutes_-_marine_mammals_091121_-_final.pdf

4 Methods

4.1 Monitored wind farms and study site

The study site is the Forth and Tay region, between Eyemouth and Stonehaven, off the east coast of Scotland (Figure 4-1).

The Seagreen project is located in the outer Forth and Tay region, around 27 km from the coast of Angus (Figure 4-1). The passive acoustic monitoring covered Phase 1 of the installation, where 114 WTGs have been constructed alongside one OSP (Seagreen 2022). WTGs were installed on three-legged steel jackets using suction bucket caissons and the OSP was installed on a jacket foundation using impact piling of 2m in diameter pin piles. Foundation installation activities at Seagreen commenced in October 2021 and finished in April 2023. Phase 1A, which is not yet constructed, will comprise the remaining infrastructure (up to 36 further WTGs, one or more further OSPs, a network of inter-array cables and a single HVDC export cable to Cockenzie, East Lothian).

NnG is located to the northeast of the Firth of Forth, 15.5 km directly east of Fife Ness (Figure 4-1). The revised design included the wind farm (54 WTGs, their foundations and inter-array subsea cables) as well as offshore transmission components (two OSPs, interconnector cable, two offshore export cables). The WTGs and OSPs were installed on jacket substructures secured by pre-piled foundations (Neart na Gaoithe 2024). Pile installation was undertaken by drilling only, using template and steel duct casings. The drilling process at NnG involved creating rock sockets in the seabed to accommodate foundation piles. Steel casings were first installed to guide and support the drilling operation and prevent collapse of the hole. The drill removed material until the target socket depth was reached, at which point it was retrieved. After drilling, the pile was lowered into the pre-drilled socket and secured in place with grout. Foundation installation activities at NnG commenced in August 2020 and finished in August 2023.

4.2 Target species

This study focused on the acoustic presence of delphinids and harbour porpoise. Based on historic survey data, the most commonly recorded dolphin species within the waters of the east of Scotland and the wider Firth of Tay and Forth include bottlenose dolphin and white-beaked dolphin (*Lagenorhynchus albirostris*). Other species such as short-beaked common dolphin (*Delphinus delphis*), Risso's dolphin (*Grampus griseus*) and Atlantic white-sided dolphin (*Lagenorhynchus acutus*) have been recorded as occasional or rare visitors to this region (Hammond et al. 2021, Gilles et al. 2023, Gilles et al. 2025).

Both porpoises and dolphins show large spatial and temporal (diurnal and seasonal) changes in presence and distribution at the study site, see section 9 for more details.

4.3 Deployment

An array of Passive Acoustic Monitoring (PAM) sensors was designed to supplement the stations already deployed in the region as part of the East Coast Marine Mammal Acoustic Study (ECOMMAS) array. This is a project led by Marine Directorate - Science, Evidence, Data and Digital (MD-SEDD) designed to build a regional dataset for monitoring cetacean acoustic presence and underwater noise levels. Two additional PAM arrays were added: a dedicated array around NnG (extending the existing ECOMMAS array transect offshore from Fife Ness) and a transect from land out to the Seagreen site. All together this regional PAM array comprised twenty-one monitoring sites across the Forth and Tay region (Figure 4-1).

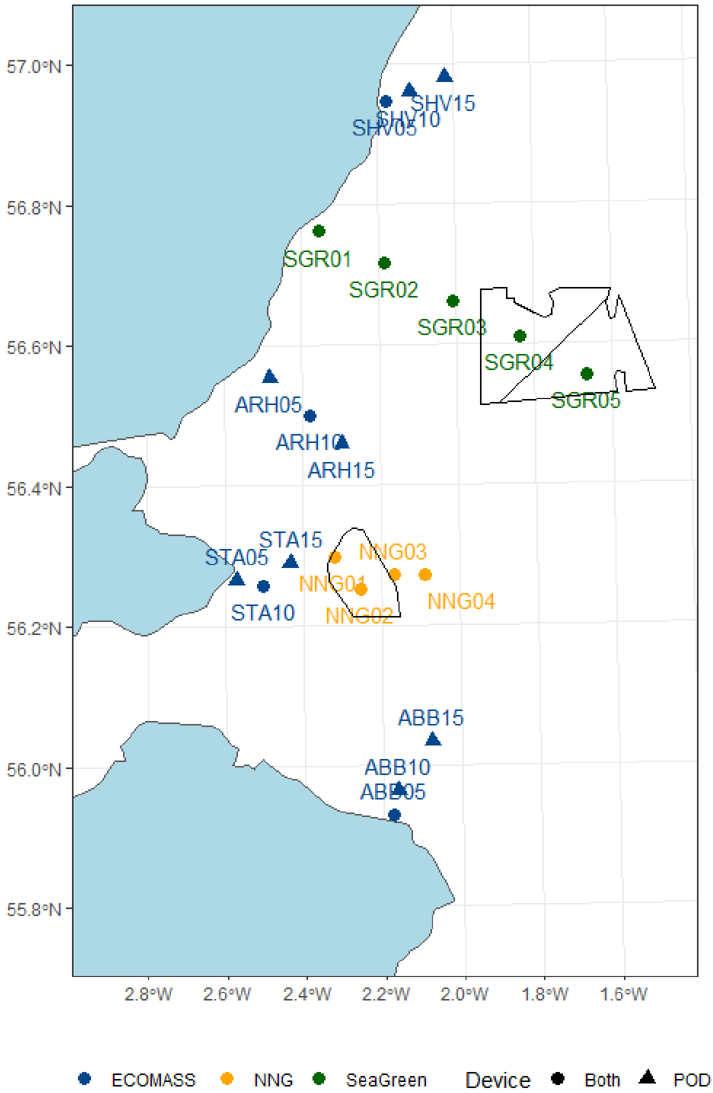

Figure 4-1. Deployment location of the three monitoring projects (colour) with the names of individual monitoring sites used throughout the text. Symbols depict whether a given site had only FPOD/CPOD (triangles) or both FPOD/CPOD and broadband recorder (dots).

4.4 Acoustic data acquisition

4.4.1 Sensors

Acoustic data were collected via passive acoustic sensors deployed on bottom-moored systems with no surface expression, following the design by Quer et al. (2023) (Figure A 10-1).

The click logging devices are manufactured by Chelonia Ltd and store instances of toothed whale echolocation clicks detected by the sensor using an on-board click detector. There are two models that have been deployed during this study, the CPOD (Cetacean Porpoise Detector) and a newer version called FPOD (Full-waveform capture POD) (FPODs were only deployed around some of the ECOMMAS sites and contributed to 4% of data overall). These sensors were configured to collect data continuously (100% duty cycle), with a click limit of 4,096 clicks per minute for CPOD to prevent data overflow and were located approximately 3 m above the seabed.

The two POD devices are known to show differences in detection (e.g. Todd et al. 2025). We performed a range of analysis to compare the two devices (Figure A 13-4) and concluded that there is no basis to distinguishing between these two types. These two types are, therefore, collectively referred to as PODs throughout the text.

The broadband recorder devices consisted of either LS1x sensors manufactured by Loggerhead Instruments or Sylence-LP sensors manufactured by RTSys. These sensors were configured to collect raw acoustic data by following a 33% duty cycle (10 minutes on, 20 minutes off) at a sampling frequency of either 96 kHz (for LS1x sensors) or 128 kHz (for Sylence-LP sensors). These sensors were located above the POD on the mooring line, approximately 5 m above the seabed.

Thirteen of the 21 monitoring sites had a broadband recorder (to provide information on underwater noise and dolphin whistles) and a CPOD or FPOD deployed on the same mooring, the remaining eight sites had only a single CPOD/FPOD to provide information on dolphin and porpoise clicks (Figure 4-1).

4.4.2 Deployment timeline

PAM data, for this study, were collected between March 2019 and December 2024 (see Appendix 7 in section 15 for mooring deployment and recovery metadata). Not all monitoring sites collected data over the entire period. The NnG monitoring array was deployed in December 2019 (and many broadband recorders stopped in June 2024). Only NnG monitoring sites and two ECOMMAS sites provided acoustic data to December 2024 (Figure 4-2).

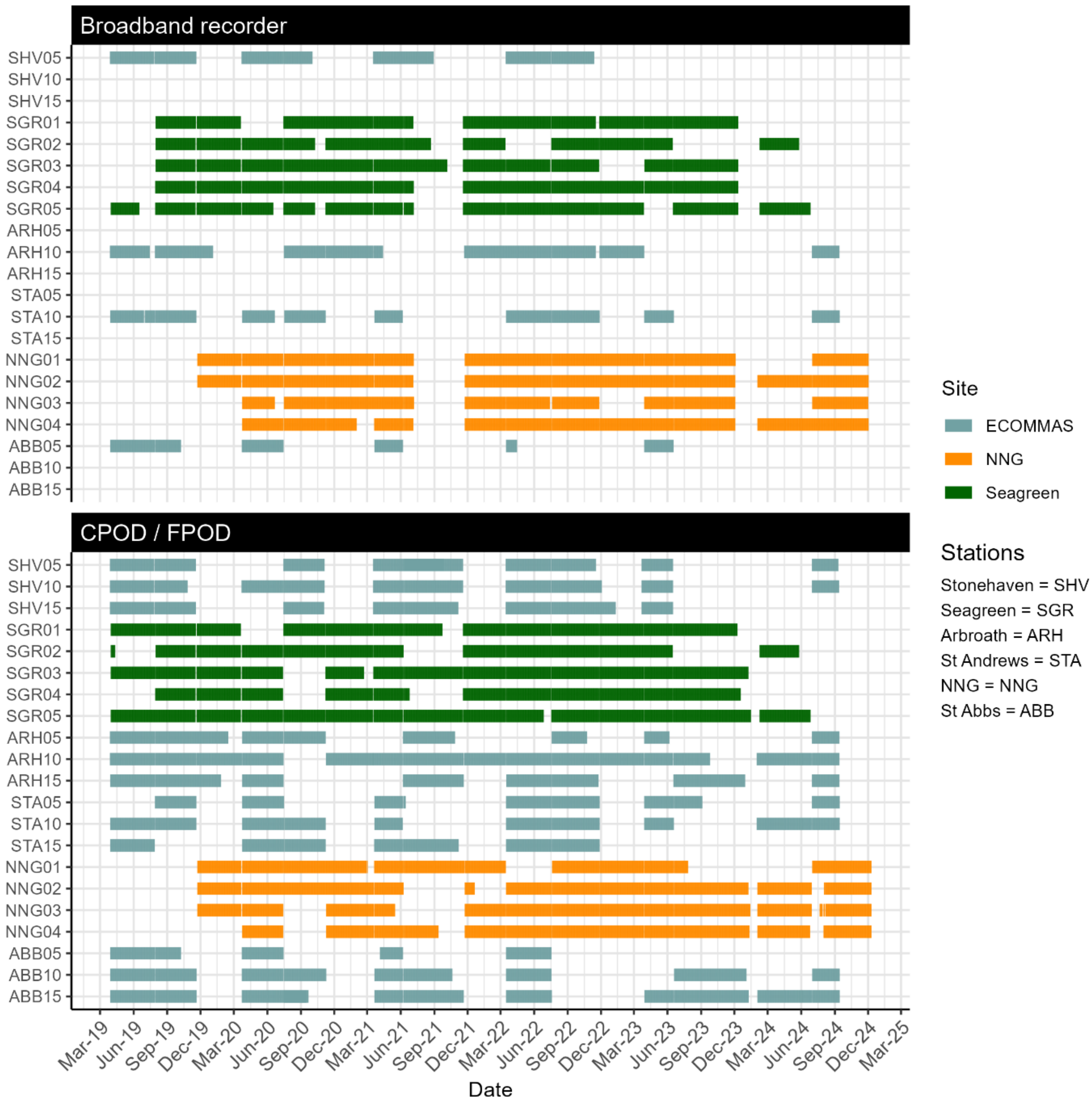

Figure 4-2. Deployment duration of each monitoring site and monitoring device.

4.5 Data pre-processing

4.5.1 Cetacean detections

The acoustic presence of dolphins and harbour porpoise was monitored using PODs, whereas dolphin acoustic presence was supplemented by identifying whistle detections in the broadband recorder data. Below we outline how these data were pre-processed to support the project analyses.

4.5.1.1 POD data

The raw POD files were processed using proprietary Chelonia software (either CPOD.exe (version 2.048) or FPOD.exe (KERNO-F version 1), depending on the sensor type involved) to identify series of clicks (i.e., click trains) resembling those produced by toothed whales. This is done via a built-in algorithm, implementing the Chelonia proprietary “KERNO Classifier” and the “GENENC encounter classifier”, which label series of clicks as either Narrowband (i.e., porpoise), Other Cetacean (e.g., delphinids), or Sonar. Detection positive minutes were extracted from the POD files for the Narrowband and Other Cetacean categories and only click trains of high and moderate quality were kept. The number of detection positive minutes for each hour was calculated for all periods when the units were deployed. These post-processing calculations as well as all modelling and data preparation were carried out in R 4.4.0 (R-Core-Team 2023).

4.5.1.2 Dolphin whistle detections

The raw acoustic files from the broadband recorders were stored in the .WAV file format and were given as inputs to the PAMGuard bioacoustics software (version 2.02.14, www.pamguard.org) for the dolphin whistle analysis. The PAMGuard 'Whistle and Moan Detector' was used to identify tonal signals in the 5-20 kHz range and the settings used for this detector included a signal-to-noise ratio of at least 8 dB and a minimum duration of 0.1 seconds (10 time slices).

The automated whistle detections were reviewed by experienced PAM analysts on a spectrogram display in PAMGuard to identify the 10-minute recording bins with dolphin whistles present. The first instance of confirmed dolphin whistles in a bin was marked to label that bin as detection positive, after which the operator moved to the next bin. It is important to note that classification of dolphins to a species level was not attempted during the manual review of the detections. Therefore, all detections are referred to collectively as dolphins throughout this text.

Dolphin positive bins were marked using the 'Spectrogram Annotation' module in PAMGuard, which stores all the annotations in one SQLite database per sensor deployment. Each database was queried after the manual review using a custom R script which extracts the timestamps of the annotations along with the timestamps of each recording and outputs a table with the start and end time of each recording and a record of whether the recording was detection positive or negative.

4.5.1.3 Underwater noise

To measure underwater noise levels, the raw acoustic files from the LS1x broadband recorders and their corresponding calibration details were given as input to a custom MATLAB routine based on the PAMGuide soundscape analysis tool developed by Merchant et al. (2015). LS1x sensors have hydrophones manufactured by High-Tech Inch, with a typical sensitivity of approximately -170 dB re 1V/µPa and gain was primarily set to 12.4 dB for each deployment, with four exceptions from the ECOMMAS array where gain was set to 2.05 dB (please see Appendix 5). for these noted deployments). Further calibration checks were performed for some of the sensors by Campbell Associates Ltd and the resulting hydrophone calibration certificates were used to calculate the root-mean-squared end-to-end sensitivity. A subset of the LS1x sensors did not have calibration certificates available and therefore the end-to-end sensitivity was calculated by subtracting the gain value from the default sensitivity of –170 dB re 1V/µPa. The Sylence-LP sensors were not used to calculate underwater noise levels due to variations in sensor and hydrophone configuration.

Sound pressure levels (SPL, dB re 1 µPa) for every minute of acoustic data were calculated using a custom MATLAB (v. 2023a; The MathWorks Inc. 2023) routine based on the soundscape analysis tool PAMGuide, described by Merchant et al. (2015). This custom MATLAB routine outputs median SPLs in broadband (0.01 - 48 kHz), frequency (0.01 - 0.1 kHz, 0.1 - 1 kHz, 1-10 kHz, 10-48 kHz) band and decidecade (or one-third octave) bands as well as power spectral density (PSD) values for each millidecade band. SPLs were described in the form of exceedance percentiles calculated on an hourly basis, including median (L_{50}) and 10% (L_{10}) and 90% (L_{90}). These metrics are recommended by the European Union's Marine Strategy Framework Directive as an environmental indicator to assess trends in ambient noise caused by anthropogenic sources (Dekeling et al. 2014). These noise measurements were then investigated on multiple temporal scales. Median broadband and frequency band time series plots for the six years of data at daily, weekly, monthly and yearly resolution at each site were then generated for quality assurance checks of the dataset. This study reports underwater noise levels in the 0.1 - 1 kHz and 10-48 kHz frequency bands using the median SPLs (L_{50}), as well as the loudest SPLs, exceeded only 10% of the time (L_{10}). The 0.1 – 1 kHz frequency band is mainly impacted by low frequency anthropogenic noise such as drilling, suction bucket caisson installation and vessel noise, whereas the 10 – 48 kHz band is affected by higher frequency noise, including vessel dynamic positioning systems, echosounders and depth scanners.

4.5.2 Covariate data

In addition to underwater noise levels, ancillary data were used to contextualize and interpret trends and patterns in cetacean presence observed in the Forth and Tay study area. This section describes the covariate data that were obtained.

Categories of candidate explanatory covariates were initially grouped into eight categories: spatial, temporal, underwater noise, physical, oceanographic, tidal variables, vessel traffic and those related to the construction of the NnG and Seagreen foundations (Figure 4-3). All covariates examined are detailed in Table A 11-1 and below we provide a short summary.

Oceanographic and tidal data were obtained from Copernicus Marine Service based on remotely sensed satellite observation. Additional tidal data were obtained from World Tides (WorldTides.info) which combines satellite telemetry, gauge data and harmonic analysis into tidal predictions. Data related to Sea Surface Temperature were obtained from National Oceanic and Atmospheric Association (NOAA) Coral Reef Watch (NOAA 2019) which utilises remotely sensed data, in-situ measurements and modelled data. Bathymetric data for the study region were obtained from GEBCO (2022) and combines measured and modelled depth data. Sunrise and sunset times were obtained from R package: ‘suntools’ (Bivand and Luque 2023).

Vessel traffic data (Automatic Identification System (AIS)) were obtained from Anatec Ltd. Hourly vessel density and intensity were calculated as the mean number of instantaneous vessels per km^2 and the cumulative number of hours all vessels spent within an area per hour within 3km of each monitoring site, respectively. Both metrics were calculated based on the methods described in EMODnet (2019).

The two metrics were divided between construction and non-construction vessels based on information provided by the developer. Construction vessels included only those involved in wind farm foundation installation and excluded other vessels that may be associated with the wind farm such as crew transfer vessels.

Data on construction vessels and the timing and duration of construction activities at NnG and Seagreen (suction, drilling, piling, UXO removal) were provided by the wind farm developers (NnGOWL, SWEL respectively).

Although construction of a wind farm involves multiple activities, for the purposes of this report, the term *construction* refers specifically to the period of foundation installation. Construction logs detailing hours in which drilling, suction or piling took place were obtained from the developers. Other activities such as pre-construction surveys, UXO clearance, turbine and cable installations are not considered in this report. Distinctions are made between four construction phases: pre-construction (prior to foundation installation), construction with foundation installation, construction without foundation installation, and post-construction (following foundation installation).

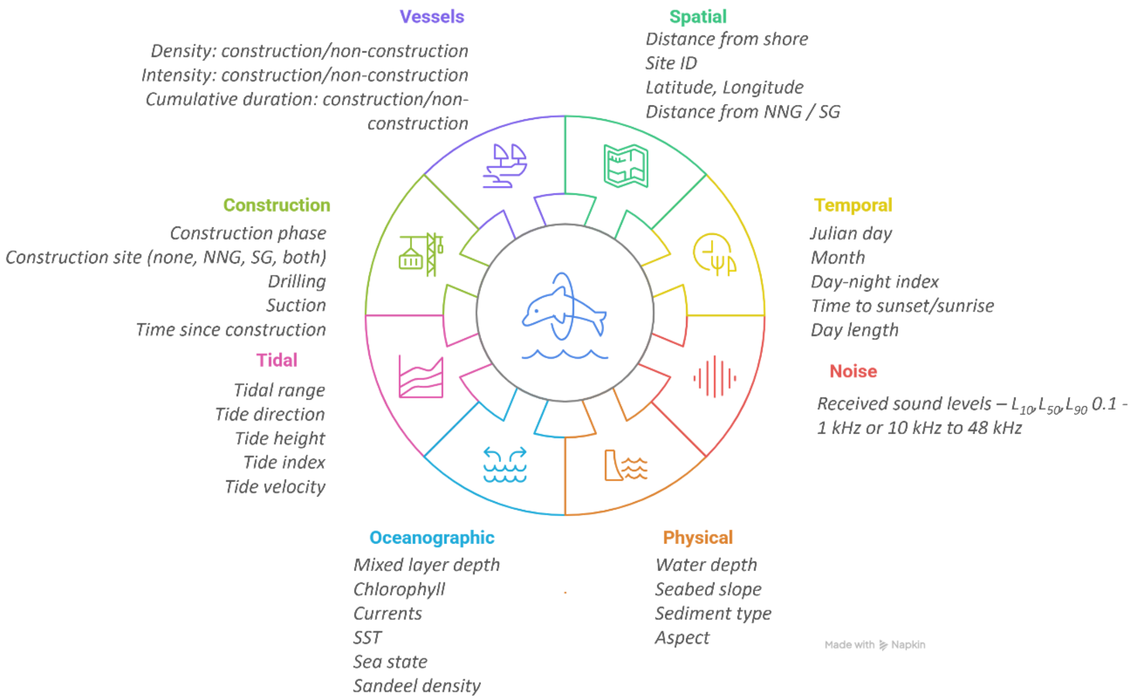

Figure 4-3. Schematic overview of the covariates considered in the model.

4.5.3 Statistical approach

4.5.3.1 Aim of the modelling

The aim of the modelling was to explore and identify spatial and temporal trends in detection of porpoises and dolphins across the 6-year period of monitoring from March 2019 to December 2024. Particularly, we aimed to explore whether the range of chosen covariates (including wind farm construction related variables) could explain patterns in cetacean presence.

We fitted two separate models for porpoises and dolphins.

4.5.3.2 Data preparation and checks

All data were collated to 1-hour resolution. A thorough examination of missing values and their spatio-temporal trends (if any), outliers and correlation between covariates was performed before the modelling. Understanding patterns in missing data is crucial because systematic gaps in space or time can introduce bias and affect the reliability of model predictions in those areas or periods. Outliers were identified as they can disproportionately influence model results, potentially leading to misleading conclusions about the relationships being studied. Each outlier was investigated to determine whether it represented a genuine extreme value or resulted from data collection errors (e.g. calibration), ensuring that only valid data points were retained for analysis. Additionally, highly correlated covariates (predictor variables) were assessed since including multiple variables that measure essentially the same thing can make the model unstable and difficult to interpret, while also inflating the apparent importance of that shared information.

To minimise bias from small sampling periods, hours for which broadband recorders monitored for <15 out 60 minutes were removed from further analysis. To account for a decrease in cetacean detectability with an increase in ambient noise, we removed all hours collected at the time when significant wave heights >5 m and total current velocity >1 m/s.

Prior to model fitting, the input data were ordered by location, then by the date and time of recordings. This ordering is essential because observations that are close together in space or time are often more similar to each other than to distant observations (a phenomenon known as autocorrelation, see below). Without proper ordering, the model may fail to detect these spatial and temporal dependencies, leading to underestimated uncertainty in predictions and potentially incorrect conclusions about the significance of relationships in the data

4.5.3.3 Modelling approach

For both the porpoise and dolphin models, a range of Generalised Additive Models (GAM) and Generalised Additive Mixed Models (GAMM) were fitted using the 'mgcv' R package and function *bam* (Wood 2023). The *bam* function makes some approximations to decrease run times and its memory footprint that are particularly relevant for large datasets such as those commonly generated by PAM data. Porpoise positive minutes (PPM) per hour and dolphin presence/absence per hour (binary variable based on detections on either a POD or broadband recorder in a given hour) were used as response variables for the porpoise and dolphin models, respectively. Different response variables were chosen to reflect the data collection methods: porpoise data were recorded continuously (i.e., 100% duty cycle), allowing us to use PPM as it captures more nuanced information about detection intensity within each hour. In contrast, dolphin data were collected using a duty cycle of 10 minutes recording followed by 20 minutes off, meaning continuous monitoring was not available. Additionally, dolphin presence was determined by combining data from two collection methods: PODs, which record continuously but have poor sensitivity for detecting dolphin vocalizations, and broadband recorders, which are more effective at detecting dolphins but operated on the intermittent duty cycle. For this combined and intermittent sampling approach, presence/absence per hour was more appropriate as it avoids potential bias from the variable recording effort within each hour.

After inspecting the distribution in the response variable for the porpoise model (Figure A 13-1) and testing for zero inflation using 'DHARMa' package (Hartig 2024), two model families were considered: poisson and Tweedie with logarithmic link function. The model diagnostics were better for the latter family and Tweedie using *tw* function from the 'mgcv' package was used in the final model. The dolphin model was fitted using binomial family with logit link function.

Given that the data consisted of observations (measurements at each acoustic recording station) collected close together in time and space, consecutive observations are likely to be correlated beyond the underlying processes included in the model, resulting in residual autocorrelation which violates a key assumption of a GAM. We used auto- and cross-correlation functions (*acf* and *pacf* functions from the R stat package (R-Core-Team 2023) to assess residual correlation. To account for the spatial and temporal autocorrelation related to the data collected at the same location, we added AR1 correlation structure. Each panel contained all recordings from a given acoustic recording station and a given day. Additionally, if applicable, we added either site as a random variable or a 2D interaction between latitude and longitude of each site to account for spatial autocorrelation. The latter was fitted using tensor product smooth (*te*) and thin plate regression splines (*bs="tp").*

Fitting a correlation structure in *bam* requires manual specifications of the AR1 correlation parameter (*rho*). We, therefore, first fitted a full model without the correlation structure and used *acf* function to calculate *rho*.

4.5.3.4 Model formulation, selection and diagnostics

We fitted three different models for each studied group (porpoise and dolphin): i) model based on data from the entire monitoring period and including noise covariate(s) and therefore only including sites for which this covariate was available ('noise model'), ii) model based on data from the entire monitoring period and including vessel related covariate(s) as a proxy for noise and therefore included all sites (‘vessel model’), iii) model based only on data collected during days when foundation construction activity happened (‘construction model’).

The aim of the ‘noise model’ was to understand how underwater noise in particular affects detections of the two groups. The aim of the ‘vessel model’ was to utilise all collected data to understand how the result change if more sites at various distance from the coast (ECOMMAS) are included. A model containing both noise and vessel metrics was not possible as these two covariates are highly correlated. The aim of the ‘construction model’ was to understand whether any changes in detection of porpoise/dolphins can be attributed to construction and how (or if) it differs between the two installation types: suction and drilling.

The list of all explanatory variables tested in the model, their description and observed values is given in Table A 11-1. Exploration of correlation between covariates (Figure A 13-2) led to grouping of the covariates into three categories: anthropogenic (ambient noise, construction and AIS), temporal (temporal, oceanographic, tidal), and static (spatial, physical) (Figure 4-3). We fitted a range of models where one or more (if not correlated) covariate from each group was added to the initial model. Some covariates had a large proportion of missing variables, either due to gaps in data collection or due to unavailability of this covariate for a time period or a location (Figure A 13-3). Such covariates were given least priority in being included in the model.

Each initial model included the spatial covariate (site as random variable, or 2D latitude longitude interaction or this 2D interaction for each construction phase), a covariate related to construction activity, covariate(s) related to temporal (seasonal or diurnal) cycles, covariates related to noise or vessel activity, and presence of the other cetacean group. The dolphin model also included dolphin presence source (referred to as device setup) as a random covariate to account for variability in probability of detecting dolphins depending on whether data from only a POD, only a broadband recorder or both devices were available. In the next steps, each covariate from a given category was replaced by another candidate covariate from that category. Model diagnostics (observed versus fitted values, fitted versus scaled Pearson residual plots, qq plots, partial effect plots, the distribution of residuals, tests for temporal autocorrelation using ‘DHARMa’ R package (Hartig 2024)), visual model fit, deviance explained and/or Aikaike Information Criteria (AIC) scores were used to determine which covariates to retain in the model. Deviance explained was used to compare models which had same-category covariates varying in number of missing values and AIC otherwise. We also evaluated concurvity between smooth terms using *concurvity* function from ‘mgcv’ package. Variable with values >= 0.70 were excluded from the model.

We fitted cyclic splines for temporal variables related to time of day, tides and time of year to account for cyclicity for these covariates and thin plate regression splines (default value in model formula) for the remaining smooth variables. Factor – smooth interactions were fitted using random wiggly curves (bs=”fs”). This approach produces a smooth curve for each level of the factor, treating the curves as entirely random (Wood 2023).

To order the relative effect of each covariate on the response variable in the final models, we fitted the final model based on the complete cases (all missing data were removed) and fixed degrees of freedom regression splines and then removed one covariate at the time and noted the difference in deviance explained between final and each of the reduced model.

5 Results

This section summarises the results in the context of project objectives. The results in in the context of NnG and Seagreen PEMPs are summarised in Appendix 6.

5.1 Detected cetacean presence

Both dolphins and porpoises were recorded at each monitoring site. There was considerably fewer dolphin detections compared to porpoise detections, and this trend was valid for all monitoring stations (Figure 5-1, Figure 5-3). Dolphins were recorded mainly closer to the coast whereas porpoises were present throughout the study site (Figure 5-1, Figure 5-2). The monitoring sites further offshore (NnG and Seagreen sites) recorded dolphin presence for <5% of the monitored hours.

There was a clear cyclical pattern in the detections of porpoises with minimum detections between April – June for most monitoring years and sites. The cyclic pattern for dolphins was not so pronounced. For the ECOMMAS sites where dolphins were detected most frequently (STA10, ARH10, ABB05, SHV05), the peak detections occurred in autumn months (September – November) (Figure 5-2). The SG sites located further offshore showed peak occurrence of dolphins in April-May.

For the monitoring stations where PODs and broadband recorders were deployed simultaneously, <5% of detections were recorded simultaneously on these two types of devices in the same time monitoring window (Figure 5-3). Hence, the acoustic detection of dolphins was primarily based on whistle detections from broadband recorders.

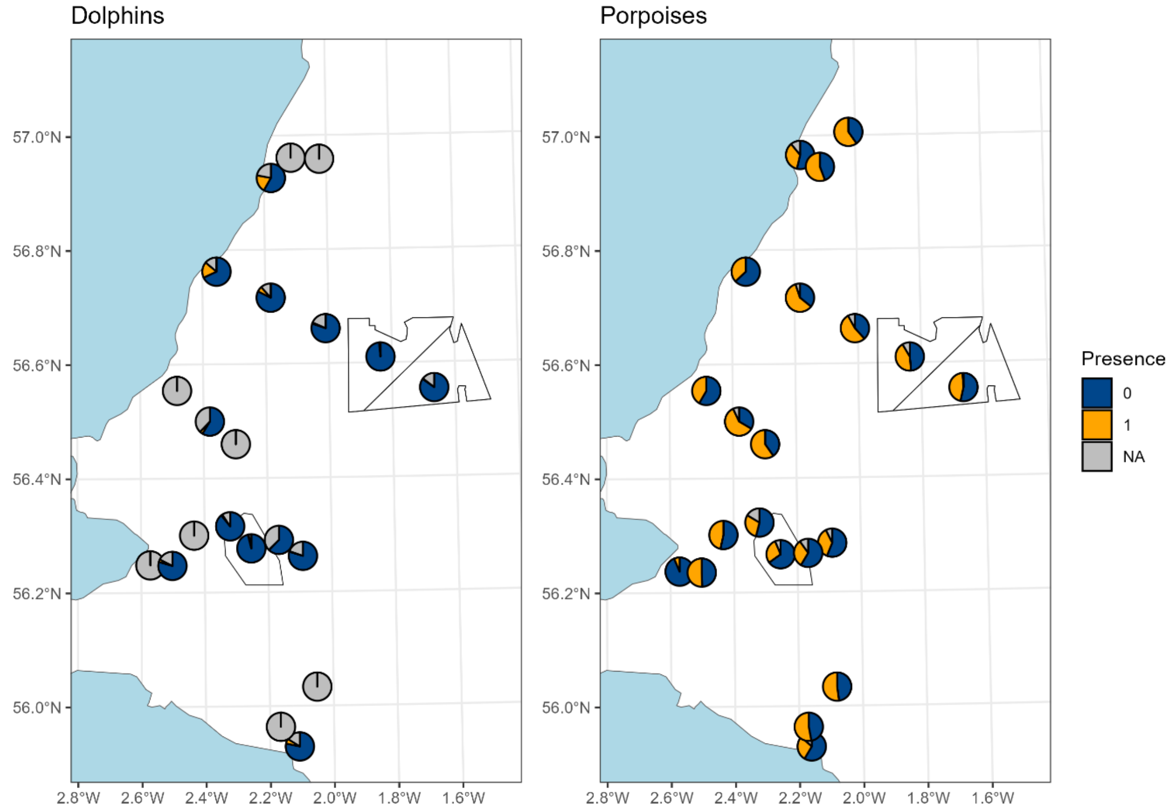

Figure 5-1. Proportion of dolphin/porpoise positive hours recorded throughout the monitoring period. For dolphins, only data from broadband recorders are shown. NA for both groups refers to either periods when data were not collected or to a site which did not collect the data (sites without a broadband recorder). Note that jitter was added to the coordinates of each pie chart to improve visibility.

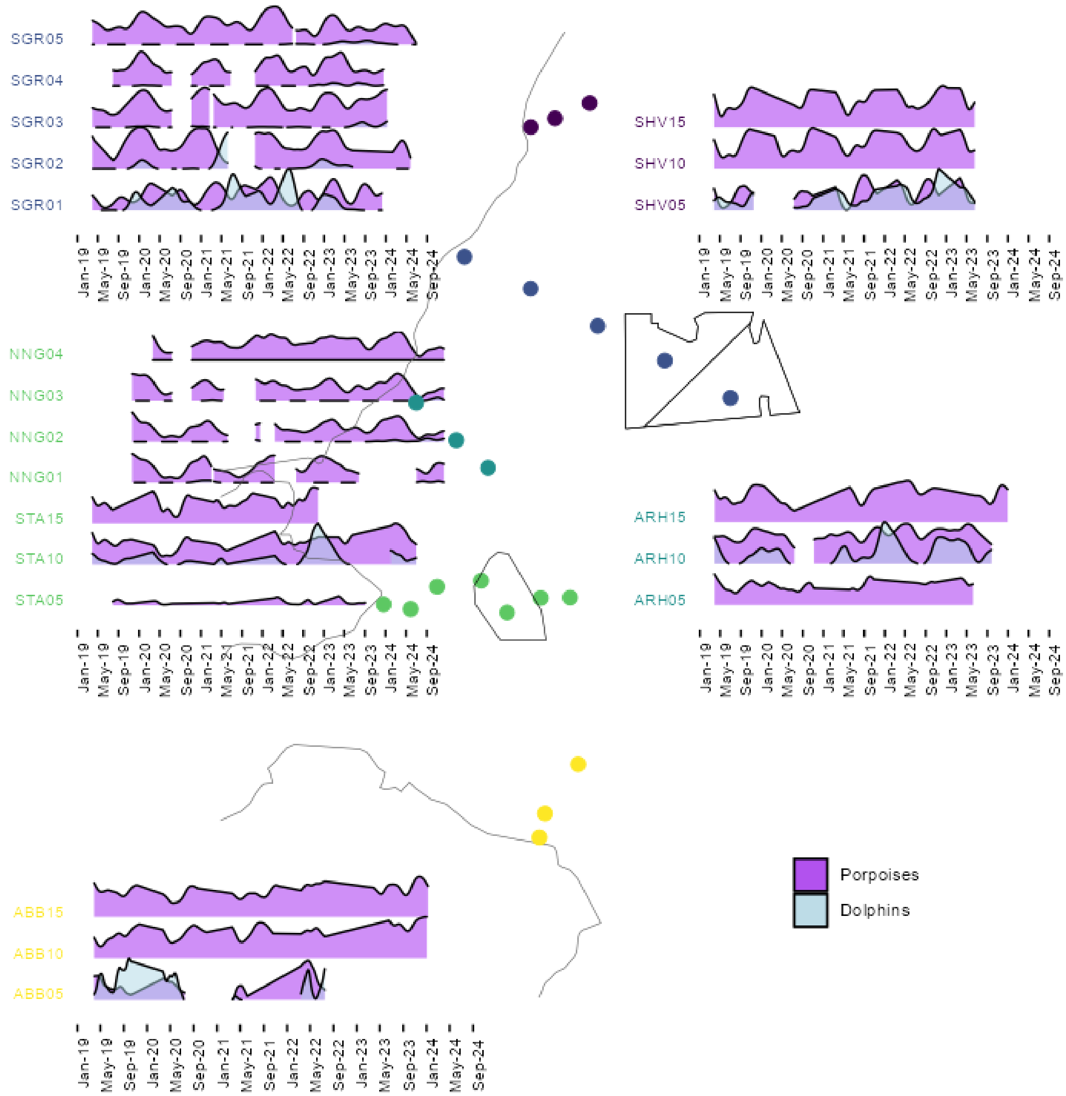

Figure 5-2. Trends in porpoise (purple) or dolphin (light blue) positive hours per 24h over the entire monitoring period for each monitoring site. For dolphins, only data from broadband recorders are shown here. On each panel, monitoring sites are ordered from closest (bottom) to further away from the coast.

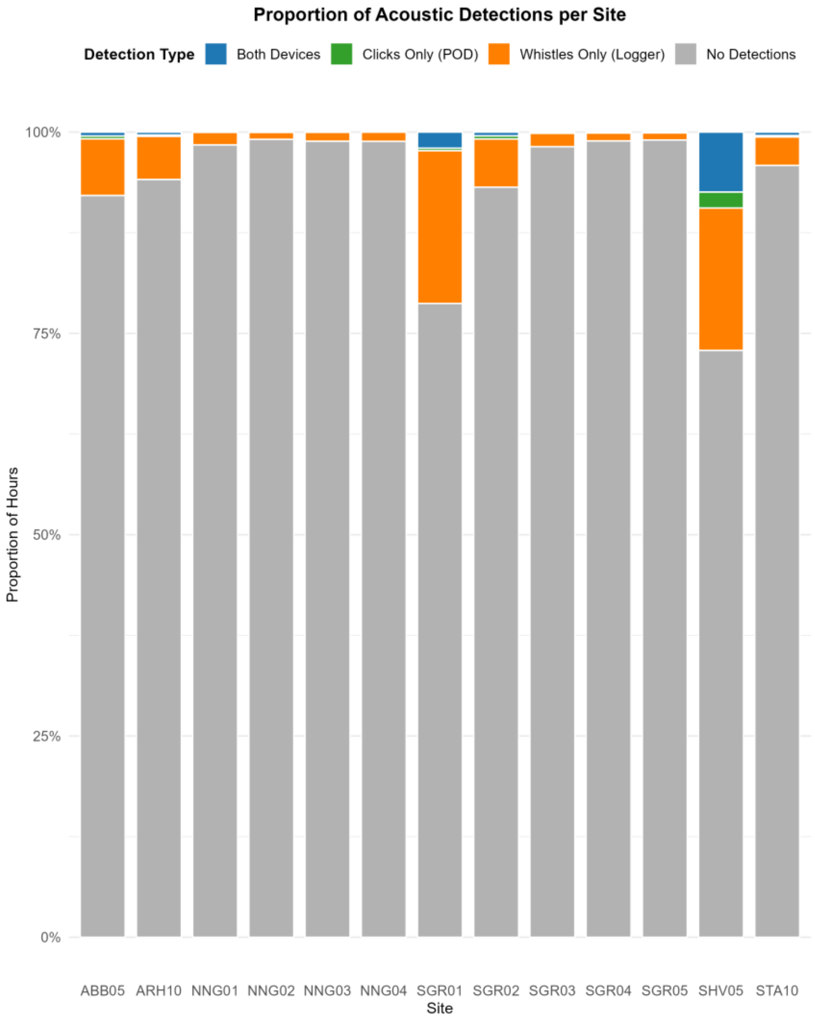

Figure 5-3. Proportion of dolphin acoustic detections per monitoring site for which PODs, and broadband recorders were deployed simultaneously.

5.2 Covariates

5.2.1 Construction

Foundation construction at NnG commenced in August 2020 and finished in August 2023 (Figure 5-4) with the majority of drilling activities happening in the second half of 2020, the first half of 2021, the second half of 2022 and in 2023. Foundation construction at Seagreen commenced in October 2021 and finished in April 2023 (Figure 5-4). Piling occurred only for 8 days at this wind farm in December 2021. The simultaneous construction of both wind farms only occurred in 2022 and 2023. There were 28 days over the monitoring period when construction happened at the same day at NnG and Seagreen simultaneously.

The monitoring period was divided into 4 periods: i) pre-construction: time from the start of the monitoring period to the first day of construction, ii) construction on: days in which there was construction of a given type, iii) construction off: a period longer than 24h when no construction took place, iv) post-construction: time from the last day of construction to the end of the monitoring period.

Figure 5-4. Construction activities at the two wind farms: suction and piling at Seagreen (green and purple) and drilling at NnG (orange). Light blue shades depict pre- and post-construction periods.

5.2.2 Underwater noise

The following sub-sections are split into (1) general spatio-temporal variations in measured underwater noise during this study and (2) noise associated with specific construction activities (drilling, suction caissons, and piling activities). The results focus on the decade band ranging between 0.1 and 1 kHz because of the frequency overlap with vessel- and construction-related noise. It must be emphasized that the precision of the hydrophones deployed can be usually within ± 1 dB, therefore the reported noise levels were rounded up to the closest integer. For further details on underwater noise, including summaries on noise in 10 and 48 kHz band, please see Appendix 4 (section 12).

5.2.2.1 General spatio-temporal patterns in SPLs

Figure 5-5 provides an overview of the measured underwater noise levels in the 0.1 – 1 kHz frequency band for all the stations and monitored years. The ECOMMAS sites exhibited an increase in median L_{50} SPLs between 2021 and 2023, but absolute noise levels were generally the lowest compared to

NnG and Seagreen PAM locations, ranging between 93 and 118 dB. At NnG, the median L_{50} SPL remained relatively stable from 2019 to 2024, ranging from 110 to 121 dB, whereas at Seagreen, there was an increase in median L_{50} SPLs between 2022 and 2024, with median L_{50} SPL across all years ranging from 104 to 127 dB in the 0.1 - 1 kHz frequency band. Comparable spatiotemporal trends were also observed in in 10 and 48 kHz band (Figure A 12-1).

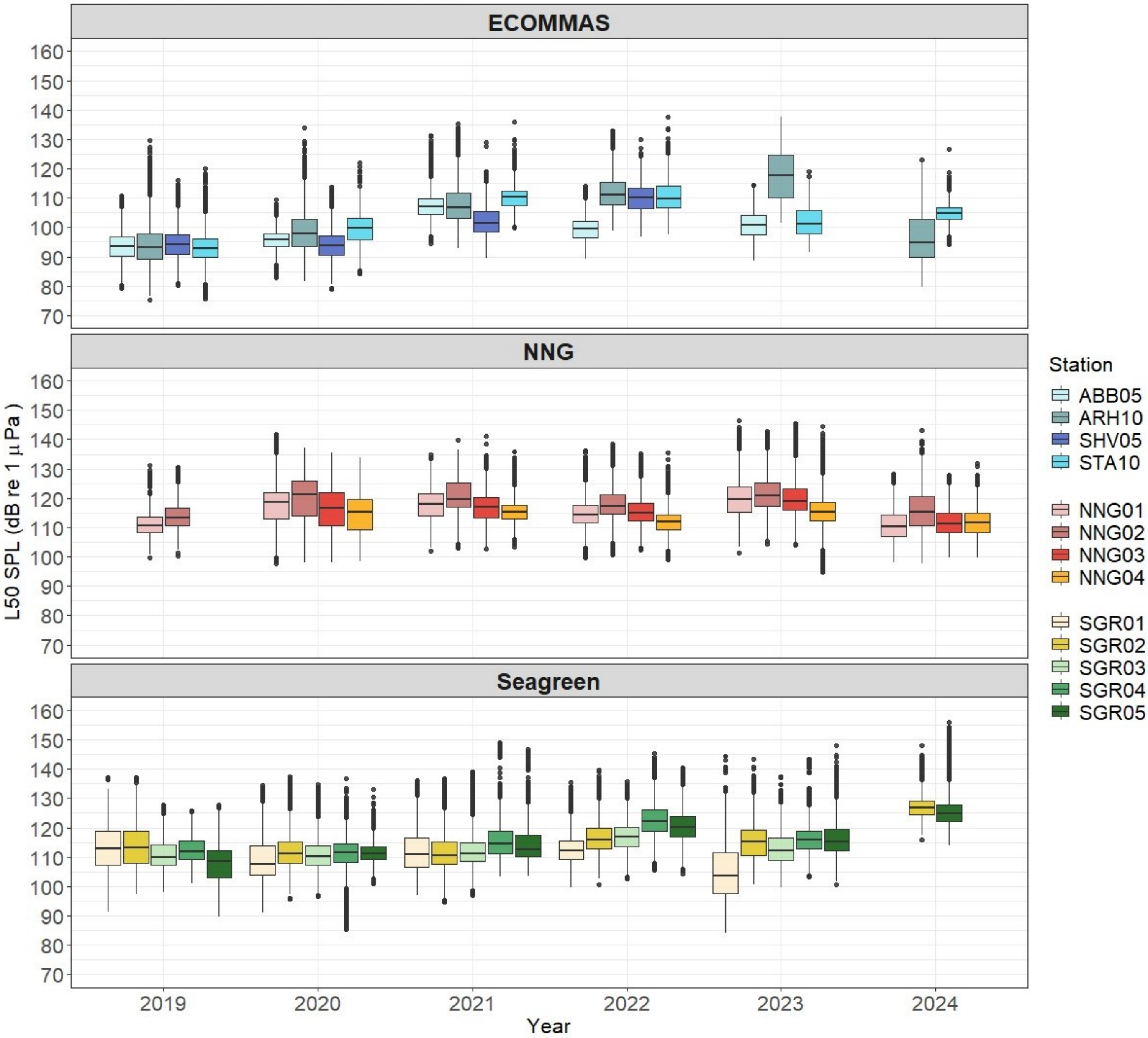

Figure 5-5. Annual variation of L_{50} sound pressure levels in the 0.1 – 1 kHz frequency band recorded at monitoring stations within the ECOMMAS monitoring site and two offshore wind farm monitoring sites (NnG and Seagreen) from 2019 to 2024. Boxplots show the median, interquartile range and outliers of sound pressure levels, with each coloured box representing a different noise monitoring station within each site. Where no data were available for a station for a given year, no box is shown.

5.2.2.2 Noise associated with specific construction activities: drilling, suction caissons, and piling activity

To investigate the noise signatures associated with specific construction activities, the median L_{50} SPL in the 0.1 – 1 kHz frequency band during periods of time with drilling, suction, or pile driving were examined at a finer, hourly temporal resolution.

To quantify changes in noise attributable to construction, we conducted three comparisons:

i. Noise levels during construction hours on construction days with all hours on non-construction days within the same month;

ii. Noise levels during non-construction hours on construction days with all hours on non-construction days within the same month;

iii. Noise levels during construction hours with non-construction hours on the same construction days.

5.2.2.2.1 Drilling

To quantify changes in noise attributable to drilling we compared days of construction period of October – December 2022 with non-construction days in the same months at the NnG monitoring sites.

i. The drilling hours had a consistently higher median L_{50} SPL in the 0. 1 – 1 kHz frequency band, with the median of drilling hours being 5 dB higher on average than hours from days with no drilling activity (range 2 – 14 dB depending on the site and month) (Figure 5-6).

ii. The median L_{50} SPL remained elevated in the non-drilling hours on drilling days, although the difference between drilling and non-drilling days became less pronounced (particularly in November 2022); However, on drilling days, the non-drilling hours were on average 3 dB higher than hours from days with no drilling activity, thus suggesting that the 5 dB increase during drilling operations may have been a result of a combination of sound sources, both drilling- and non-drilling-related (Figure A 12-2).

iii. Focusing on days with drilling activity only, an overall difference in the median L_{50} SPL of 2 dB was observed. However, these differences were station and month-specific and in the month of November differences in the median L_{50} SPL of 11 and 12 dB were observed at NnG02 and NnG03 (Figure A 12-3).

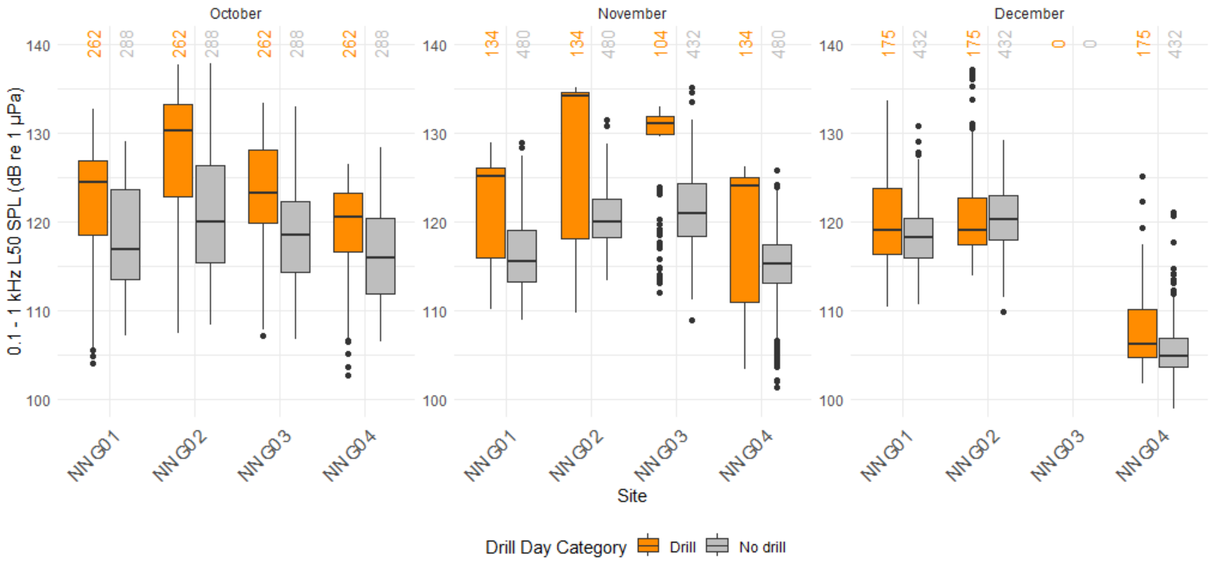

Figure 5-6. The comparison of the L_{50} SPL in the 0.1 – 1 kHz frequency band during three months of construction (October, November and December 2022) at the NnG monitoring sites. Only drilling hours from drilling days are retained in the analysis ("Drill" category) and these are compared to non-drilling hours from days where there was no construction in the same month ("No drill" category). The sample size (number of hours within each site and category) is displayed above the bars.

5.2.2.2.2 Suction bucket caisson

To quantify changes in noise attributable to suction bucket caisson we compared days of construction period of October – December 2022 with non-construction days in the same months at the Seagreen monitoring sites.

i. The suction hours had a consistently higher median L50 SPL in the 0. 1 – 1 kHz frequency band, with the median of suction hours being 3 dB higher on average than hours from days with no drilling activity. The highest differences in noise levels were observed at the monitoring stations closest to the construction site (Figure 5-7).

ii. On suction days, the non-suction hours exhibited higher median L_{50} SPL by 2 dB compared to non-suction days, thus suggesting that the 3 dB increase from i. during suction operations may have been a result of a combination of sound sources, both suction- and non-suction-related (Figure A 12-4).

iii. When only construction days on which suction occurred are considered, the median L_{50} SPL of suction hours was 1 dB higher than during non-suction hours, which is within the precision of the hydrophones (Figure A 12-5).

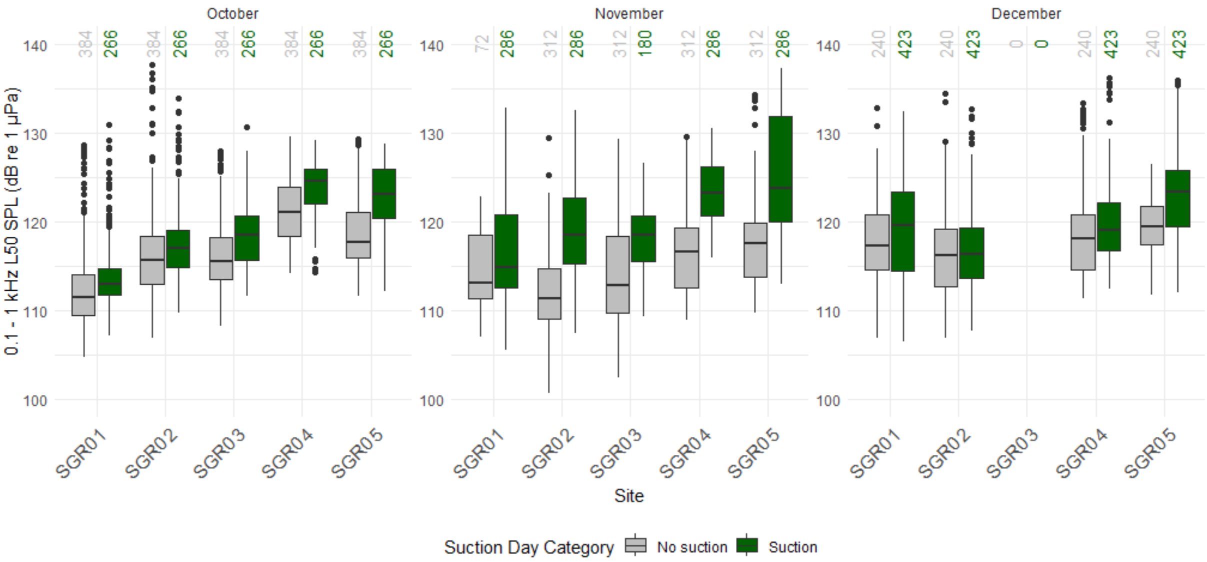

Figure 5-7. This figure compares the L_{50} SPL in the 0.1 – 1 kHz frequency band during three months of construction (October, November and December 2022) at the Seagreen monitoring sites. Only suction hours from suction days are retained in the analysis ("Suction" category) and these are compared to non-suction hours from days where there was no construction in the same month ("No suction" category). The sample size (number of hours within each site and category) is displayed above the bars.

5.2.2.2.3 Pile driving

Pile driving only took place over 8 days in December 2021. To quantify changes in noise attributable to this activity we compared piling days of December 2021 with non-piling days from the same month at the Seagreen monitoring sites.

i. Median L_{50} SPL of piling hours was 18 dB higher than non-piling hours from non-piling days, making this activity the loudest out of all construction types. This was particularly pronounced at the SGR04 and SGR05 stations (the two within the OWF array area, 22 and 16 km away from the piling location, respectively), where the difference was 27 dB and 25 dB at these stations. (Figure 5-8).

ii. If piling hours are removed from the piling days, then the noise levels of piling days become almost identical to the noise levels on non-piling days, with a difference in median L_{50} SPL of 1 dB). This indicates that it was the piling activity itself driving the increase in noise levels on piling days and not associated vessel activity (Figure A 12-6).

iii. There was a 17 dB difference in median L_{50} SPL between piling and non-piling hours. This difference was greatest at SGR04 and SGR05, the stations within the wind farm (25 dB and 22 dB respectively (Figure A 12-7).

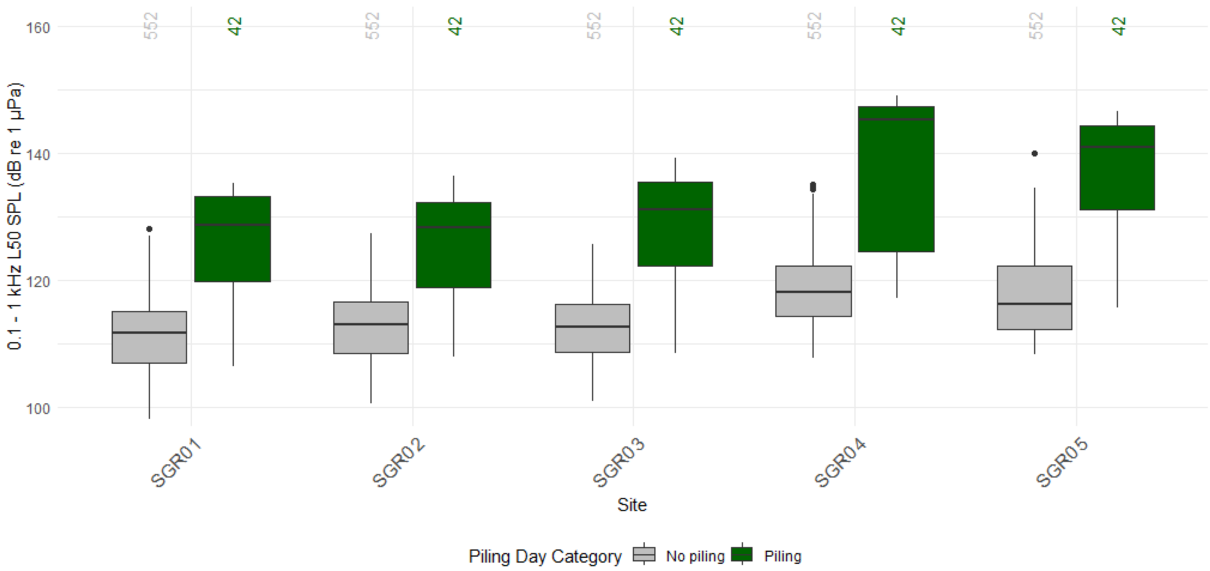

Figure 5-8. This figure compares the L_{50} SPL in the 0.1 – 1 kHz frequency band during the month of December 2021 at the Seagreen monitoring sites. Only piling hours from piling days are retained in the analysis ("Piling" category) and these are compared to non-piling hours from days where there was no piling activity in the same month ("No piling" category). The sample size (number of hours within each site and category) is displayed above the bars.

5.2.2.2.4 Summary

The median L_{50} SPL in the 0.1 – 1 kHz frequency band for all activity types is summarized in Table 5.1. Drilling and suction hours exhibited a 3-5 dB increase compared to non-construction days, whereas piling exhibited an 18 dB increase.

Table 5.1. Median L_{50} sound pressure levels (SPLs) in the 0.1 – 1 kHz frequency band for construction and non-construction hours or days for three activity types. Note the construction period is Oct-Dec 2022 for NnG Drilling and Seagreen suction, December 2021 for Seagreen Piling.

Construction Site and Activity	Median L_{50} SPLs (Construction hours on construction days, dB)	Median L_{50} SPLs (Non-construction hours on construction days, dB)	Median L_{50} SPLs (Non-construction days, dB)
NnG Drilling	123	121	118
Seagreen Suction	120	118	116
Seagreen Piling	132	115	114

5.2.2.3 AIS

The highest vessel density and intensity has been in the more coastal waters (and around harbours), and this trend has not changed across the monitoring years (Figure A 11-5, Figure A 11-6). Vessel intensity increased at both OWFs between 2022 and 2024 both for the construction and non-construction related vessels (Figure A 11-5, Figure A 11-6), as well as for all vessels combined (Figure 5-9). Vessel intensity at the ECOMMAS sites did not show changes in between the years.

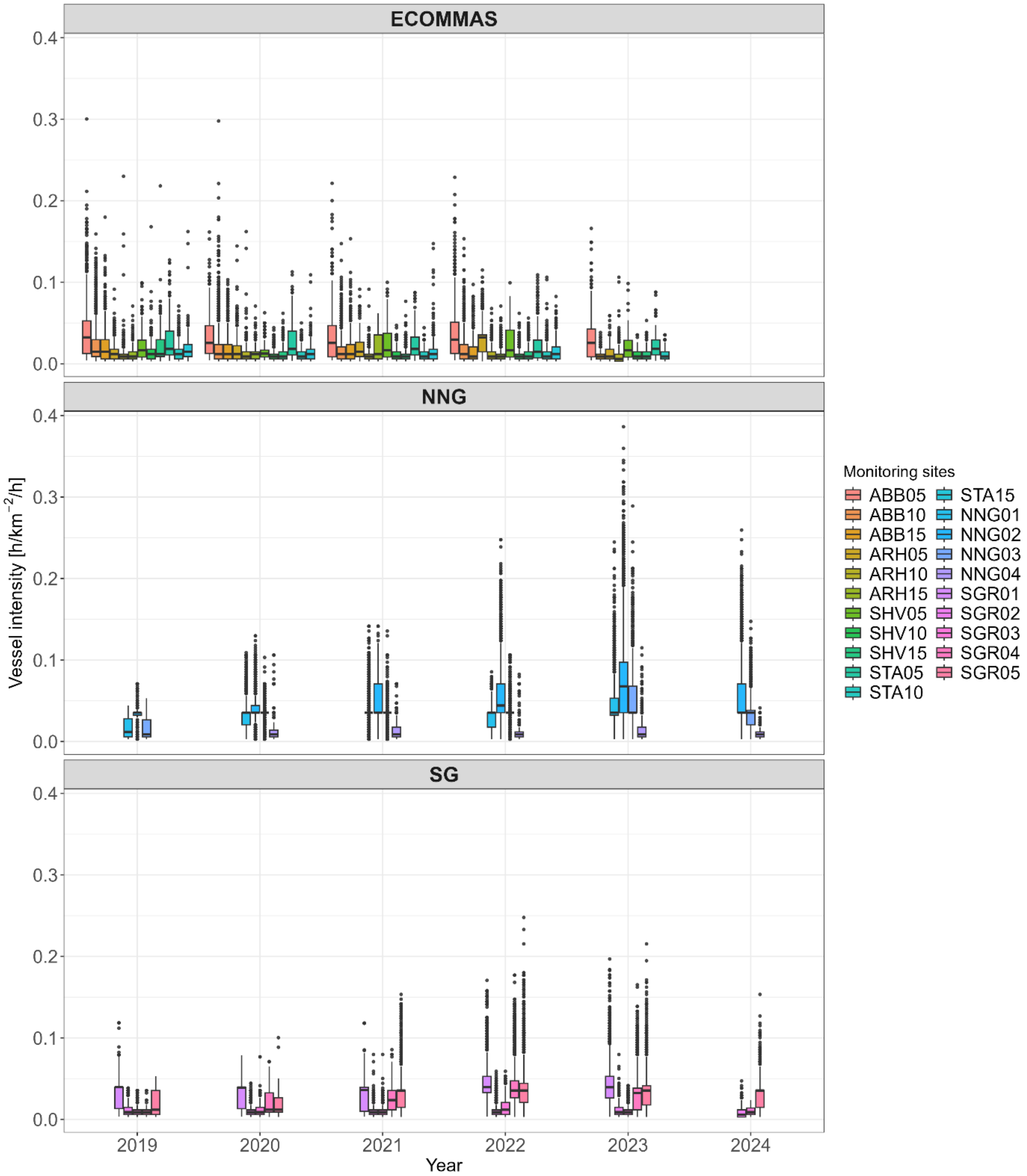

Figure 5-9. Changes in vessel intensity for all vessel types in between years, sites and projects.

There was a poor correlation between SPLs in both frequency bands and vessel density. Loudest noise in these frequencies was rarely associated with highest vessel density. Instead, low or no vessel densities for both frequency ranges were associated with a large span of underwater noise indicating no clear correlation between vessel density and underwater noise (Figure A 12-1, Figure A 12-2).

5.3 Modelling

For both species, the noise and vessel models are presented below, and the construction models are presented in section 13.

5.3.1 Porpoise models

Diagnostic plots for each model are presented in Figure A 13-5, Figure A 13-6, Figure A 13-7. No significant deviation from the assumptions of GAM was observed. Whilst autocorrelation in the model residuals was partially accounted for through inclusion of an AR(1) correlation structure, some residual autocorrelation remained.

To assess the importance of variables in the final models, we can consider the estimate of deviance explained by each covariate (the greater the percentage deviance explained, the greater influence the covariate had on the model). For both the noise and vessel models, latitude, longitude interaction with phase explained markedly more deviance than other covariates, indicating strong spatial structuring in porpoise detections. Time of year (represented by Julian Day) and time of day (day-night index) were the next most influential covariates, followed by the presence of dolphins in the same period. Noise levels or the density of vessels (depending on the model), the state of tide (tide index), presence of construction activities and construction phase explained <1% each (Table 5.2, Figure 5-10, Figure 5-11).

All the covariates which were retained both in the vessel and noise models, showed the same patterns in the two models (Figure 5-10, Figure 5-11):

- Porpoises were detected throughout the entire study area and there was no clear pattern in between construction phases in spatial distribution. Spatial patterns had the largest deviance explained.
- Porpoises were detected less during April – September and less during the day than during nighttime. Porpoise detections decreased when dolphins were present. These three covariates explained cumulatively 6 and ~8% of deviance in the noise and vessel models respectively.
- There was an observed decrease in porpoise detections when both wind farms were constructed simultaneously but not when each was constructed separately, but this covariate explained <1% deviance.
- There was no difference in porpoise detections in between the construction phases.

Porpoise detections decreased with an increase in underwater noise (L_{50} 0.1 – 1 kHz) and this relationship was similar for all construction phases (including pre- and post-construction). The large decrease in porpoise detections with underwater noise for the post-construction phase was largely driven by periods >140 dB. Such levels were not recorded during other phases (Figure 18).

In the vessel model, there was a clear decrease in porpoise detections with an increase in vessel density but this large decrease was mainly driven by vessel density >0.4 vessels/km^2/h which was not common for any phase (Figure 5-10).

When the model was fit to data from days when construction activity occurred, spatial, temporal and environmental variation have the strongest influence on porpoise detections (Figure A 13-11, Table A 13-1). Consistent with the previous models, temporal trends of lower porpoise detections during summer months, during daytime, and when dolphins were present were also observed. There was an increase in porpoise detections when suction at Seagreen happened and decrease when drilling happened at NnG but these patterns explained <1% of deviance. This indicates that at the spatial and temporal resolutions evaluated, specific construction activities did not have a discernible impact on porpoise presence.

Table 5.2. Generalised Additive Model (GAM) coefficients for models of porpoise positive minutes. Two models are presented: (i) noise model based on 13 sites where broadband recorders were deployed and therefore L_{50} SPL in the 0.1-1 kHz frequency band is included as a covariate, (ii) vessel model, including all 21 sites and vessel related covariates as a proxy for noise. Covariates are presented in order from the highest deviance explained to the lowest deviance explained.

Variables with p < 0.05 are considered statistically significant. The F-statistic tests whether each variable contributes meaningfully to explaining the data beyond what would be expected by chance (note that F values cannot be directly compared between different types of variables or interactions). p-values indicate the probability that the observed relationship occurred by chance alone (values below 0.05 are considered statistically significant, meaning the relationship is unlikely due to random variation). Note that each model was formulated to test which of the covariates from the defined groups affect the detections of the animals. We, therefore, kept in the model covariates which were not significant. Degrees of freedom (edf) reflect the complexity of each variable's relationship with the response - values close to 1 indicate a simple linear relationship, while higher values suggest more complex, non-linear patterns, common for interactions.

<table>
<tr><th></th><th>Covariate</th><th>F</th><th>p</th><th>(e)df</th><th>Approx. deviance explained [%]</th></tr>
<tr><td rowspan="9">(i) noise model</td><td>(Lon,Lat) * phase</td><td>253.6</td><td><0.05</td><td>47</td><td>9</td></tr>
<tr><td>Julian</td><td>2090.6</td><td><0.05</td><td>6</td><td>3</td></tr>
<tr><td>Day-night index</td><td>1602.5</td><td><0.05</td><td>2</td><td>2</td></tr>
<tr><td>Dolphin presence</td><td>414.3</td><td><0.05</td><td>1</td><td>1</td></tr>
<tr><td>L_{50} SPL in the 0.1-1 kHz * phase</td><td>17.7</td><td><0.05</td><td>12</td><td><1</td></tr>
<tr><td>Tide index</td><td>41.9</td><td><0.05</td><td>2</td><td><1</td></tr>
<tr><td>Construction presence</td><td>7.1</td><td><0.05</td><td>3</td><td><1</td></tr>
<tr><td>Construction phase</td><td>0.5</td><td>0.67</td><td>3</td><td><1</td></tr>
<tr><td>Full model</td><td></td><td></td><td></td><td>24</td></tr>
<tr><td rowspan="9">(ii) vessel model</td><td>(Lon,Lat) * phase</td><td>6326.0</td><td><0.05</td><td>64</td><td>7</td></tr>
<tr><td>Julian</td><td>3170.4</td><td><0.05</td><td>6</td><td>7</td></tr>
<tr><td>Day-night index</td><td>2089.4</td><td><0.05</td><td>2</td><td>1</td></tr>
<tr><td>Dolphin presence</td><td>699.3</td><td><0.05</td><td>1</td><td><1</td></tr>
<tr><td>Vessel density * phase</td><td>35.2</td><td><0.05</td><td>4</td><td><1</td></tr>
<tr><td>Tide index</td><td>82.7</td><td><0.05</td><td>2</td><td><1</td></tr>
<tr><td>Construction presence</td><td>5.2</td><td><0.05</td><td>3</td><td><1</td></tr>
<tr><td>Construction phase</td><td>0.2</td><td>0.87</td><td>3</td><td><1</td></tr>
<tr><td>Full model</td><td></td><td></td><td></td><td>20</td></tr>
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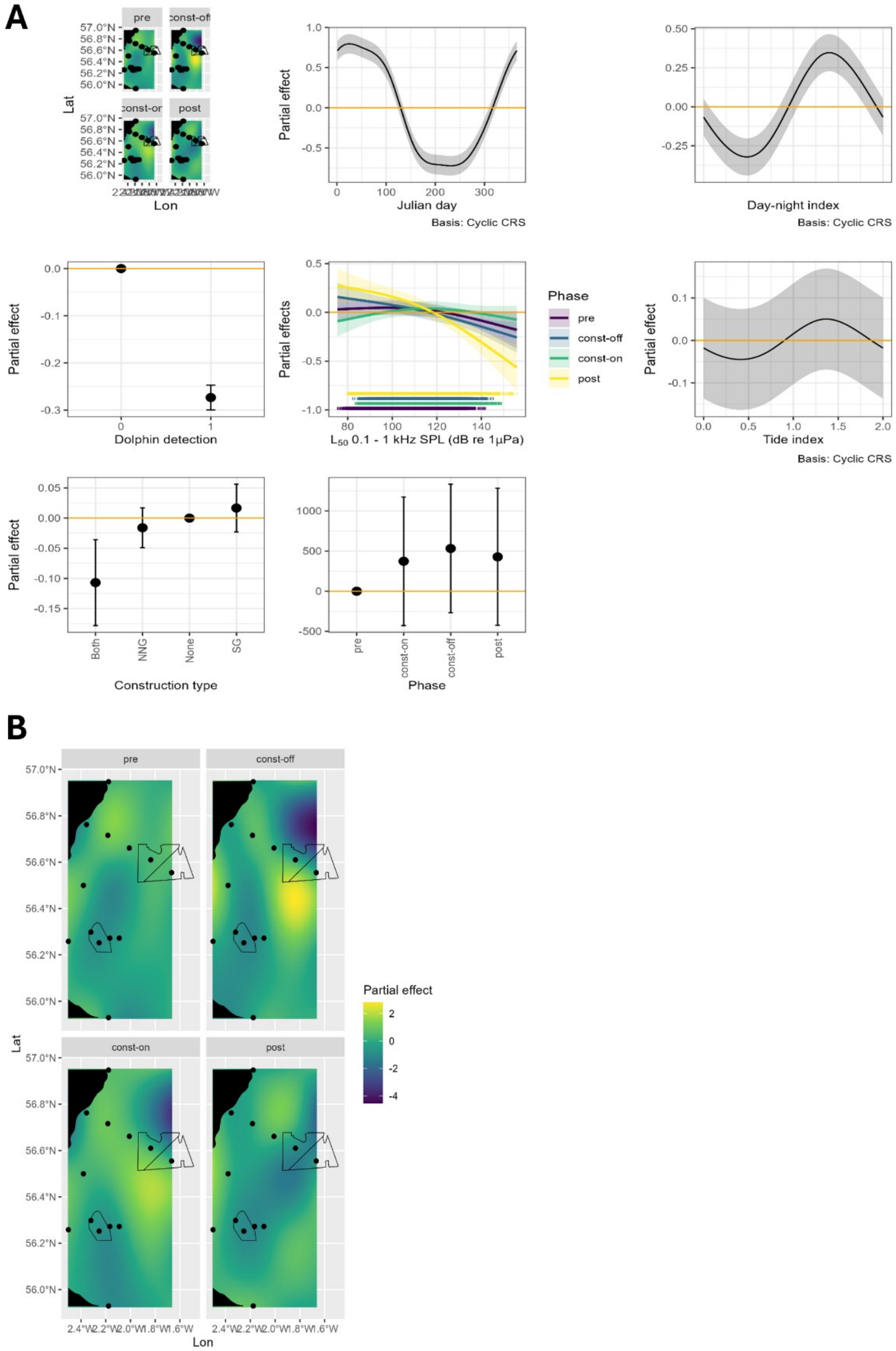

Figure 5-10 (A)Generalised Additive Model (GAM) predicted partial effects of covariates in the noise model, ordered from highest to lowest deviance explained. Partial effects in a GAM show the individual effect of one covariate (Julian day) on the outcome, while holding the other variables constant. Values above orange horizontal line show an increase in detections and below, decrease. The points above the x-axis, in noise plot, are a rug plot, indicating the spread of noise values in the raw data used to fit the model. (B) Enlarged predicted partial effect of latitude and longitude on porpoise positive minutes as a function of construction phase (pre, construction-on, construction-off or post). Darker blue indicates lower detections, yellow increase in detections.

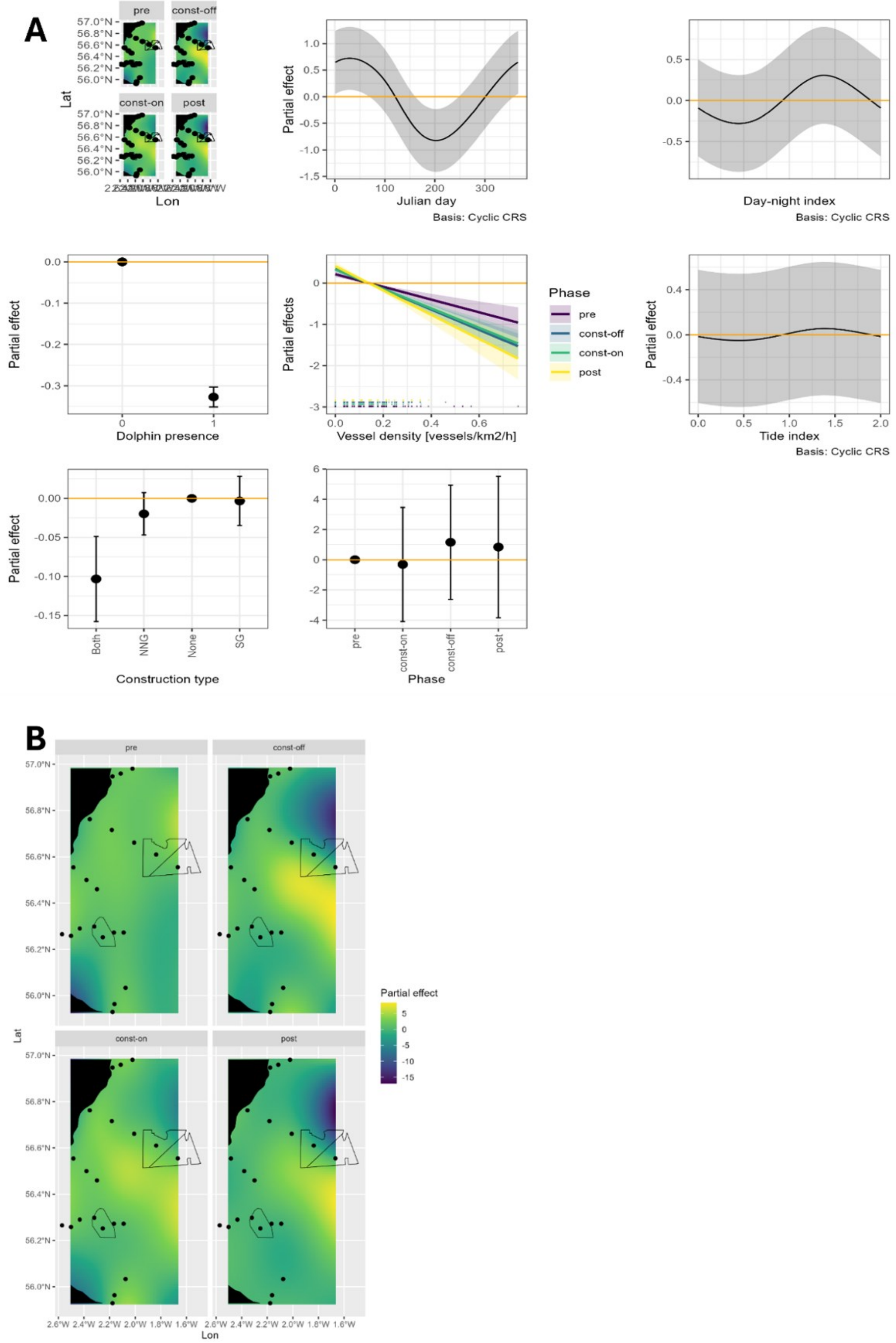

Figure 5-11 (A) Generalised Additive Model (GAM) predicted partial effects of covariates in the vessel model, ordered from highest to lowest deviance explained. Partial effects in a GAM show the individual effect of one covariate (Julian day) on the outcome, while holding the other variables constant. Values above orange horizontal line show an increase in detections and below, decrease. The points above the x-axis, in noise plot, are a rug plot, indicating the spread of noise values in the raw data used to fit the model. (B) Enlarged predicted partial effect of latitude and longitude on porpoise positive minutes as a function of construction phase (pre, construction-on, construction-off or post). Darker blue indicates lower detections, yellow increase in detections.

5.3.2 Dolphin models

Diagnostic plots for each model are presented in Figure A 13-8, Figure A 13-9, and Figure A 13-10. No significant deviation from the assumptions of GAM was observed. Whilst autocorrelation in the model residuals was partially accounted for through inclusion of an AR(1) correlation structure, some residual autocorrelation remained, but much less than in case of porpoise model.

Similarly to porpoise model, for both the noise and vessel models, latitude, longitude interaction with phase explained markedly more deviance than other covariates, indicating strong spatial structuring in dolphin detections. Time of year (represented by Julian Day), and time of day (day-night index) were the next most influential covariates but they only explaining 1% of deviance each. The presence of porpoises in the same period, the state of tide (tide index) and all anthropogenic covariates: noise levels or the duration of vessels (depending on the model), presence of construction activities and construction phase explained <1% each (Table 5.3, Figure 5-12, Figure 5-13).

All the covariates which were retained both in the vessel and noise models, showed the same patterns in the two models (Figure 5-12, Figure 5-13):

- Dolphin presence was generally highest at coastal sites and declined with increasing distance offshore, including in areas adjacent to the wind farm developments. This spatial trend was broadly consistent across construction phases.
- As for porpoises, dolphin presence was higher during nighttime hours. Their seasonal presence peaked between April through early September, which is the time when porpoises were detected less. Tidal state had a small, but statistically significant effect on dolphin presence, whereby dolphin presence was highest around low tide. Dolphin presence was inversely correlated with porpoise presence. These four covariates explained cumulatively <3% of deviance.
- There was no difference in dolphin detections in between the construction phases, and whether construction happened at individual wind farms or simultaneously. These two covariates explained <1% deviance each.

Noise levels in the 0.1 - 1 kHz frequency band interacting with construction phase had a significant negative effect on dolphin detections. This covariate, however, had the lowest effect on the deviance explained. However, this appears to be largely driven by the post-construction phase where some hours were atypically loud (as shown by the rug plot). It is not possible to discern whether the reduced detections resulted predominantly from behavioural responses or reduced detectability in high noise (Figure 20, Table 5.3).

Cumulative vessel duration within 3 km of the PAM stations had no significant effect on dolphin presence and did not vary between construction phases (Figure 21, Table 5.3).

When the model was fit to data from days when construction activity occurred, that spatial, temporal and environmental variation have the strongest influence on dolphin presence (Table A 13-1, Figure A 13-12). Specifically, distance to NnG and distance to Seagreen were the most influential predictors. Dolphin presence was lowest near the wind farms and generally increased with increasing distance from both NnG and Seagreen. This suggests that the observed spatial gradients reflect broader habitat preferences (e.g. toward coastal sites which are inherently further from the wind farm sites), rather than responses to foundation construction. Consistent with the previous models, temporal trends of higher dolphin detections during summer months, during nighttime, and when porpoises were not present were also observed. There was no significant effect of the presence of drilling at NnG or suction at Seagreen indicating that the specific construction activities did not have a discernible impact on dolphin presence.

Table 5.3. Generalised Additive Model (GAM) coefficients for models of dolphin presence. Three models are presented: (i) noise model based on 13 sites where broadband recorders were deployed and therefore L90 SPL in the 0.1-1 kHz frequency band is included as a covariate, (ii) vessel model, including all 21 sites and vessel related covariates as a proxy for noise, and (iii) construction model based only on data during foundation construction. Covariates are presented in order from the highest deviance explained to the lowest deviance explained.

Variables with p < 0.05 are considered statistically significant. The F-statistic tests whether each variable contributes meaningfully to explaining the data beyond what would be expected by chance (note that F values cannot be directly compared between different types of variables or interactions). p-values indicate the probability that the observed relationship occurred by chance alone (values below 0.05 are considered statistically significant, meaning the relationship is unlikely due to random variation). Degrees of freedom (edf) reflect the complexity of each variable's relationship with the response - values close to 1 indicate a simple linear relationship, while higher values suggest more complex, non-linear patterns, common for interactions.

	Covariate	Chi. sq	p	(e)df	Approx. deviance explained [%]
(i) noise model	(Lon,Lat) * phase	7790.0	0.36	36	14
	Day-night index	872.7	<0.05	2	1
	Julian day	657.5	<0.05	4	1
	Porpoise presence	227.5	<0.05	1	<1
	Tide index	18.4	<0.05	2	<1
	Construction presence	7.4	0.06	3	<1
	Construction phase	0.2	0.97	3	<1
	L90 noise in 0.1-1 kHz band * phase	203.1	<0.05	9	<1
	Full model				**23**
(ii) vessel model	(Lon,Lat) * phase	10633.3	<0.05	46	19
	Day-night index	1198.1	<0.05	2	1
	Julian day	597.9	<0.05	4	1
	Porpoise presence	328.4	<0.05	1	<1
	Tide index	43.9	<0.05	2	<1
	Construction presence	14.7	0.06	3	<1
	Cumulative vessel duration within 3km * phase	0.0	0.87	0	<1
	Construction phase	0.3	0.95	3	<1
	Full model				**27**

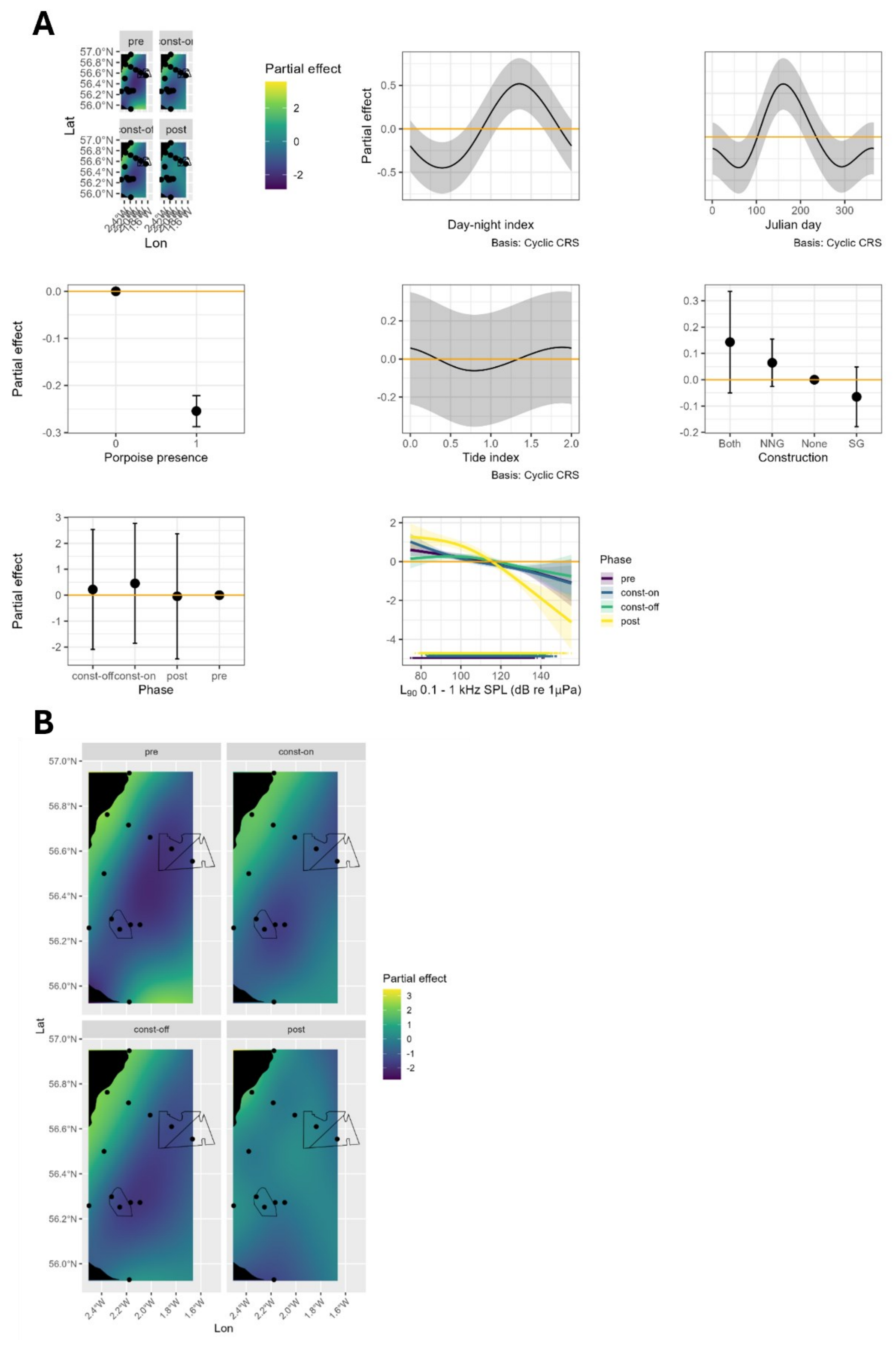

Figure 5-12 (A) Generalised Additive Model (GAM) predicted partial effects of covariates in the noise model, ordered from highest to lowest deviance explained. Partial effects in a GAM show the individual effect of one covariate (Julian day) on the outcome, while holding the other variables constant. Values above orange horizontal line show an increase in detections and below, decrease. The points above the x-axis, in noise plot, are a rug plot, indicating the spread of noise values in the raw data used to fit the model. (B) Enlarged predicted partial effect of latitude and longitude on porpoise positive minutes as a function of construction phase (pre, construction-on, construction-off or post). Darker blue indicates lower detections, yellow increase in detections.

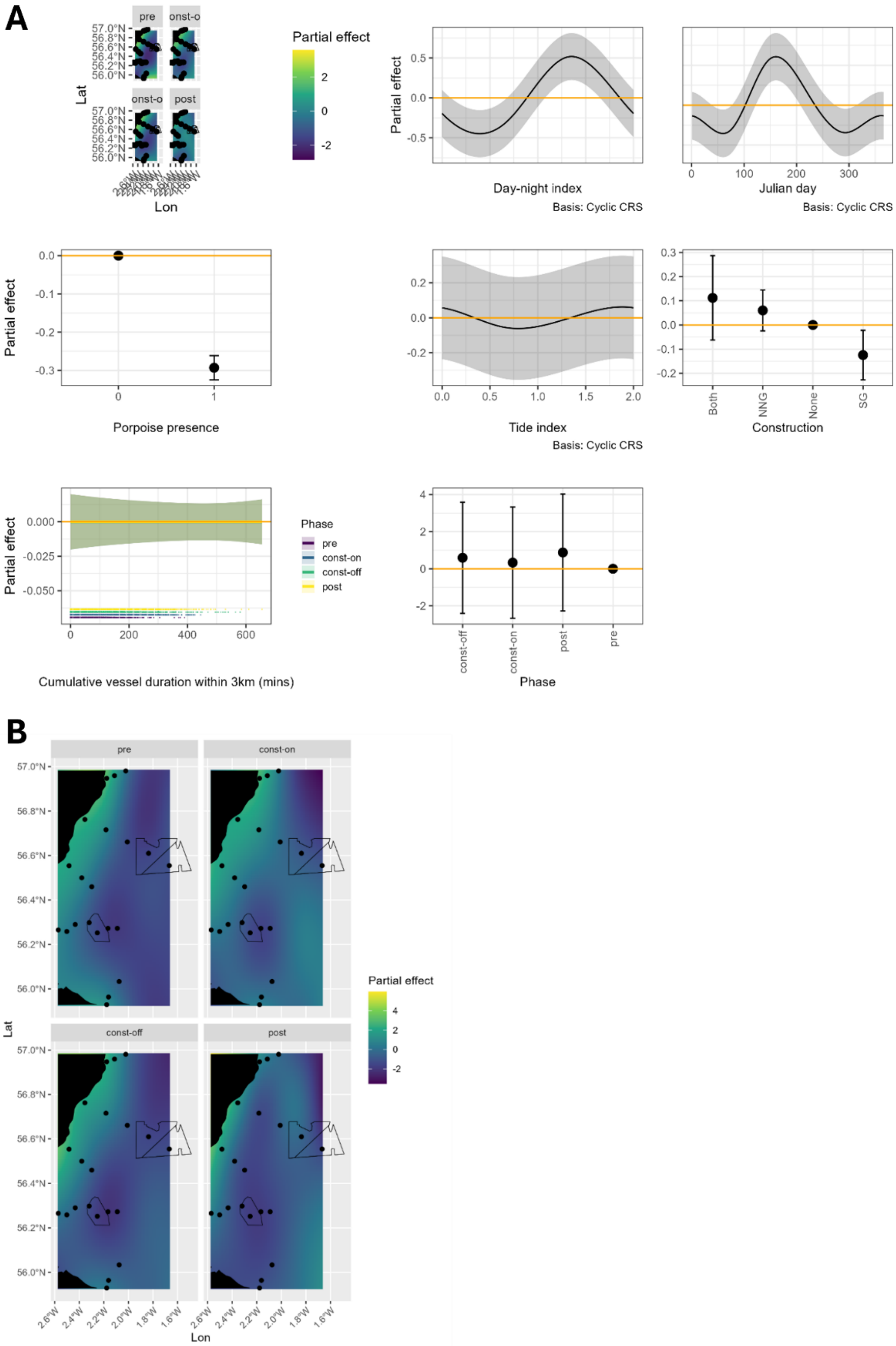

Figure 5-13 (A) Generalised Additive Model (GAM) predicted partial effects of covariates in the vessel model, ordered from highest to lowest deviance explained. Partial effects in a GAM show the individual effect of one covariate (Julian day) on the outcome, while holding the other variables constant. Values above orange horizontal line show an increase in detections and below, decrease. The points above the x-axis, in noise plot, are a rug plot, indicating the spread of noise values in the raw data used to fit the model. (B) Enlarged predicted partial effect of latitude and longitude on porpoise positive minutes as a function of construction phase (pre, construction-on, construction-off or post). Darker blue indicates lower detections, yellow increase in detections.

5.3.3 Summary of the modelling results

Overall, anthropogenic covariates (related to construction and vessel traffic) explained the lowest proportions of deviance in all the models and for both species groups, indicating that patterns in dolphin and porpoise presence and detections are primarily driven by natural and environmental variation at the spatial and temporal scales evaluated in this study. Specific construction activities did not have a discernible impact on dolphin and porpoise detections.

6 Discussion

This study offers a rare, long-term, and spatially extensive analysis of the effects of offshore wind farm construction on marine mammals in the Forth and Tay region. Through six years of passive acoustic monitoring across 21 stations, we evaluated not only traditional piling activities, but also the comparatively under-studied drilling and suction bucket caisson installation methods. The inclusion of pre-, during-, and post-construction phases across two concurrently constructed wind farms allows for a more holistic understanding of potential impacts than most existing studies, which typically focus on single construction types in isolation over a shorter period of time.

The long-term monitoring in this study also allowed for detailed evaluation of inter-annual and inter-seasonal occurrence of the two cetacean groups studied.

Detailed description of the study findings in the context of Seagreen and NnG PEMPs are provided in Appendix 6.

6.1 Baseline and construction technique related changes in underwater noise

The objective of the underwater noise analysis was to characterise changes in underwater noise over the monitoring period and monitoring sites. Two frequency bands were analysed 1) 0.1 - 1 kHz (drilling, suction, vessel) and 2) 10 - 48 kHz (echosounders and vessel dynamic positioning systems).

The acoustic signatures associated with foundation installation were primarily apparent at finer temporal resolutions. Piling had a higher noise signature than drilling or suction bucket caisson installation. The median increase in the 0.1 – 1 kHz frequency band during hours with piling compared to baseline (all hours from non-piling days in the same months when construction happened) was 18 dB and reached a maximum of 25 dB inside of the wind farm array. This increase was 3-5 dB for drilling activity at NnG but varied between months and stations and reached a maximum increase of 14 dB. Suction caisson installation at Seagreen resulted also in a 3-5 dB increase from baseline for sites within the wind farm array area.

Interestingly, for both drilling and suction bucket caisson installation, the differences between construction and non-construction hours were relatively minor suggesting that vessel traffic, mobilization, and ancillary operations contribute substantially to the overall increase in underwater noise on construction days. However, this was month and station-specific, and at certain stations (typically within the wind farm), larger differences between construction and non-construction hours were observed.

Impact piling remains the most extensively studied source of construction-related underwater noise, with previous research showing harbour porpoise displacement from piling sites (Brandt et al. 2018, Rose et al. 2019, Brown et al. 2023, Benhemma-Le Gall et al. 2024). Minor changes in bottlenose dolphin presence during pile driving have been recorded (Graham et al. 2017), but the effect of piling on this species, or dolphins in general, are not well studied and there remains a key knowledge gap on dolphin behavioural responses to pile driving. In our study, piling activity was limited to the installation of a single offshore substation platform at Seagreen.

More novel, however, are our findings related to suction bucket caisson installation and drilling activities. Both were associated with elevated noise levels in the 0.1–1 kHz frequency band. These changes were spatially variable, but most pronounced at stations within and closest to the wind farm array areas. The SPL increases associated with suction and drilling were generally much lower than those from piling and comparable to differences in SPL in-between monitoring sites and years far from the construction sites (ECOMMAS).

Decibels are logarithmic; therefore, a 3 dB increase means a doubling of acoustic intensity, and a 5 dB increase represents about a 3.2-fold increase in acoustic intensity. While this change is modest compared to the tens of decibels associated with pile-driving (this study) or large vessel passages (Hildebrand 2009, Merchant et al. 2014), it represents a detectable elevation in background levels. Such an increase is within the range of natural variability. In many offshore environments, short-term natural fluctuations in ambient noise (e.g., due to wind, rain, wave action) can be on the order of 3–10 dB or more, particularly in low-frequency bands (Mustonen et al. 2019, Schwock and Abadi 2021). Given a hydrophone precision of ±1 dB, the observed differences of around 3 dB between construction and non-construction periods should be interpreted with caution, as the true change may be slightly over- or underestimated.

Among all monitoring projects, the ECOMMAS sites monitored in this study were the quietest overall, yet they were the only locations where an increase in L50 SPL in the lower-frequency band was observed across monitoring years. Although vessel intensity at ECOMMAS sites were the highest of the three projects and remained relatively stable over time, this factor does not explain the observed trend in underwater noise. This interpretation is further supported by the weak correlations found between vessel density or intensity and L50 SPL across both frequency bands.

In 2024, south of Seagreen, a series of geophysical surveys were carried out in relation to the Berwick Bank offshore wind farm. Comparison of the recorded noise levels with the geophysical survey dates provided by the Developer (SSE Renewables) indicated increases in detected noise across several frequency bands on certain survey days, though not consistently across all. Although monitoring ambient noise during geophysical surveys was not the primary objective of this project, these findings underscore the complexity of the soundscape in construction areas and the contribution of multiple anthropogenic activities to it.

6.2 Baseline levels of detections of vocalising marine mammal

Dolphin presence showed a strong spatial pattern where detections were highest at coastal sites. In contrast, porpoises were detected across the study area and displayed less of a predictable spatial pattern with increased detections further offshore than dolphins. The described differences in spatial distribution of the two groups are consistent with known habitat preferences (Arso Civil et al. 2019, Gilles et al. 2025).

Both porpoise and dolphins showed strong seasonal cycles, with consistent declines in the summer months between April–September across all years for porpoises and the opposite pattern for dolphins, with peak of occurrence in the summer months between April-September. These seasonal patterns are again consistent with previous studies although the exact timing of peak of occurrence is site specific (Verfuss et al. 2007, Zein et al. 2019, Benhemma-Le Gall and Cheney 2025).

Our study also reaffirmed previously reported patterns of interspecies interactions. In particular, the presence of porpoise was negatively correlated with dolphin detections, suggesting competitive or avoidance behaviour (Gutiérrez-Muñoz et al. 2021, Williamson et al. 2021).

Temporal variables, such as diel cycle, also strongly influenced detection rates, particularly for porpoises. These findings are consistent with studies suggesting nocturnal foraging and habitat use variability across seasons (see details in the Introduction). Spatial autocorrelation and tide-related metrics added explanatory power to the models, highlighting the complex interplay between environmental drivers.

None of the models suggested that the above-mentioned temporal and spatial patterns were affected by the monitoring phase (pre-, during-, and post-construction). These natural (baseline) temporal and spatial patterns showed highest explanatory power suggesting being the main drivers behind observed changes in detections of both species groups.

6.3 The effect of construction on marine mammal detection

Statistical modelling indicated that both anthropogenic and natural covariates influenced cetacean detections. Nevertheless, baseline spatial patterns accounted for the majority of the explained deviance, while anthropogenic factors such as noise, vessel presence, and construction activity each contributed less than 1% of the explained deviance. Construction effects were only significant for harbour porpoises, and this was primarily driven by days when construction occurred simultaneously at both wind farm sites. However, this only occurred during 28 days across the monitoring period. No significant differences in cetacean detections were observed between monitoring phases.

These findings are specific to the large spatial scale of the analysis and may not reflect patterns at smaller spatial scales, particularly in the immediate vicinity of the wind farms (meters to few kilometres). Our analysis was not designed to look at small-scale effects of construction such as animals leaving the footprint of the wind farms or stopping vocalizing. While our monitoring network provided good spatial coverage, the inclusion of all sites across the study region in a single statistical model may have resulted in effect dilution, where localised responses near construction activities (if any) could be obscured by the predominance of sites experiencing no effect, reducing the model's power to detect spatially heterogeneous impacts. In order to study a small scale effect, a network of monitoring sites closer to the wind farms would be needed (Graham et al. 2019, Chudzinska and Thomas 2023). For a full understanding of the effect of construction, analysis at both small and regional scale is needed and this study is one of the few addressing the latter.

Incorporating three model types—noise-, vessel-, and construction-specific—enabled detection trends to be compared across differing spatial and temporal contexts. Although the models differed in sample size due to missing data and design constraints, they yielded consistent patterns, enhancing confidence in the results. Such consistency would likely have been more challenging to detect over a shorter monitoring period.

6.4 Marine mammal distribution

The PAM array deployed across the Forth and Tay region successfully characterised baseline levels of harbour porpoise and dolphin detections and allowed for assessment of potential changes associated with construction activity. Our analyses showed that the dominant factors affecting porpoise and dolphin occurrence were natural spatio-temporal and environmental factors (including the influence of the presence of each species on one another, with dolphins likely having negative affect on porpoise presence), rather than anthropogenic influences. While drilling at NnG and suction bucket caisson installation at Seagreen modestly elevated underwater noise levels (3-5 dB) and piling increased noise by up to 25 dB locally (and 18 dB for offshore substation pin piles), these activities did not result in significant regional scale changes in detections of either species. Statistical modelling confirmed that construction-related variables explained <1% of the variance in detections compared to natural covariates. These findings demonstrate that the construction activities at both wind farms did not cause significant displacement or alteration in the distribution of harbour porpoises or dolphins at the regional scale. As such, this study fulfils the requirements of the PEMP objective relating to marine mammal distribution by successfully determining "*whether there are any significant changes in the* *distribution or abundance of marine mammals within the wind farm area and adjacent waters pre and during construction*".

6.5 Improving understanding of dolphin population use of the Forth and Tay Region

The long-term PAM dataset analysed in this study provides the most comprehensive records of dolphin acoustic activity in the Forth and Tay region. Results confirmed strong spatial patterns, with dolphins most frequently detected at coastal sites, as well as consistent seasonal cycles, with peak occurrence in summer months. These patterns extend current knowledge of the east coast bottlenose dolphin populations use of the Tay estuary and adjacent coastal waters, as documented through previous studies (2009 – ongoing; Arso et al. 2019, Cheney et al. 2024, Arso Civil et al. 2025). Since 2020, photo-identification studies of the coastal waters in the Tayside and Firth of Forth areas have been funded by the Forth and Tay wind farm developers (Seagreen, NnG and Inch Cape) together with NatureScot.

The dolphin detection classifier used in this study does not allow for identification of the dolphins to the species level. However, it is expected that the delphinid vocalisations detected close to the coast are most likely bottlenose dolphins given the generally coastal distributional range of this population.

Despite elevated levels of underwater noise being observed during construction phases, passive acoustic monitoring at the regional scale identified that the effects of construction on dolphins were benign. As dolphins were not identified to species level, this conclusion is based on the group as a whole. The main construction activities occurred outside the key habitat for bottlenose dolphins. Whilst many past passive acoustic studies on the effects of noise focus on short term, localised effects, this study highlights the importance of data collection over time and space and consideration of broader scale impacts.

This PAM study adds to the bottlenose dolphins photo ID information by examining presence across a range of temporal (seasonal and diel) and spatial (inshore vs offshore) scales. As such, these studies combined fulfil the requirements of the PEMP objective *"improving understanding of bottlenose dolphin population use of the Forth and Tay Region".*

6.6 Future work recommendations

The primary aim of this study was to understand regional scale spatio-temporal changes in marine mammal detections associated with natural and anthropogenic activities. The PAM study comprised of sets of arrays distributed across the study area, with the nearest hydrophone positioned 920 m from any construction site. Consequently, this study was not designed to assess small-scale construction effects.

Harbour porpoise response probability to impact pile driving is highest within 10 km of construction sites and increases markedly at closer distances (Graham et al. 2019). Given the substantially lower noise levels generated by drilling and suction activities compared to impact piling, we would expect different deterrence and dose-response functions for these activities, with the highest response probabilities occurring even closer to construction sites. However, only 23% of monitoring hours during drilling and 8% during installation of suction caissons occurred within 10 km of construction sites. When this radius is reduced to 5 km, monitoring coverage drops to 8% for drilling and 2% for suction. Establishing deterrence and dose-response functions or understanding small-scale effects of these construction methods would require a different study design with monitoring sites positioned closer to construction activities, as exemplified in Graham et al. (2019) and Chudzinska et al. (2024).

Overall, this project highlights the importance of coordinated monitoring of marine mammals across a wider region, taking into consideration a variety of noise sources. Marine mammals respond behaviourally to a variety of anthropogenic activities, and during offshore wind farm construction multiple stressors may contribute to the overall magnitude of disturbance. Monitoring efforts conducted to date have largely focused on behavioural responses specifically linked to piling activities, while relatively few studies have attempted to isolate the contribution of effects associated with vessel operations or acoustic deterrent devices (ADDs) (Dähne et al. 2017, Thompson et al. 2020, Benhemma-Le Gall et al. 2021, Voss et al. 2023, Benhemma-Le Gall et al. 2024). While small-scale studies help identify immediate responses to noise, monitoring at broader spatial scales provides a clearer picture of whether disturbances may lead to large scale displacement and subsequent population-level effects. Thus, effective collaboration across projects is essential to effectively assess impacts on marine mammals.

Multiple developments within the same region can generate additive effects (where the total impact is the sum of each individual impact), or synergistic effects (where the combined influence exceeds the sum of individual activities). Evaluating projects independently, particularly where spatial or temporal overlap occurs, reduces confidence in conclusions regarding the magnitude of disturbance. For example, if construction activities at Project A result in displacement, animals may temporarily increase their presence in the vicinity of Project B, where construction has already concluded. Such increase in marine mammal presence would not represent a genuine post-construction return to baseline conditions at Project B, but rather a redistribution driven by ongoing disturbance elsewhere. Integrated, strategic monitoring is therefore required to accurately interpret responses and support robust assessment of inter-related and cumulative effects.

While our results suggest benign effects of construction on dolphins, most construction activities occurred offshore, beyond the key habitat of the east coast bottlenose dolphin population in the Tay and Forth area. A comprehensive understanding of construction impacts on this marine mammal group would require studies with greater spatio-temporal overlap between dolphin distributions and construction activities.

6.7 Implications for monitoring and data collection

In this study, <5% of acoustic detections from broadband recorders were also recorded by PODs in the same monitoring period. This discrepancy underscores a key limitation of PODs: they detect only echolocation clicks and are effectively blind to whistles. Whistles are often crucial for detecting delphinids because many species vocalize with whistles for social communication and may not echolocate continuously. Studies deploying PODs alongside full-bandwidth recorders have similarly found that full-bandwidth devices detect significantly more vocalizations (whistles plus clicks) than click-only detectors (Garrod et al. 2018).

Moreover, full-bandwidth recorders allow post hoc manual or software-based analysis of whistle contours, burst pulses, and other tonal signals that are below or outside the detection range of click-only devices. Such components of the acoustic repertoire are important because whistles can be more frequent in certain behavioural or social contexts and may persist when echolocation is reduced or suppressed.

Therefore, for effective monitoring of delphinids—especially if the aim is to track presence, social behaviour, communication, or habitat use—it is essential to include broadband recorders to capture whistle vocalizations. Reliance solely on PODs risks underestimating delphinid activity, potentially biasing inferences about their abundance or behaviour.

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9 Appendix 1 – Studied species

9.1.1 Harbour porpoise

Harbour porpoise was the most commonly identified cetacean during historic aerial and boat-based surveys in the wider Firth of Forth and Tay region between 2009 and 2023 (Grellier and Lacey 2011, Sparling 2012, Mainstream Renewable Power 2019, RPS 2022, RPS Energy 2024). Across all surveys, including those carried out within the Seagreen and NnG array areas, harbour porpoise counts were consistently higher during the summer months. Harbour porpoise presence in the Moray Firth was found to be habitat-specific, with individuals more frequently detected at night in deeper, muddy areas, and during the day in shallower, sandy habitats (Williamson et al. 2017). Their spatiotemporal distribution may be driven by foraging which is considered to increase at nighttime (Todd et al. 2009, Brandt et al. 2014, Williamson et al. 2017, Williamson et al. 2021). Diel hour was also found to be the most significant covariate with increased detection probability around dawn and dusk in the dynamic tidal environments (Benjamins et al. 2017). Further studies indicated that mean water depth, sea state and month as environmental variables have the greatest influence on harbour porpoise occurrence (Gutiérrez-Muñoz et al. 2021). Additionally, harbour porpoises have been found to exhibit reduced occurrence in the presence of dolphins, and even in the 2–3 hours preceding dolphin detections, suggesting that they may anticipate dolphin arrival (Gutiérrez-Muñoz et al. 2021, Williamson et al. 2021).

9.1.2 Bottlenose dolphin

During historic aerial surveys in the wider Firth of Forth and Tay region, bottlenose dolphins were primarily recorded in inshore waters, with only a single individual observed offshore (Grellier and Lacey 2011). No sightings were reported during boat-based surveys for Seagreen and NnG, or aerial surveys for Ossian, all of which focused on array areas located further from the coast (Sparling 2012, Mainstream Renewable Power 2019, RPS Energy 2024). This is consistent with expectations, as bottlenose dolphins on Scotland's east coast[3] (outside the Moray Firth) are typically encountered in waters less than 20 m deep and within 2 km of the coast (Quick et al. 2014). Over the past decade, bottlenose dolphins along Scotland's east coast have expanded their range southward from the Moray Firth, with the proportion using the Tay estuary and adjacent coastal waters increasing from 52% (2009 - 2012) to 79% (2020 - 2023) (Quick et al. 2014, Arso Civil et al. 2021a, Cheney et al. 2024, Arso Civil et al. 2025). Movement patterns exhibit seasonal variation, with increased movement from the Tay estuary region to the Moray Firth Special Area of Conservation (SAC) in early summer, and a return movement toward the Tay estuary and surrounding areas in late summer (Arso Civil et al. 2021b).

Bottlenose dolphins studied in the Moray Firth exhibit significant seasonal and diel patterns in their presence, with diurnal activity predominant in summer and a shift to nocturnal activity during autumn and early winter (Fernandez-Betelu et al. 2019). Their occurrence is also influenced by tidal cycles; at two of the three study sites, bottlenose dolphins were most likely to be encountered during the flood stage of the tide (Fernandez-Betelu et al. 2019). This aligns with findings from Mendes et al. (2002), who observed increased bottlenose dolphin presence during the flood tide, particularly around the stationary stage of the tidal front (3.5 to 1 hour before high water). Bottlenose dolphin foraging behaviour also varies seasonally, mirroring the seasonal availability of prey (Pirotta et al. 2014,

[3] This refers to an inshore bottlenose dolphin population from the Coastal East Scotland Management Unit. An offshore population of bottlenose dolphins is also known to occur off the east coast of Scotland, however, this population remains poorly studied. The relationship between offshore groups and those occurring in coastal waters remains uncertain (Cheney et al. 2013).

Fernandez-Betelu 2020). Additionally, studies on bottlenose dolphin buzzing activity in the Moray Firth showed that it is significantly influenced by both static (e.g., latitude, slope) and dynamic (e.g., Julian date, frontal metrics) environmental variables (Pirotta et al. 2014).

9.1.3 White-beaked dolphin

During the historic aerial surveys of the wider Firth of Forth and Tay region, white-beaked dolphins were encountered in both, inshore and offshore waters, although most encounters were recorded offshore (Grellier and Lacey 2011). During Seagreen array area boat-based surveys, white-beaked dolphins occurred mostly further offshore and a peak in sightings and therefore density, was apparent to the north-east of the survey area (Sparling 2012). White-beaked dolphins were recorded only during a second year of the NnG array area surveys with most sightings over spring and summer (Mainstream Renewable Power 2019). The historic surveys corroborated findings of Weir et al. (2007), showing that white-beaked dolphin presence in the Firth of Forth and Tay areas is more common in summer than in winter (Grellier and Lacey 2011, Sparling 2012, RPS 2022, RPS Energy 2024). The presence of white-beaked dolphins recorded during the Seagreen and NnG array area surveys, coupled with the absence of bottlenose dolphin sightings over the 24-month survey period, indicates that in the wider Firth of Forth and Tay region white-beaked dolphins are more likely to be encountered offshore than bottlenose dolphins. Study in the north east Scotland suggested that white-beaked dolphin distribution may be linked to sea temperature as it has been identified as a significant factor affecting local abundance (Canning et al. 2008). Across the UK, white-beaked dolphins may be experiencing a decline in abundance linked to rising sea temperatures with the analyses of stranding records suggesting shifting the habitat use and distribution northward (Canning et al. 2008, MacLeod et al. 2008, Ijsseldijk et al. 2018). Studies also found a significant effect of sea depth, slope and aspect on the presence of this species (Weir et al. 2007, Canning et al. 2008).

10 Appendix 2 – Mooring schematics

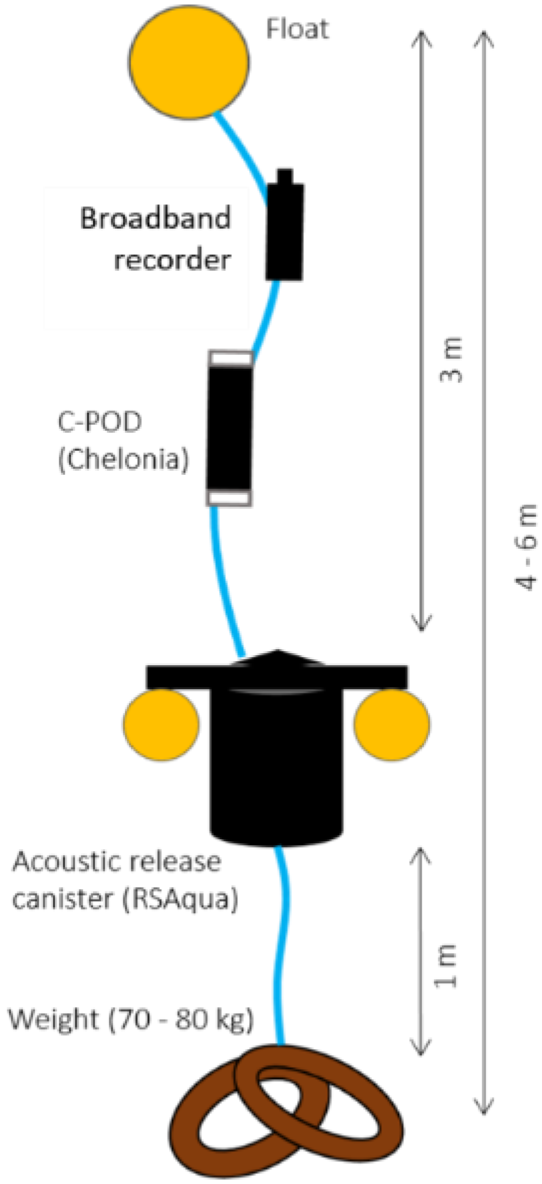

Figure A 10-1. Mooring schematics following the design by Quer et al. (2023).

11 Appendix 3 – Covariates

11.1 Summary of covariates

Table A 11-1. All response variables and explanatory covariates prepared for this study. Variable names in the brackets refer to shorter names used throughout the text and figures

Variable	Description	Source or further information	Source resolution	Values [1]	Type
Cetacean presence (response variables)					
Porpoise detection positive minutes per hour (DPMph)	Minutes per hour where porpoises were detected (for CPOD/FPODs)	CPOD/FPOD	NA	0 - 60	Continuous: integer
Dolphin detection positive minutes per hour (DPMph)	Minutes per hour where dolphins were detected (for CPOD/FPODs)	CPOD/FPOD	NA	0 - 60	Continuous: integer
Porpoise detection positive hour (DPH)	Binary variable indicating whether porpoises were detected in a given hour	CPOD/FPOD	NA	0 / 1	Binary
Dolphin detection positive hour (DPH) from CPOD/FPOD only	Binary variable indicating whether dolphins were detected in a given hour	CPOD/FPOD	NA	0 / 1	Binary
Dolphin detection positive hour (DPH) from logger data only	Binary variable indicating whether dolphins were detected in a given hour	Broadband recorder	NA	0/1	Binary
Dolphin detection positive hour (DPH) from CPOD/FPOD and logger data combined	Binary variable indicating whether dolphins were detected in a given hour on any device (POD or logger)	CPOD/FPOD or logger	NA	0/1	Binary
Monitoring effort					
POD recording minutes	Minutes per hour CPOD/FPOD is on and recording i.e. monitoring effort	CPOD/FPOD	NA	0 - 60	Continuous: integer
Broadband recorder recording minutes	Minutes per hour logger is on and recording (maximum value 20 minutes due to duty cycle of the loggers)	Broadband recorder	NA	0 - 20	Continuous: integer
Time lost	Seconds per hour that the POD device was not recording	CPOD/FPOD	NA	0 – 3547.8	Continuous: non-integer
Device setup	Whether a logger/POD or both devices were deployed. Used to control for effort in the dolphin model as detections may be more likely when both devices were deployed simultaneously.	NA	NA	POD/Broadband recorder/Both	Categorical: factor
Spatial					
Site	Hydrophone location	NA	NA	NnG01-04; SGR01-05; ABB05, ABB10, ABB15; STA05, STA10, STA15; SHV05, SHV10, SHV15;	Categorical: factor

Variable	Description	Source or further information	Source resolution	Values [1]	Type
				ARH05, ARH10, ARH15	
Longitude (°)	PAM device (Broadband recorder/CPOD/FPOD) deployment longitude	NA	NA	-2.88461 – - 1.66721	Continuous: non-integer
Latitude (°)	PAM device (Broadband recorder/CPOD/FPOD) deployment latitude	NA	NA	55.92898 - 56.98067	Continuous: non-integer
Distance to shore (km)	Shortest distance from hydrophone location to coastline	Section 11.1.1	NA	0.5 - 48.7	Continuous: non-integer
Distance to nearest wind farm (km)	Distance from each PAM deployment to the edge of the closest wind farm. Deployments inside the wind farm have distance set to zero	Calculated in R	NA	0.00 – 64.56	Continuous: non-integer
Distance to NnG (km)	Closest distance from PAM device to NnG wind farm area	Calculated in R	NA	0.00 – 76.18	Continuous
Distance to Seagreen (km)	Closest distance from PAM device to Seagreen wind farm area	Calculated in R	NA	0.00 – 66.70	Continuous
Temporal					
Year	Year of sampling	NA	Temporal: Yearly	2019 - 2024	Continuous: integer
Month	Month of the year	NA	Temporal: Monthly	1 - 12	Continuous: integer
Julian day	Day in Julian calendar	NA	Temporal: Daily	1 - 366	Continuous: integer
Hour of day	Hour of the day in local time	NA	Temporal: Hourly	0 - 23	Continuous: integer
Time since sunrise (h)	Time since last sunrise in hours	Suntools; Section 11.1.2	Temporal: Hourly	0 - 24	Continuous: non-integer
Time to sunset (h)	Time to next sunset in hours	Suntools; Section 11.1.2	Temporal: Hourly	-16.6 – 17.1	Continuous: non-integer
Day length (mins)	Time interval between sunrise and sunset on a given day in minutes	Suntools; Section 11.1.2	Temporal: Minute	403.0 – 1073.1	Continuous: non-integer
Night length (mins)	Time interval between sunset and next sunrise on a given day in minutes	Suntools; Section 11.1.2	Temporal: Minute	367.1 – 1037.5	Continuous: non-integer
Day-night index	Circular index indicating point in day, accounting for variable day lengths (0-2).	Suntools; Section 11.1.2	NA	0-2 0 = sunrise 1 = sunset 2 = next sunrise	Continuous: non-integer
Ambient noise					
Ambient noise level between 0.01–0.1 kHz (L_{10}, L_{50}, L_{90}; dB)	Median (L_{50}) and 10 and 90% (L_{10}, L_{90}) exceedance levels for low frequency noise (0.01–0.1 kHz frequency band)	Broadband recorder	NA	L_{10}: 65.7 – 162.3 L_{50}: 64.9 – 160.9 L_{90}: 64.1 – 158.7	Continuous: non-integer
Ambient noise level between 0.1-1 kHz (L_{10}, L_{50}, L_{90}; dB)	Median (L_{50}) and 10 and 90% (L_{10}, L_{90}) exceedance levels for low frequency noise (0.1–1 kHz frequency band)	Broadband recorder	NA	L_{10}: 65.6 – 156.7 L_{50}: 65.4 – 156.0 L_{90}: 64.5 – 155.4	Continuous: non-integer

Variable	Description	Source or further information	Source resolution	Values [1]	Type
Ambient noise level between 1-10 kHz (L10, L50, L90; dB)	Median (L_{50}) and 10 and 90% (L_{10}, L_{90}) exceedance levels for high frequency noise (1-10 kHz frequency band)	Broadband recorder	NA	L_{10}: 68.8 – 154.0 L_{50}: 68.3 – 148.5 L_{90}: 68.1 – 148.4	Continuous: non-integer
Ambient noise level between 10-48 kHz (L10, L50, L90; dB)	Median (L_{50}) and 10 and 90% (L_{10}, L_{90}) exceedance levels for high frequency noise (10-48 kHz)	Broadband recorder	NA	L_{10}: 77.5 – 150.3 L_{50}: 77.5 – 149.4 L_{90}: 77.4 – 148.9	Continuous: non-integer
Broadband ambient noise level 10 Hz-48 kHz (L10, L50, L90; dB)	Median (L_{50}) and 10 and 90% (L_{10}, L_{90}) exceedance levels for broadband noise (10 Hz-48 kHz)	Broadband recorder	NA	L_{10}: 79.0 – 162.3 L_{50}: 78.8 – 160.9 L_{90}: 78.8 – 158.7	Continuous: non-integer
Physical					
Depth (m) (elevation)	Bathymetric depth at hydrophone location (closest point on GEBCO grid to PAM coordinates)	GEBCO; Section 11.1.3	Spatial: 15 arc-seconds	15 - 70	Continuous: integer
Min, mean, max depth (m)	Minimum, mean and maximum bathymetric depth within 3 km buffer around hydrophone location	GEBCO; Section 11.1.3	Spatial: 15 arc-seconds	Min: 1 - 59 Mean: 17.2 - 68.7 Max: 26 - 91	Continuous: integer (min, max), non-integer (mean)
Slope (°)	Angle of sea floor slope at hydrophone location (0 - 90°)	GEBCO; Section 11.1.3	Spatial: 15 arc-seconds	43.3 – 88.9	Continuous: non-integer
Aspect (°)	Aspect bearing of sea floor slope at hydrophone location. Values of -1 are flat areas with no slope and so no aspect (-1 - 360°)	GEBCO; Section 11.1.3	Spatial: 15 arc-seconds	17.8 – 360.0	Continuous: non-integer
Sediment (RCS)	Sediment type at hydrophone location (closest point on BGS grid to PAM coordinates)	BGS; Section 11.1.3	NA	Rock > sandy gravel > gravelly sand > slightly gravelly sand > sand > muddy sand	Categorical: factor
Oceanographic					
Mixed layer depth (m)		Copernicus; Section 11.1.4	Spatial: 0.111° × 0.067° Temporal: Hourly	2.20 – 88.70	Continuous: non-integer
Chlorophyll-a concentration (mg m^{-3} day^{-1})	Chlorophyll-a concentration at 10 m depth	Copernicus; Section 11.1.4	Spatial: 0.111° × 0.067° Temporal: Daily	0.0040 – 11.93	Continuous: non-integer
Net primary productivity (mg m^{-3} day^{-1})	Net primary productivity at 10 m depth	Copernicus; Section 11.1.4, Ciavatta et al. (2018)	Spatial: 0.111° × 0.067° Temporal: Daily	0.00 – 89.54	Continuous: non-integer
Current velocity (ms^{-1})	NA	Copernicus; Section 11.1.4	Spatial: 0.111° × 0.067° Temporal: Hourly	0.0010 – 1.22	Continuous: non-integer
Current direction (°)	NA	Copernicus; Section 11.1.4	Spatial: 0.111° × 0.067° Temporal: Hourly	0 - 360	Continuous: non-integer
Current mixing ($m^{-2}s^{3}$)	Strength of current mixing calculated as $\log_{10}(H/U^3)$ where H is depth and U is current velocity	Copernicus; Section 11.1.4	NA	1.26 – 4.81	Continuous: non-integer

Variable	Description	Source or further information	Source resolution	Values [1]	Type
Significant wave height (m)	Proxy for sea state	Copernicus; Section 11.1.4	Spatial: 0.0135° × 0.0303° Temporal: three-hourly	0.03 – 7.18	Continuous: non-integer
Bottom temperature (°C)	NA	Copernicus; Section 11.1.4	Spatial: 0.111° × 0.067° Temporal: Hourly	4.93 – 15.15	Continuous: non-integer
SST (°C)	Sea surface temperature	Copernicus; Section 11.1.4	Spatial: 5 km x 5 km Temporal: Daily	5.20 – 17.25	Continuous: non-integer
SST anomaly (°C)	Difference between SST and long-term average SST	Copernicus; Section 11.1.4	Spatial: 5 km x 5 km Temporal: Daily	-0.99 – 5.20	Continuous: non-integer
Monthly mean SST anomaly (°C)	Monthly mean SST anomaly	Copernicus; Section 11.1.4	Temporal: Monthly	-0.04 – 2.68	Continuous: non-integer
Sandeel density (min/max/mean)	Minimum, maximum and mean sandeel density within a 3 km buffer of the PAM deployment	Langton et al. (2021)	Static	Min: 0.00 – 3.28 Max: 0.00 – 81.54 Mean: 0.00 – 19.71	Continuous: non-integer
Tidal					
Tide range (m/h)	Tide range per hour (difference between previous low/high tide and next low/high tide)	WorldTides; Section 11.1.5	Temporal: Hourly	-5.83 - 5.62	Continuous: non-integer
Tide direction	Rising or falling tide (ie negative tide range = falling tide, low-high; positive tide range = rising tide, high-low)	WorldTides; Section 11.1.5	NA	Rise, Fall	Factor
Tide interval (mins)	Time between previous low/high tide and next low/high tide (i.e. duration of ½ a tidal cycle)	WorldTides; Section 11.1.5	NA	308 - 437	Continuous: non-integer
Tide height (m)	Tide height over chart datum at beginning of hour	WorldTides; Section 11.1.5	Temporal: Hourly	0.0 - 5.9	Continuous: non-integer
Tide index	An index indicating the current state of tide between low and high when rising (0-1) and high and low when falling (1-2)	WorldTides; Section 11.1.5	NA	0 - 2	Continuous: non-integer
Tidal velocity (ms^{-1})	Current velocity due to tides	Copernicus; Section 11.1.5	Spatial: 0.083° × 0.083° Temporal: Hourly	0.00 – 0.89	Continuous: non-integer
Tidal direction (°)	Current direction due to tides	Copernicus; Section 11.1.5	Spatial: 0.083° × 0.083° Temporal: Hourly	0 - 360	Continuous: non-integer
Construction					
Drilling at NnG	Binary variable indicating whether drilling took place at NnG in a given hour (based on drill logs)	NnG drill logs	Temporal: Hourly	0 / 1	Binary
Distance to drilling at NnG (km)	Distance from coordinates of the drilling location to each PAM deployment, given drilling was occurring.	NA	NA	0.92 – 86.72 or NA where no drilling took place	Continuous: non-integer
Time since last drilling at NnG (h)	Time in hours since the end of the last drilling event at NnG	NA	Temporal: Hourly	-28202 - 11373	Continuous: integer

Variable	Description	Source or further information	Source resolution	Values [1]	Type
Suction at Seagreen	Binary variable indicating whether suction took place at Seagreen in a given hour (based on construction logs)	Seagreen construction logs	NA	0 / 1	Binary
Distance to suction at Seagreen (km)	Distance from coordinates of the suction location to each PAM deployment, given suction was occurring.	NA	NA	1.40 – 82.45 or NA where no suction took place	Continuous: non-integer
Time since last suction at Seagreen (h)	Time in hours since the end of the last suction event at Seagreen	NA	Temporal: Hourly	-27887 - 18936	Continuous: integer
Time since last construction (h)	Time in hours since the end of the last suction or drilling	NA	NA	-28202 - 11373	Continuous: integer
Construction	Binary variable indicating whether foundation construction took place in a given hour at either NnG or Seagreen (including suction, drilling and piling)	NnG and Seagreen construction logs	Temporal: Hourly	0 / 1	Binary
Construction type	Categorical variable indicating whether construction was happening at no wind farm, at NnG, at Seagreen or at both wind farms.	NnG and Seagreen construction logs	NA	None NnG Seagreen Both	Categorical: factor
Distance to construction (km)	Closest distance between PAM deployment and any construction activity (suction or drilling) at NnG or Seagreen, given construction was taking place	NA	NA	0.92 – 86.72	Continuous: non-integer
Time since last construction (h)	Time in hours since the end of the last construction activity at either NnG or Seagreen	NA	NA	-22216 - 11373	Continuous: integer
Phase	Categorical variable indicating whether the given hour was pre-construction, during construction period with construction occurring that day, during construction period without construction occurring that day or post-construction.	NA	NA	Pre, construction on, construction off, post	Categorical: factor
NnG phase	Categorical variable indicating whether the given hour was pre-construction at NnG, during construction period with construction occurring that day at NnG, during construction period without construction occurring that day at NnG post-construction at NnG.	NA	NA	Pre, construction on, construction off, post	Categorical: factor
Seagreen phase	Categorical variable indicating whether the given hour was pre-construction at Seagreen,	NA	NA	Pre, construction on, construction off, post	Categorical: factor

Variable	Description	Source or further information	Source resolution	Values [1]	Type
	during construction period with construction occurring that day at Seagreen, during construction period without construction occurring that day at Seagreen post-construction at Seagreen.				
AIS					
Minimum vessel distance to hydrophone (km) (for construction, non-construction and all vessels)	Minimum distance of all vessels within a 3 km of the PAM station per hour, for construction, non-construction and all vessels. Construction vessels refer only to those involved with foundation installation.	Anatec Ltd; Section 11.1.6	NA	Construction: 0.01-3.00 Non-construction: 0.00 – 3.00 All vessels: 0.00 – 3.00	Continuous: non-integer
Mean vessel distance to hydrophone (km) (for construction, non-construction and all vessels)	Mean distance of all vessels within a 3 km of the PAM station per hour, for construction, non-construction and all vessels. Construction vessels refer only to those involved with foundation installation.	Anatec Ltd; Section 11.1.6	NA	Construction: 0.06-3.00 Non-construction: 0.05 – 3.00 All vessels: 0.09 – 3.00	Continuous: non-integer
Cumulative vessel duration within 3km (mins) (for construction, non-construction and all vessels)	Total cumulative duration spent by all vessels within a 3 km buffer of each PAM station per hour. Calculated separately for construction, non-construction and all vessels. Construction vessels refer only to those involved with foundation installation.	Anatec Ltd; Section 11.1.6	NA	Construction: 0 – 360 Non-construction: 0 – 505 All vessels: 0 – 655	Continuous: integer
Vessel density (vessels/km^2/h) (for construction, non-construction and all vessels)	Instantaneous density of vessels within 3 km buffer of each PAM station. Calculated separately for construction, non-construction and all vessels. Construction vessels refer only to those involved with foundation installation.	Anatec Ltd; Section 11.1.6	NA	Construction: 0.00 – 0.21 Non-construction: 0.00 – 0.76 All vessels: 0.00 – 0.76	Continuous: non-integer
Vessel intensity (total hrs/km^2/h) (for construction, non-construction and all vessels)	Intensity of vessel presence within 3 km buffer of each PAM station. Calculated separately for construction, non-construction and all vessels. Construction vessels refer only to those involved with foundation installation.	Anatec Ltd; Section 11.1.6	NA	Construction: 0.00 – 0.21 Non-construction: 0.00 – 0.30 All vessels: 0.00 – 0.39	Continuous: non-integer

[1] Values presented are based on data prior to filtering explained in Data preparation and check (Section 4.5.3.2).

11.1.1 Spatial covariates

A 10 m resolution land shapefile was downloaded from Natural Earth (1:10m Physical Vectors > land, downloaded from Natural Earth (2012). Distance to shore from the hydrophone locations was calculated by finding the nearest point on land to each hydrophone and calculating the distance between these two points using the 'sf' package in R.

Distance between the hydrophone location and the nearest wind farm, NnG and Seagreen were also calculated using the 'sf' package in R (Pebesma and Bivand 2023).

11.1.2 Temporal covariates

11.1.2.1 Day-night Index

Sunrise and sunset times were compiled for the duration of the study using the 'suntools' package in R with NOAA astronomical calculations (Bivand and Luque 2023). For each date, these were organised into sunrise A, sunset, and sunrise B (the following date). From this, a day length (time from sunrise A to sunset) and night length (time from sunset to sunrise B) was calculated for each date. Finally, a continuous cyclical *day-night* index was calculated whereby 0 = sunrise A, 1 = sunset and 2 = sunrise B. The times between sunrises and sunsets were scaled by the respective day or night length so that for daytime (0-1), *day-night* index = time since sunrise A/day length, and for nighttime (1-2), *day-night* index = (time since sunset/night length) + 1 (Figure A 11-1).

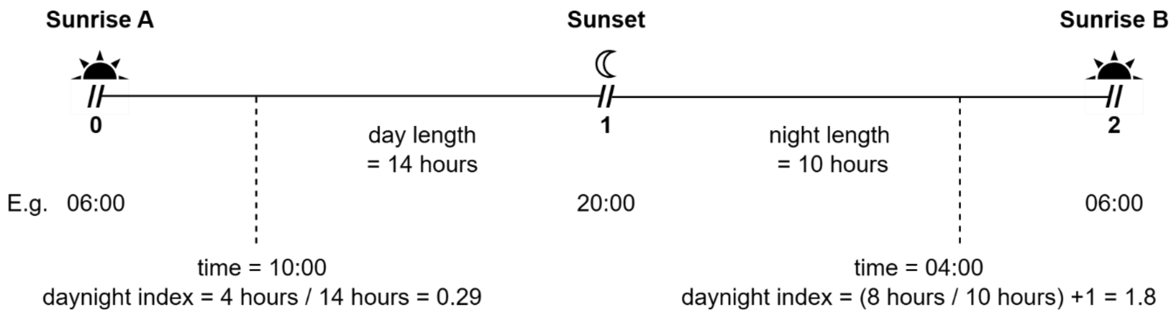

Figure A 11-1. Schematic of how *daynight* index was calculated.

11.1.3 Physical covariates

11.1.3.1 Depth, slope, aspect

Bathymetry data were accessed from GEBCO (2022) and downloaded as a netCDF file for the full extent of the project area at 15 arc-second spatial resolution (approx. 500 x 500 m). The depth in metres at each hydrophone was then extracted by taking the depth from the GEBCO grid at the closest point to the PAM coordinates. In addition, the GEBCO bathymetry grid was intersected with the 3 km hydrophone buffers to calculate the minimum, mean and maximum sea floor depth within a 3 km radius of each hydrophone. This gives an indication of the variability of the bathymetry in the area immediately surrounding the hydrophone.

Slope and aspect of the sea floor were calculated using the 'SDMTools' package in R (Burrough and McDonell 1998, Van Der Wal et al. 2019). Given that z represents the depth at each point on the grid, x and y are the longitude and latitude coordinates, respectively, $A = \frac{z_2 - z_1}{x_2 - x_1}$ and $B = \frac{z_2 - z_1}{y_2 - y_1}$.

Slope, representing the gradient angle of the sea floor in degrees (°) is calculated by:

$$slope = \arctan\left(\sqrt{A^2 + B^2}\right)$$

and aspect, representing the bearing of the slope in degrees (°) is:

$$aspect = \arctan\left(\frac{-B}{-A}\right)$$

Slope can take values 0-90°, whereas aspect represents compass directions and can have values 0-360°.

11.1.3.2 Sediment

Sediment type was downloaded from the British Geological Survey, DiGSBS250K dataset and intersected with the hydrophone locations. Sediment types present in the dataset are explained in Table A 11-2, and Figure A 11-2 (Cooper et al. 2010).

Table A 11-2. Sediment types at hydrophone locations from British Geological Survey seabed sediment dataset (DiGSBS250k)

Sediment type	Description
Rock	Undifferentiated
Sandy gravel (sG)	30 - 80% gravel with >90% of remainder sand
Gravelly sand (gS)	5 – 30% gravel with >90% of the remainder sand
Slightly gravelly sand ((g)S)	1 – 5% gravel particles and >90% of the remainder sand
Sand (S)	<1% gravel and 90% of remainder sand
Muddy sand (mS)	<1% gravel particles and 50-90% of the remainder sand

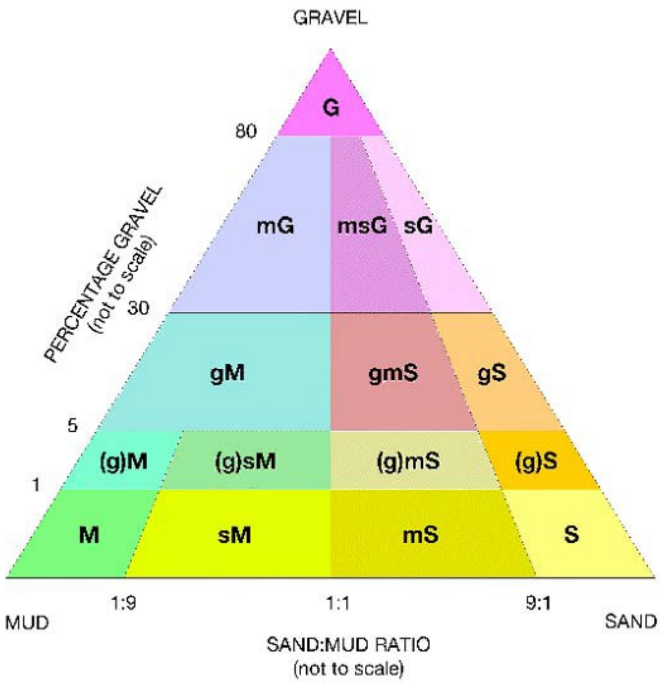

Figure A 11-2. Modified sediment classification scheme used in BGS dataset DiGSBS250k displaying the sand:mud:gravel ratios of sediment types present at the study locations. Abbreviation meanings are given in Table A 11-3.

11.1.4 Oceanographic covariates

Numerous oceanographic covariates were downloaded from the Copernicus Marine Data Store using the Copernicus Marine Toolbox API in Python. All covariates used are detailed in Table A 11-3, along with the Product name, Product ID and dataset ID that each covariate came from within the Copernicus data server. All covariates were downloaded for the full spatial and temporal extent of all hydrophone deployments. Some Copernicus covariates are not available for the full date range of the present study. As such, the range of available dates for each dataset are detailed in Table A 11-3.

Table A 11-3. Covariates accessed from Copernicus Marine Service, with associated product and dataset information.

Product name	Product ID	Dataset ID	Covariate	Spatial resolution	Date range
Atlantic-European North West Shelf-Ocean Physics Reanalysis	NWSHELF_MULTIYEAR_PHY_004_009	cmems_mod_nws_phy-sst_my_7km-2D_PT1H-i	Sea surface temperature (as sea water potential temperature at the surface; °C)	0.111° × 0.067°	1993-01-01 - 2024-07-01
		cmems_mod_nws_phy-mld_my_7km-2D_PT1H-i	Ocean mixed layer depth (m)		
		cmems_mod_nws_phy-bottomt_my_7km-2D_PT1H-i	Bottom temperature (as sea water potential temperature; °C)		
		cmems_mod_nws_phy-uv_my_7km-2D_PT1H-i	Northward (vo) and Eastward (uo) current velocity (ms^{-1})		
Atlantic-European North West Shelf-Ocean Biogeochemistry Reanalysis	NWSHELF_MULTIYEAR_BGC_004_011	cmems_mod_nws_bgc-chl_my_7km-3D_P1D-m	Chlorophyll concentration at 10 m depth (mg m^{-3})	0.111° × 0.067°	1993-01-01 - 2024-06-30
		cmems_mod_nws_bgc-pp_my_7km-3D_P1D-m	Net primary productivity at 10 m depth (mg m^{-3} day^{-1})		
Atlantic-European North West Shelf-Wave Physics Reanalysis	NWSHELF_REANALYSIS_WAV_004_015	MetO-NWS-WAV-RAN	Significant wave height (m) - proxy for sea state	0.0135° × 0.0303°	1979-12-31 - 2024-12-11
Global Ocean Physics Analysis and Forecast	GLOBAL_ANALYSISFORECAST_PHY_001_024	cmems_mod_glo_phy_anfc_merged-uv_PT1H-i	Northward (vtide) and Eastward (utide) tidal current velocity (ms^{-1})	0.083° × 0.083°	2020-11-01 - 2024-12-11

All Copernicus covariates are given in 1-hour temporal resolution, except significant wave height (SWH) which is available at only 3-hour resolution, and biogeochemical covariates (chlorophyll concentration and primary productivity) which are available at daily resolution. To match the 1-hour resolution of the response variables (cetacean presence), SWH data were forward- and backward-filled by 1 hour in each direction (i.e. given SWH of 1.0 m at 12:00 at location (x,y), the value of SWH at 11:00 and 13:00 at the same location was taken to also equal 1.0 m). Biogeochemical covariates were expanded to each hour in the given day.

Covariates with the same spatial resolution (all those from Atlantic- European North West Shelf- Ocean Physics Reanalysis and Atlantic- European North West Shelf- Ocean Biogeochemistry Reanalysis products) were joined together by latitude, longitude and time (hour).

11.1.4.1 Current covariates

Current velocity (ms^{-1}) and direction (°) were calculated for both general ocean circulation currents (combined tide and waves – current velocity/current direction) and for tidal currents (tidal velocity/tidal direction), by:

$$velocity = \sqrt{u^2 + v^2}$$

$$direction = \left(\operatorname{atan2}(u, v) \cdot \frac{180}{\pi}\right) mod\ 360$$

where u is the eastward current velocity and v is the northward current velocity.

Finally, strength of current mixing ($m^{-2}s^3$) was calculated based on the method given in Garrett et al. (1978):

$$current\ mixing = \log_{10}\left(\frac{H}{U^3}\right)$$

where H is the depth and U is the tidal current velocity.

After preparation of each of the above covariates, they were then merged with the hydrophone deployment metadata by taking the nearest point with available oceanographic data to each hydrophone location and selecting all hours between the hydrophone deployment and recovery dates for each unit.

11.1.4.2 Sea surface temperature anomaly

Sea surface temperature anomaly (SSTA) was downloaded for the full spatial and temporal extent of the response (cetacean presence) data from NOAA (2024) v3.1. SSTA are available at daily resolution and represent the difference between daily SST and the long-term average SST in °C, where SSTA > 0 indicates warmer than average temperatures and SSTA <0 indicates cooler than average temperatures.

11.1.5 Tidal covariates

Tidal data were obtained from WorldTides (WorldTides.info), using the closest tidal station for each deployment location. The exact times of high and low tides and the height of those tides were obtained from the Tidal Extremes dataset. From this, a data-frame was created containing the previous tide time, state and height (e.g. 12:00, Low, 2.0 m), the following tide time, state and height (e.g. 18:00, High, 6.0 m), the tide direction for that interval (‘rise’ or ‘fall’), the full tidal range for that interval (e.g. 4.0 m), and the duration of that interval (e.g. 6 hrs).

For each hour, a tidal index was calculated, indicating the current time relative to the tidal cycle, whereby 0 = Low A, 1 = High, 2 = Low B. The times between tides were scaled by the corresponding tide interval, so that for rising tides (0-1), tide index = time since Low A/tide interval A, and for falling tides (1-2), tide index = (time since High/tide interval B) + 1 (Figure A 11-3).

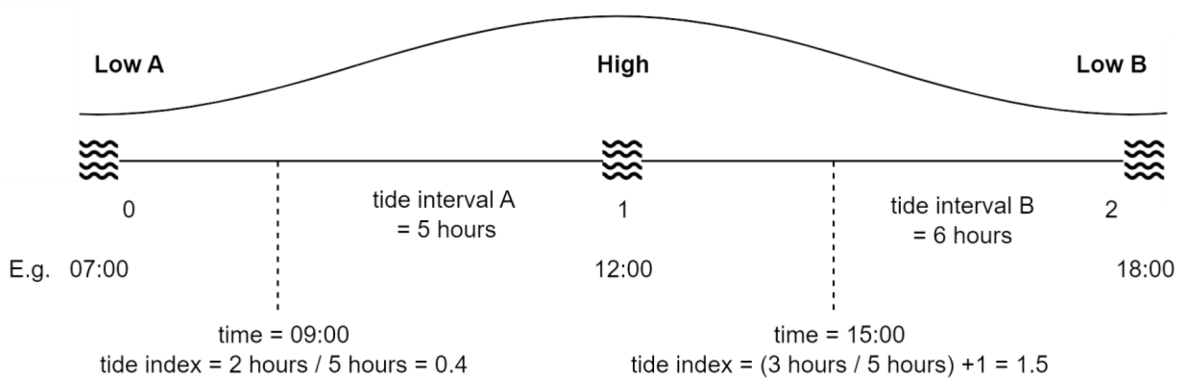

Figure A 11-3. Schematic of how tide index was calculated.

An additional dataset, Tide Heights, provided the actual height of tide per hour (taken from the beginning of the hour) so did not require further processing.

11.1.6 AIS-based Vessel Traffic covariates

AIS data for the Firth of Forth (latitudes 55. 7839°N to 57. 2661°N, longitudes -3.1302°W to -0.8133°W), between 2019-03-01 to 2024-11-31, were purchased from Anatec Ltd. Hourly vessel density and intensity were calculated as the mean number of instantaneous vessels per km^2 and the cumulative number of hours all vessels spent within an area per hour, respectively. Both metrics were calculated based on the methods described in EMODnet (2019).

Due to the propagation of sound from vessels, spatial buffers were created around each of the acoustic recording stations. This was done to isolate the AIS data for periods when the AIS-emitting vessels were close to the hydrophones. A radius of 3 km was created around each hydrophone location and any areas that were on land or separated from the hydrophone location by a land mass were removed.

The AIS data - comprising latitude, longitude, and time – were resampled to equal 5-minute intervals by unique transits using a linear interpolation. A unique transit was defined as a group of observations with the same Maritime Mobile Service Identity (MMSI), International Maritime Organization Number (IMO) (if applicable) numbers, and vessel type, that occurred within 1 hour of the previous observation for that vessel. After resampling, the 'pathroutr' package was used to ensure any observations that were now intersecting with land, as a result of the linear interpolation, would be moved away from land, into the area of interest in the sea (London 2020).

The resampled AIS data were assigned 'construction' or 'non-construction' for each vessel and day, based on the developers' construction reports and notices to mariners, listing the vessels involved in OWF foundation installation and the dates that they were working. Data were then intersected with the hydrophone buffers, discarding any observations that fell outside of the 3 km buffer areas.

The residence time of each vessel within the buffer area per hour, Ti,t was calculated by:

$$Ti,t = ni,t \cdot 5$$

where n is the number of 5-minute interpolated observations of vessel i in hour t. Each observation

represents a 5-minute residence since the previous observation. The total vessel density per hour (mean count of instantaneous vessels per km^2, per hour) was then calculated by:

$$\frac{\sum_{i=1}^{n(vessels)} T_{i,t}}{A}$$

where A is the buffer area. This value was calculated separately for both construction and non-construction vessels. The depiction of the 3 km buffers and an example of AIS data used is given in Figure A 11-4.

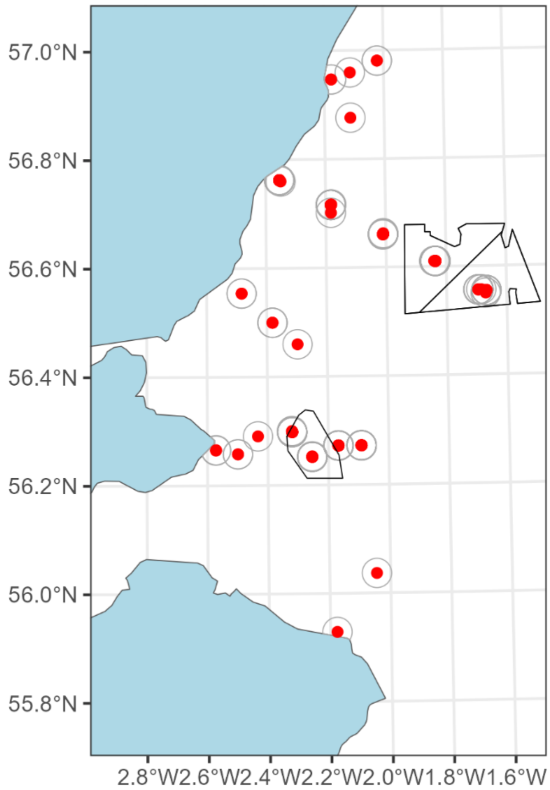

Figure A 11-4. Depiction of 3 km radius buffer around each monitoring site used to calculate vessel statistics. Note that redeployment of certain sites resulted in slight change in location deployments, hence multiple buffer depictions as certain sites.

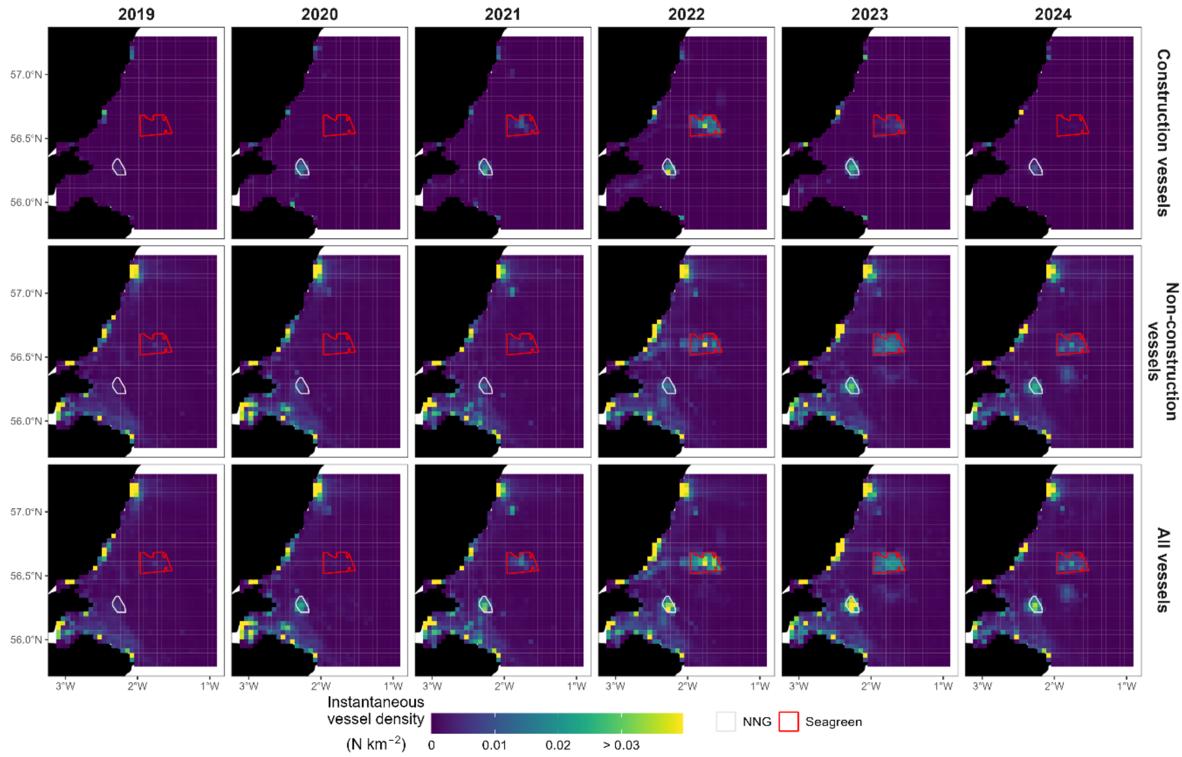

Figure A 11-5. Vessel density across monitoring years (columns) for construction related vessels (top row), non-construction vessels (middle row) and all vessels (bottom row).

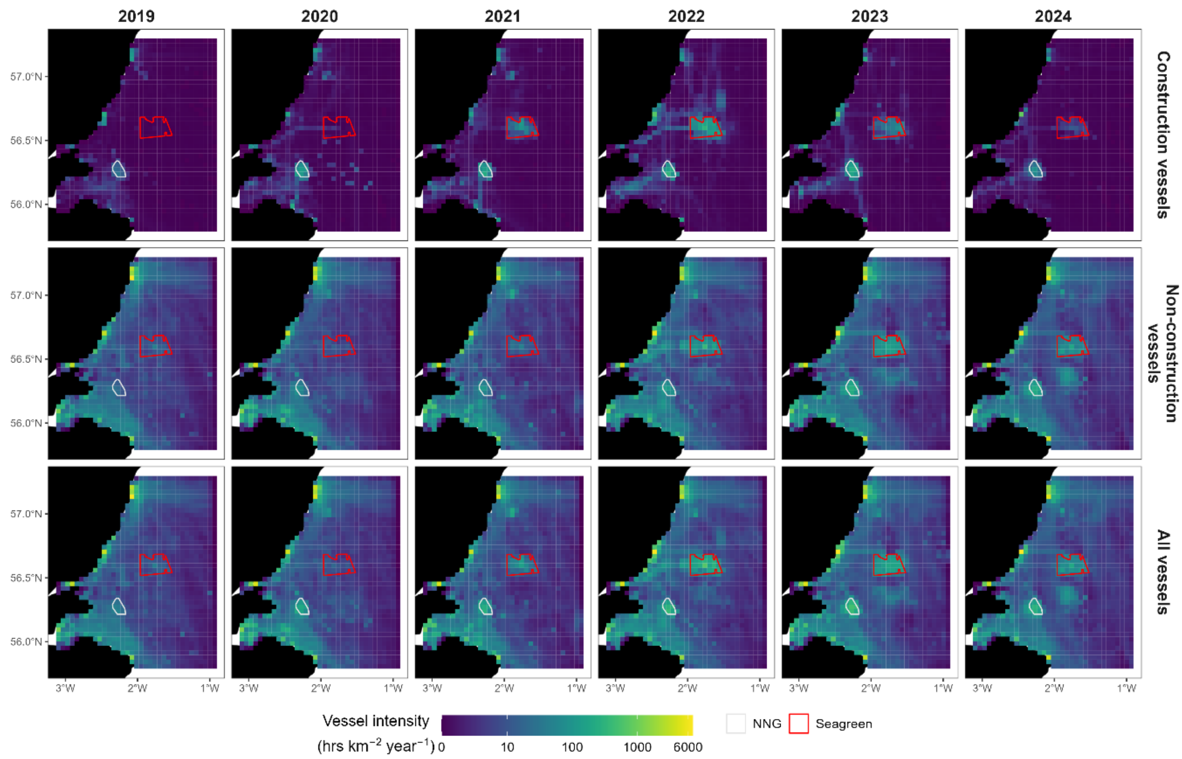

Figure A 11-6. Vessel intensity across monitoring years (columns) for construction related vessels (top row), non-construction vessels (middle row) and all vessels (bottom row).

12 Appendix 4 – underwater noise

12.1 General spatio-temporal patterns in SPLs in the 10 - 48 kHz frequency band

ECOMMAS sites were the quietest of the three monitoring projects, where the median L_{50} SPLs ranged from 79 to 94 dB in the 10 - 48 kHz frequency band.

At NnG, the median L_{50} SPL remained relatively stable from 2019 to 2024, notably during the construction period from 2020 to 2022. The median SPLs at the NnG stations ranged from 91 to 97 dB in the 10 - 48 kHz frequency band.

Out of the three monitoring projects, Seagreen recorded the highest median L_{50} SPLs. These ranged from 86 to 108 dB in the 10 - 48 kHz frequency band. This was particularly evident in 2024, where values in 2024 were approximately 12 dB higher at the SGR02 and SGR05 stations than in 2023.

Within the wind farm array areas, the stations with the highest median L_{50} SPLs in both the 0.1 – 1 kHz and 10 - 48 kHz frequency bands were NnG02 at NnG and SGR04 and SGR05 at Seagreen.

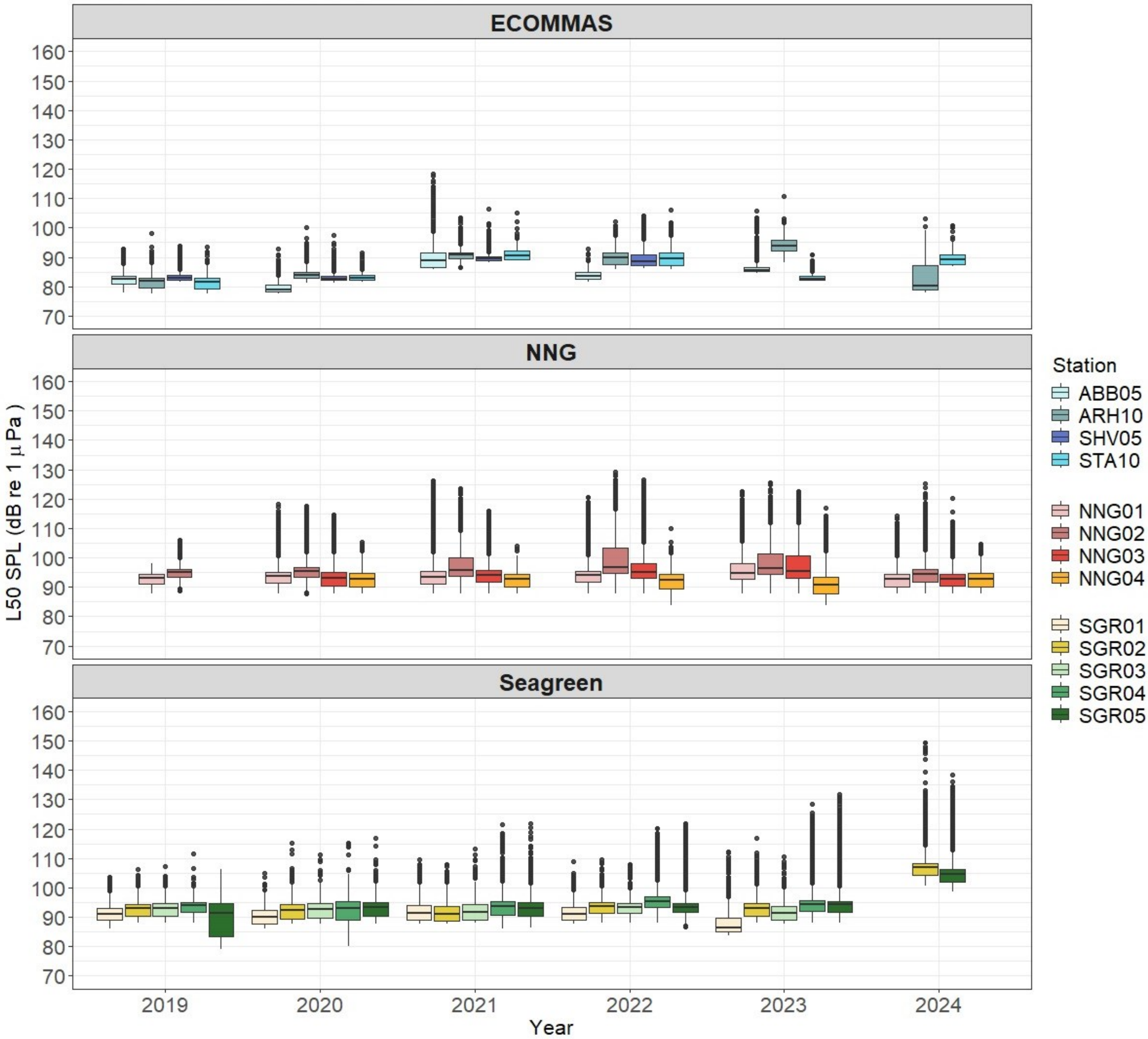

Figure A 12-1. Annual variation of L_{50} sound pressure levels in the 10 – 48 kHz frequency band recorded at monitoring stations within the ECOMMAS monitoring site and two offshore wind farm monitoring sites (NnG and Seagreen) from 2019 to 2024. Boxplots show the median, interquartile range and outliers of sound pressure levels, with each coloured box representing a different noise monitoring station within each site. Where no data were available for a station for a given year, no box is shown.

12.2 Noise associated with specific construction activities: drilling, suction caissons, and piling activity

12.2.1 Drilling

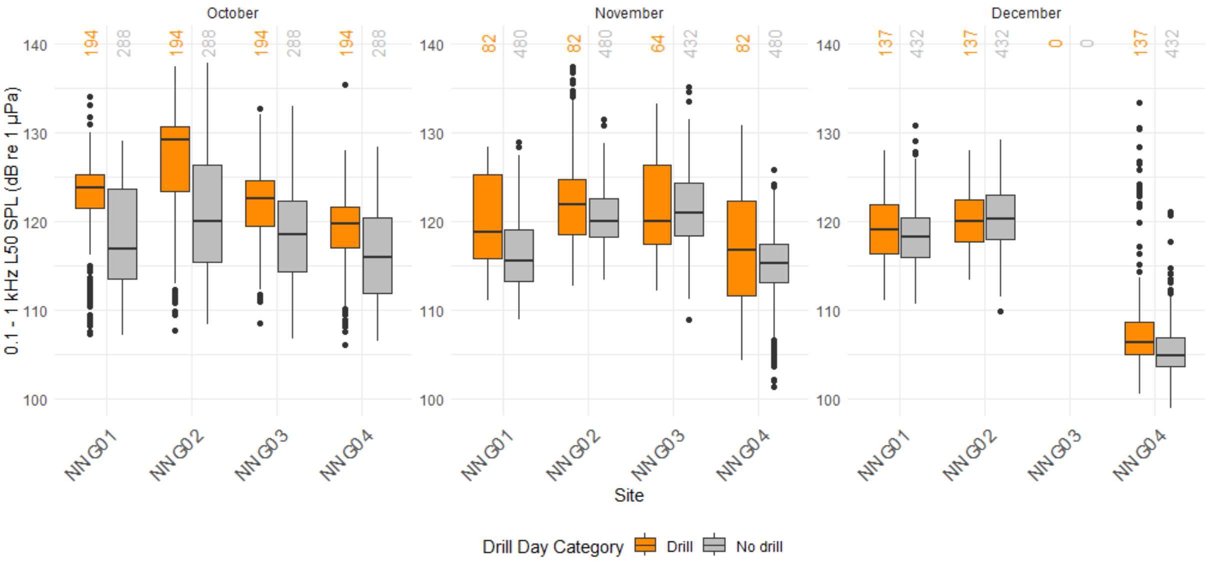

Figure A 12-2. This figure compares the L50 SPL in the 0.1 – 1 kHz frequency band during three months of construction (October, November and December 2022) at the NnG monitoring sites. "Drill" days are compared to "No drill days". Only the non-drilling hours have been retained from "Drill" days and these are compared against non-drilling hours from "No drill" days. In this way we can compare the noise levels associated with construction in general (excluding drilling) to the noise levels on days with no construction activity in the same month. The sample size (number of hours within each site and category) is displayed above the bars.

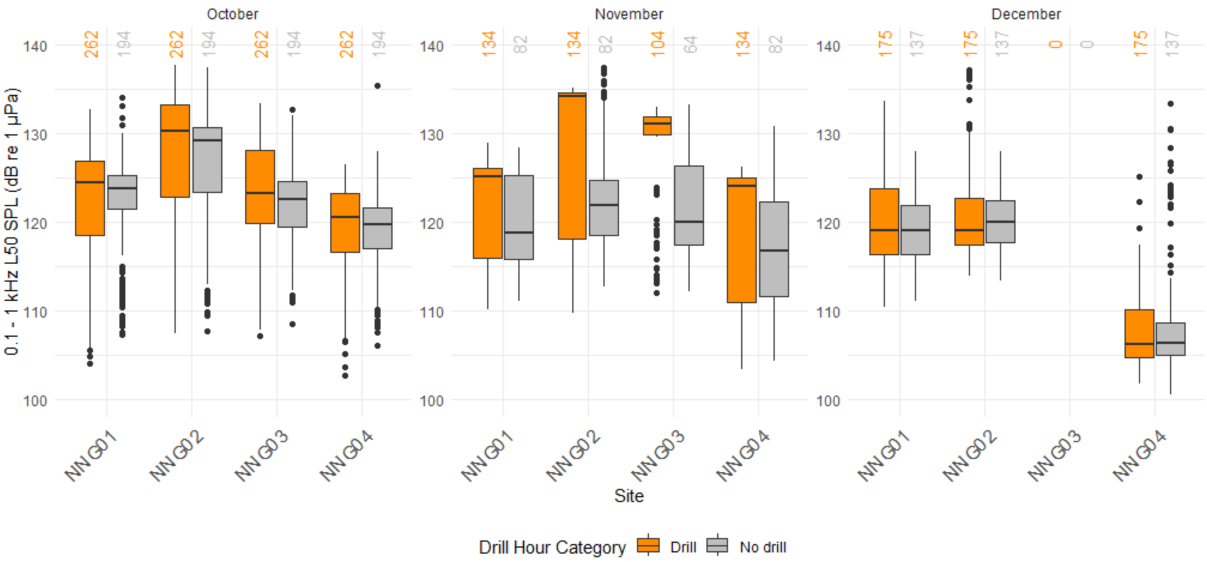

Figure A 12-3. This figure compares the L_{50} SPL in the 0.1 – 1 kHz frequency band during three months of construction (October, November and December 2022) at the NnG monitoing sites. Drilling hours are compared against non-drilling hours from Drill days. The sample size (number of hours within each site and category) is displayed above the bars.

12.2.2 Suction bucket caissons

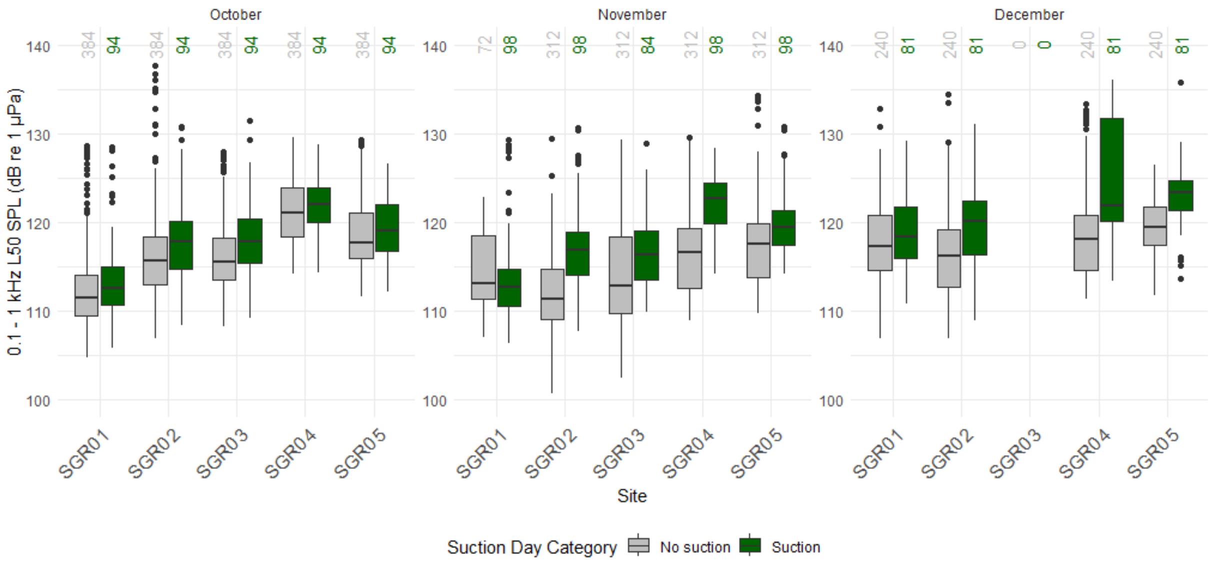

Figure A 12-4. This figure compares the L_{50} SPL in the 0.1 – 1 kHz frequency band during three months of construction (October, November and December 2022) at the Seagreen monitoring sites. "Suction" days are compared to "No suction days". Only the non-suction hours have been retained from "Suction" days and these are compared against non-suction hours from "No suction" days in the same month. In this way we can compare the noise levels associated with construction in general (excluding suction) to the noise levels on days with no construction activity. The sample size (number of hours within each site and category) is displayed above.

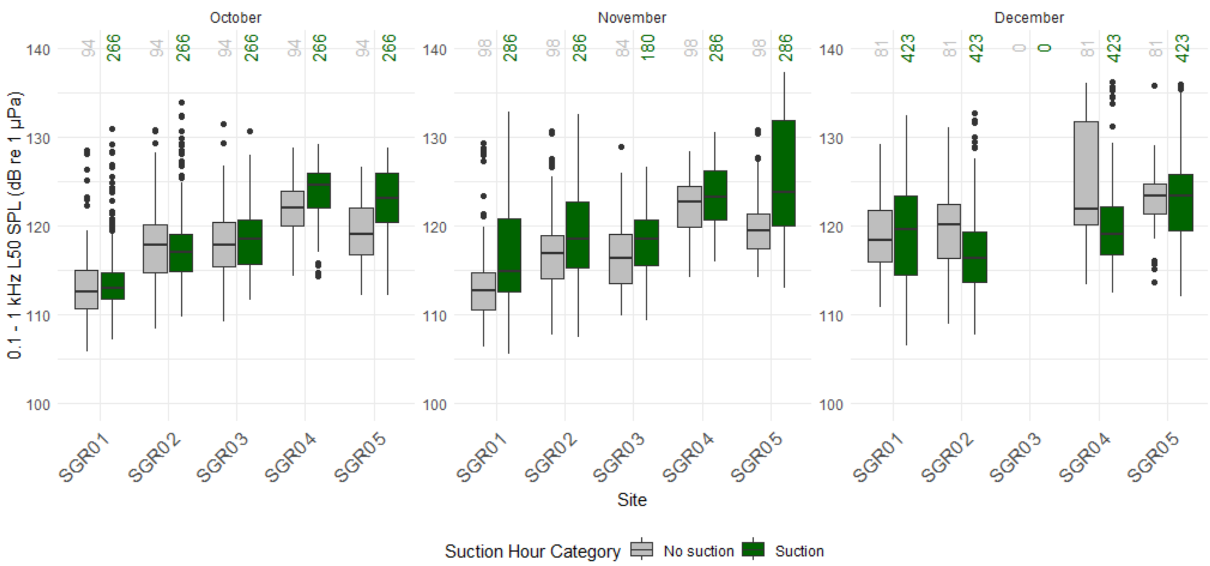

Figure A 12-5. This figure compares the L_{50} SPL in the 0.1 – 1 kHz frequency band during three months of construction (October, November and December 2022) at the Seagreen monitoring sites. Suction are compared against non-suction hours from Suction days. The sample size (number of hours within each site and category) is displayed above.

12.2.3 Pile driving

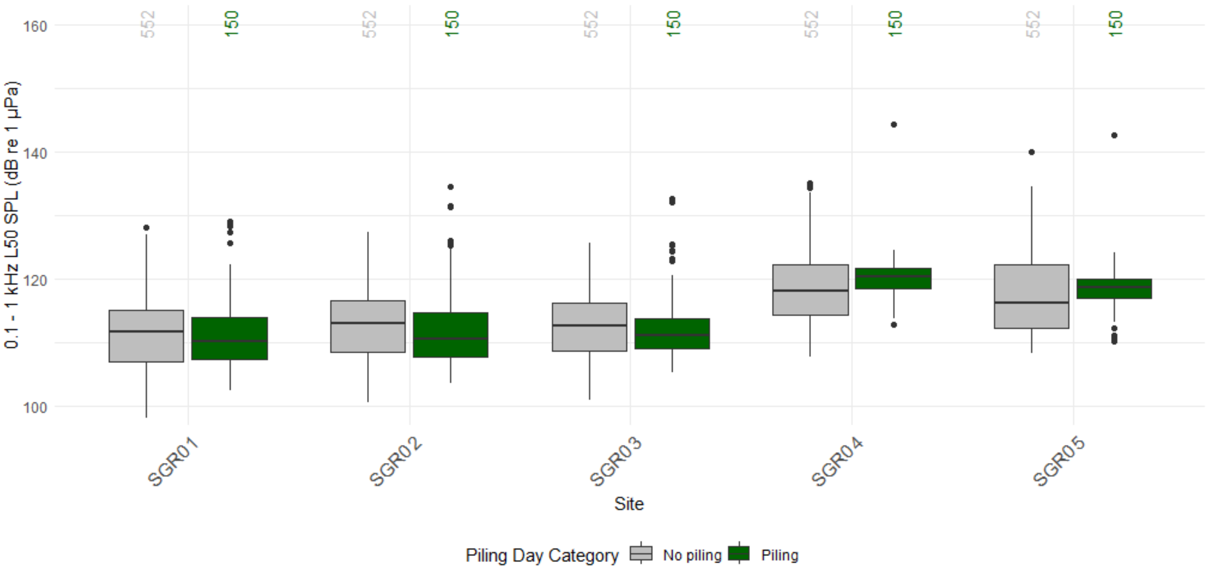

Figure A 12-6. This figure compares the L_{50} SPL in the 0.1 – 1 kHz frequency band during the month of December 2021 at the Seagreen monitoring. "Piling" days are compared to "No Piling days". Only the non-piling hours have been retained from "Piling" days and these are compared against non-piling hours from "No Piling" days in the same month. In this way we can compare the noise levels associated with construction in general (excluding piling) to the noise levels on days with no construction activity. The sample size (number of hours within each site and category) is displayed above.

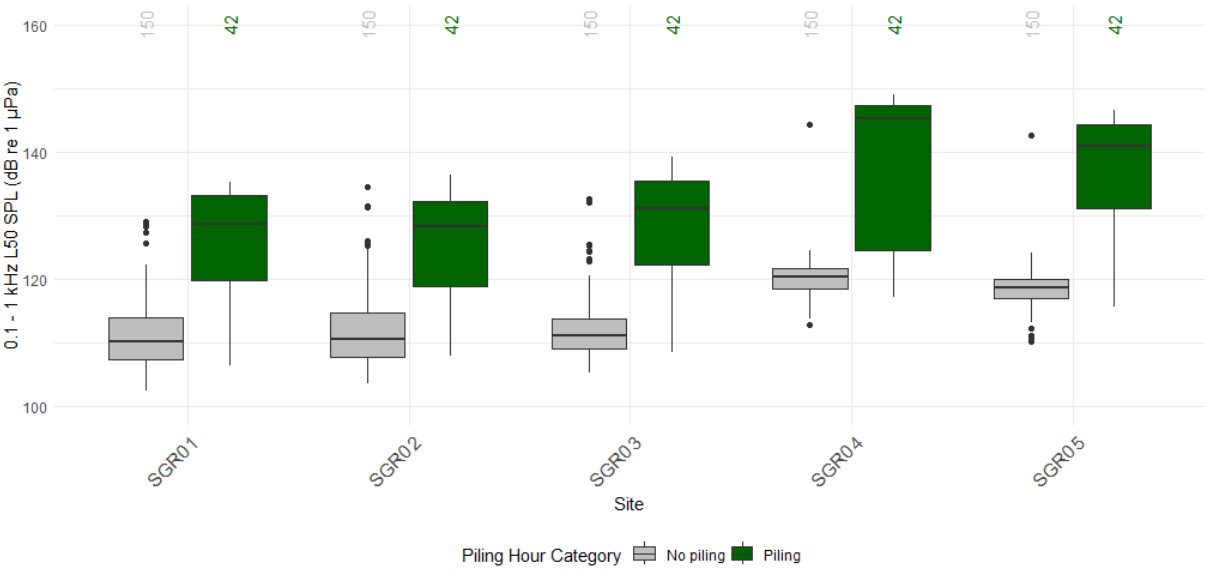

Figure A 12-7. This figure compares the L_{50} SPL in the 0.1 – 1 kHz frequency band during the month of December 2021 at the seagreen monitoring sites. "Piling" days are compared to "No Piling days". Suction are compared against non-suction hours from Suction days. The sample size (number of hours within each site and category) is displayed above.

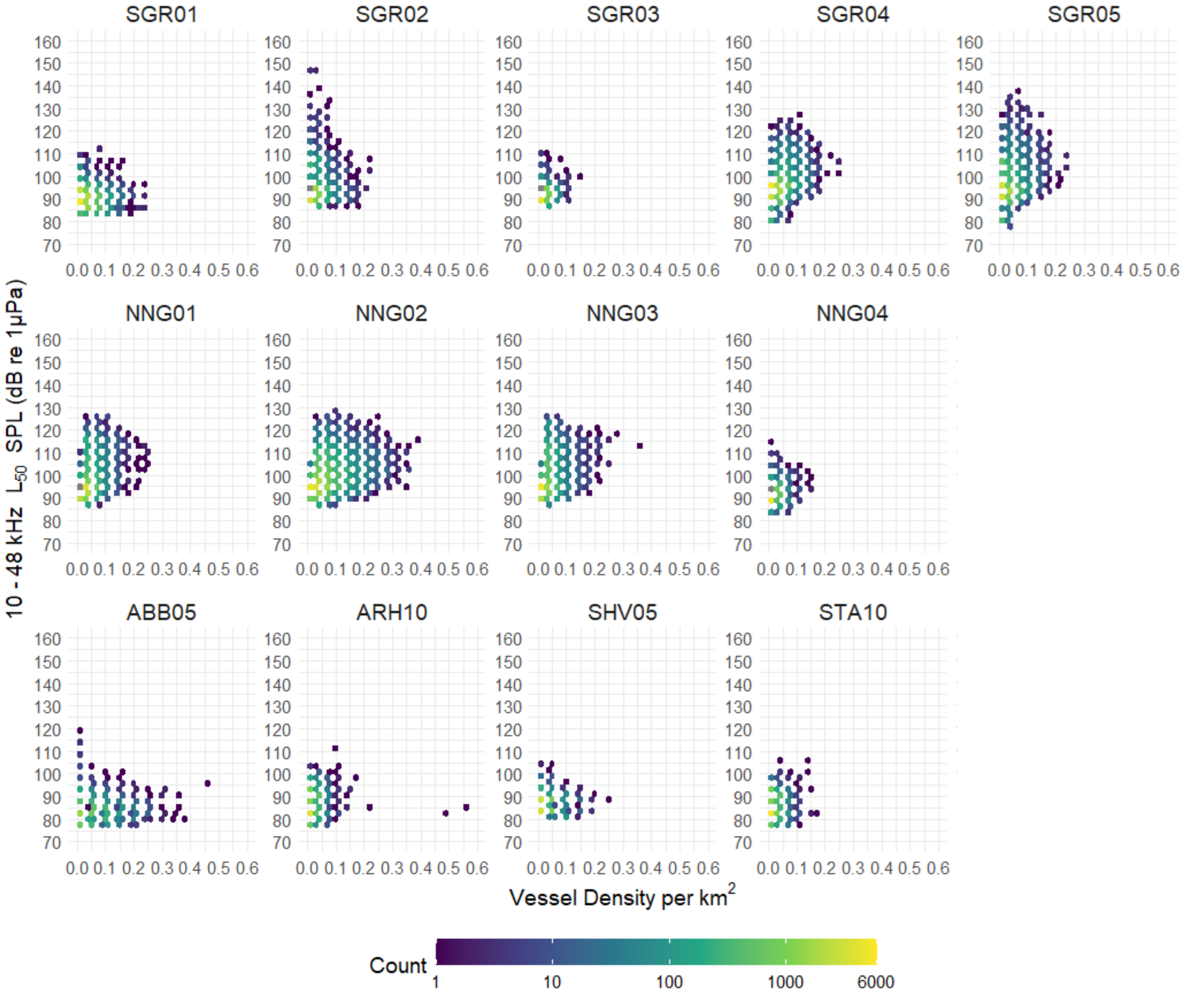

Figure A 12-8. Relationship between vessel density [km^2 h^{-1}] and L_{50} SPL 10 – 48 kHz for all monitoring sites for which information on underwater noise were available. The colour scale is logged, the lighter the colour the higher data count.

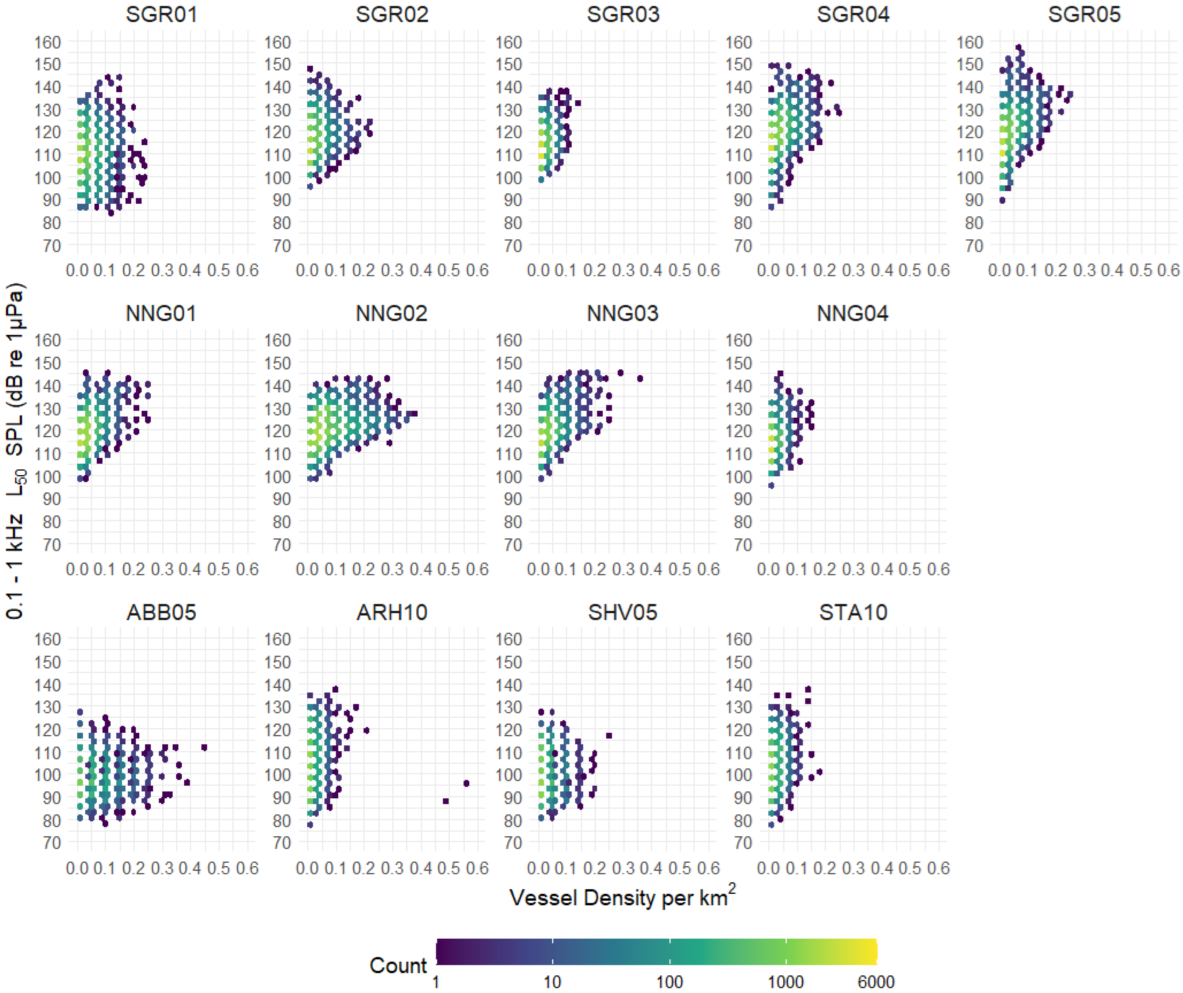

Figure A 12-9. Relationship between vessel density [km² h⁻¹] and L_{50} SPL 0.1 – 1 kHz for all monitoring sites for which information on underwater noise were available.

13 Appendix 5 – Modelling

13.1 Data preparation

This section presents some of the data summaries during data preparation for the modelling. Please refer to figure captions for further details.

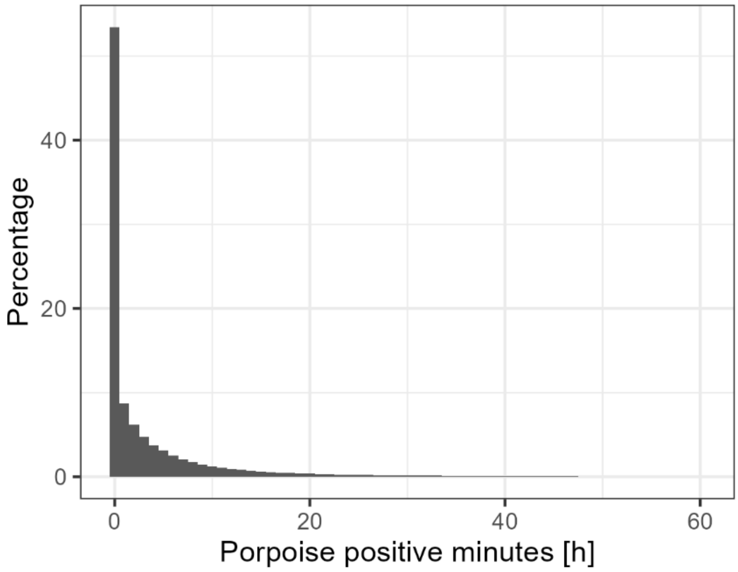

Figure A 13-1. Distribution of response variable for the porpoise model. The distribution is showing zero inflation in the data and, therefore, justification for using model family suitable for such zero – inflation (Tweedie).

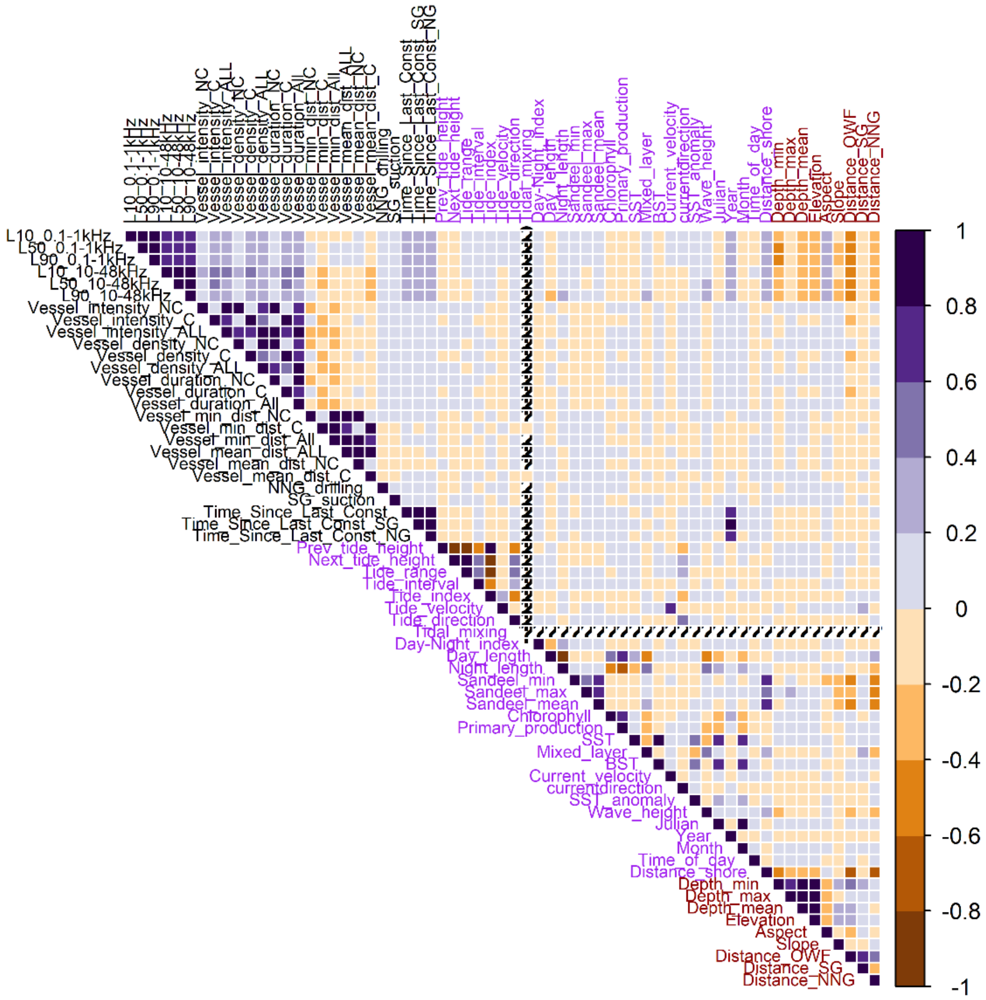

Figure A 13-2. Pearson's correlation between modelling covariates. Highly correlated covariates were grouped into three categories: anthropogenic (black), temporal (purple) and static (dark red). Only one covariate from each group was used in the model formulation. Refer to Table A 10.1 for the description of the covariates.

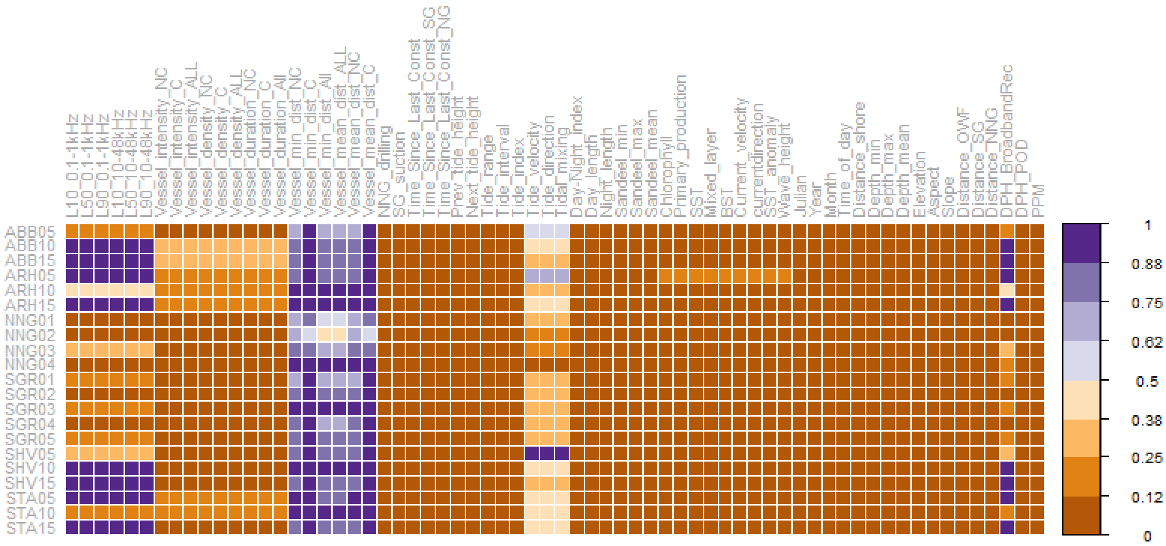

Figure A 13-3. Proportion of missing values for each covariate per monitoring site. In the final model formulation, priority was given to covariates having fewer missing values if they belonged to the same covariate group (see graph above). Refer to Table A 10.1 for the description of the covariates.

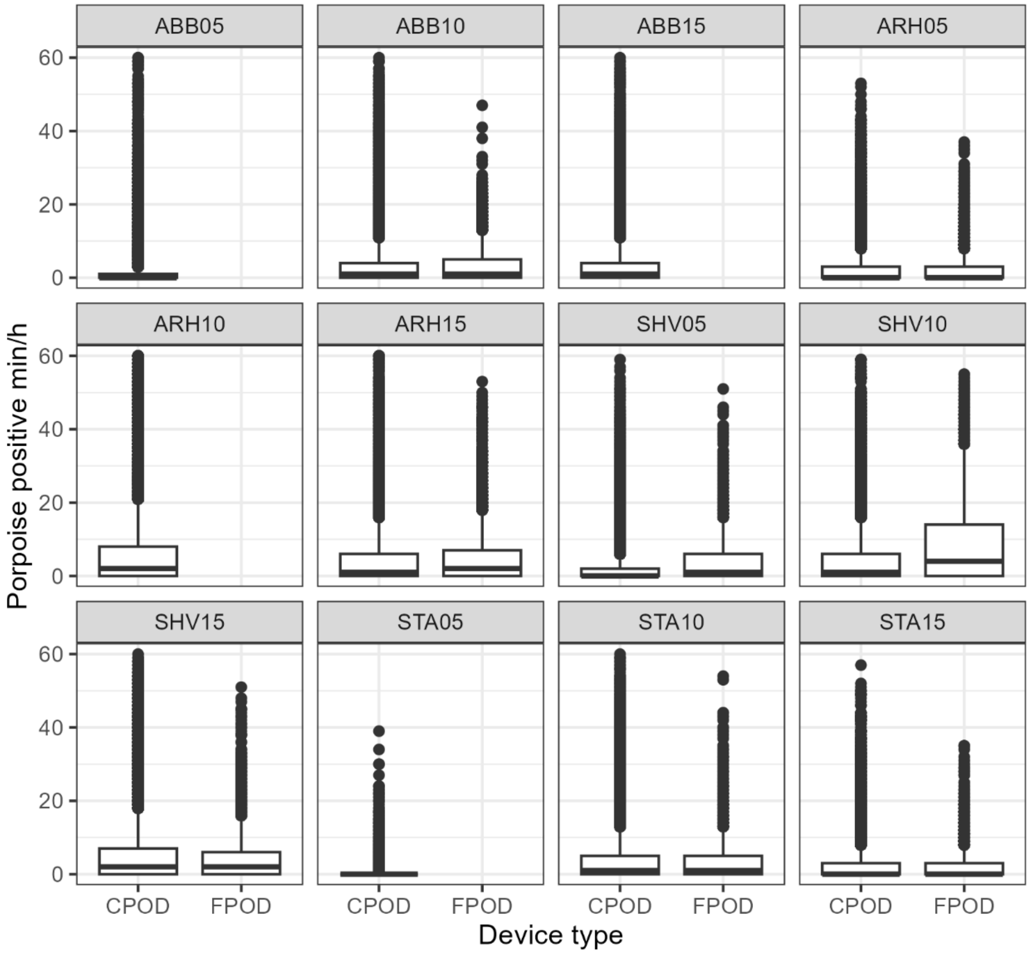

Figure A 13-4. Difference between porpoise positive minutes per hour detected by two device types: CPODs and FPODs. Note that FPODs have been deployed only at the ECOMMAS sites and data for this device type constituted to 4% of all POD data.

13.2 Model diagnostics

The below model diagnostics are standard diagnostic for GAM models.

- **Q-Q plot (quantile–quantile plot)** – This checks if the residuals follow the kind of distribution the model assumes (often normal for some GAMs). If the points mostly fall on a straight line, that's a good sign.
- **Residual plots** – These show the difference between what the model predicts and what was actually observed. If the model is good, the residuals should look like random noise (no clear patterns). Note that count or presence absence data types are bound by zero and one (in the latter case), hence the residuals plots are not random around these values.
- **Histogram of residuals** – A bar chart of the model's errors (residuals = observed – predicted). If the histogram looks roughly bell-shaped and cantered around zero, the model isn't systematically over- or under-predicting.
- **Response vs fitted values** - A scatterplot of actual data values (response) on one axis and the model's predictions (fitted values) on the other. If the model is doing well, points should cluster around the diagonal line (where prediction = reality). Note that the data in this project consist of thousands of rows and a clear pattern may not be visible.
- **Partial Autocorrelation Function (PACF) plot** - is a tool for checking whether the model's errors (residuals) are behaving like random noise. If the PACF bars mostly stay within the dashed lines area, it means the errors don't show any strong pattern. If some bars stick out, it suggests the model might be missing something (like a repeating pattern over time), and this has to be accounted for in the model formulation, as done in this project.

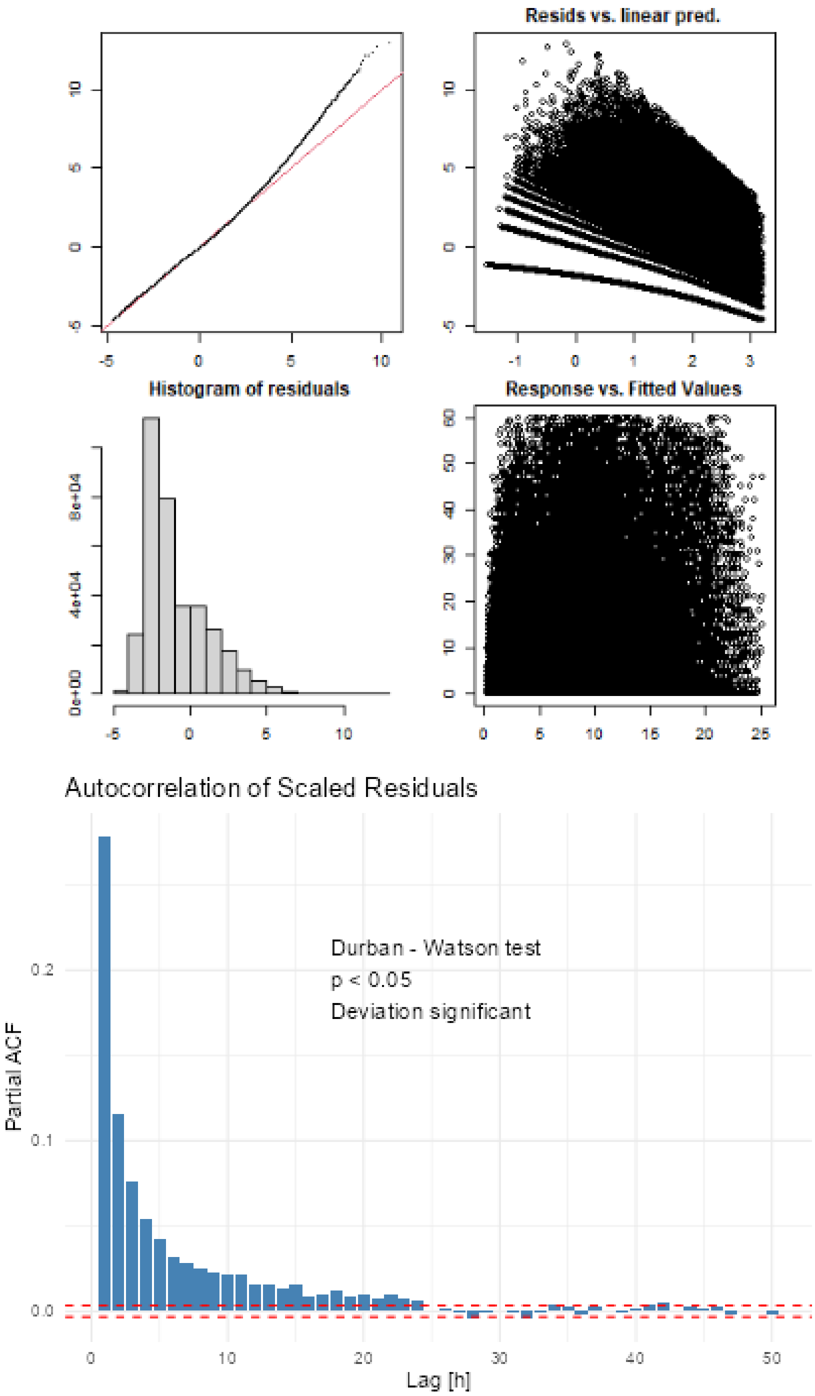

Figure A 13-5. Model diagnostic plots for GAM with porpoise positive minutes as a response and data from 13 sites (noise model).

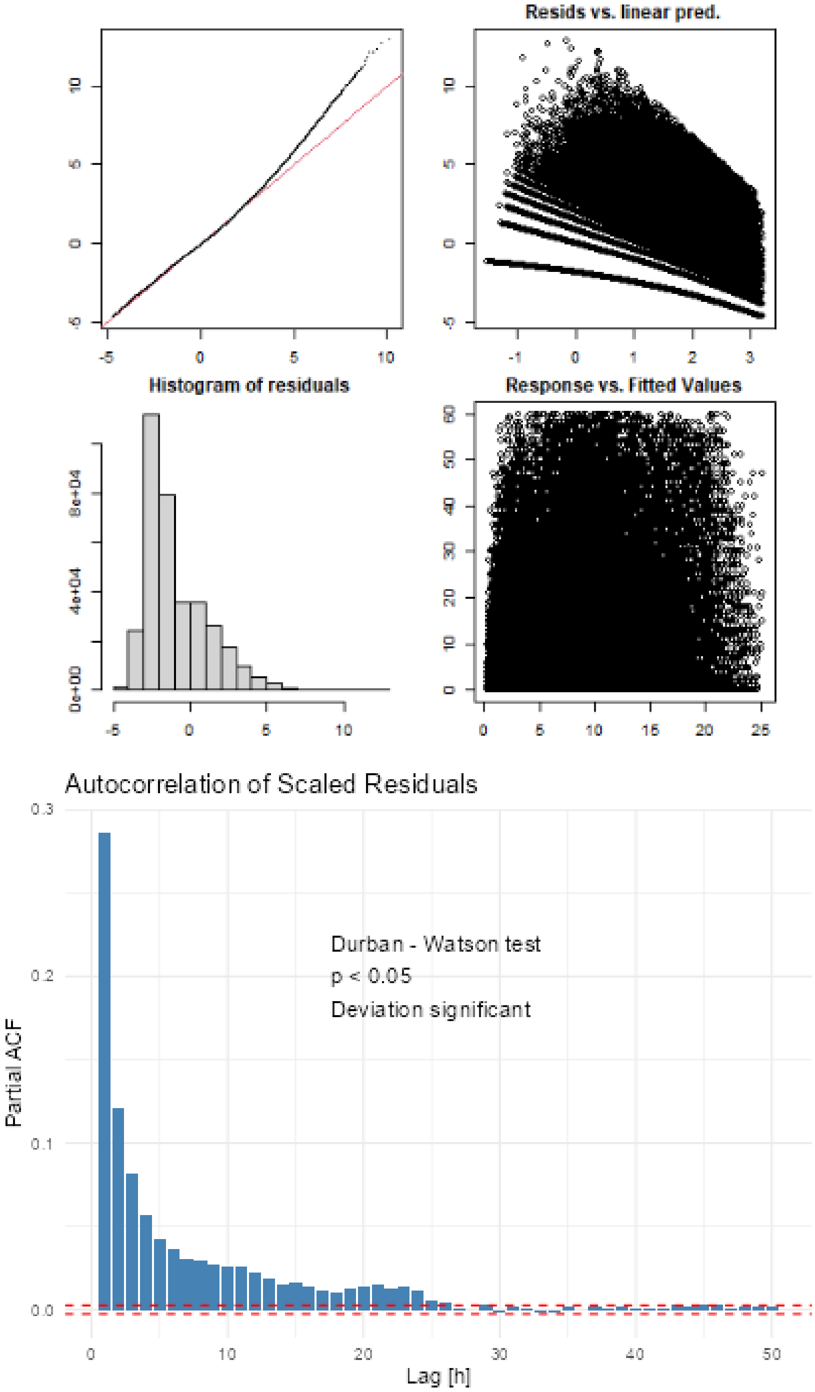

Figure A 13-6. Model diagnostic plots for GAM with porpoise positive minutes as a response and data from 21 sites (vessel model).

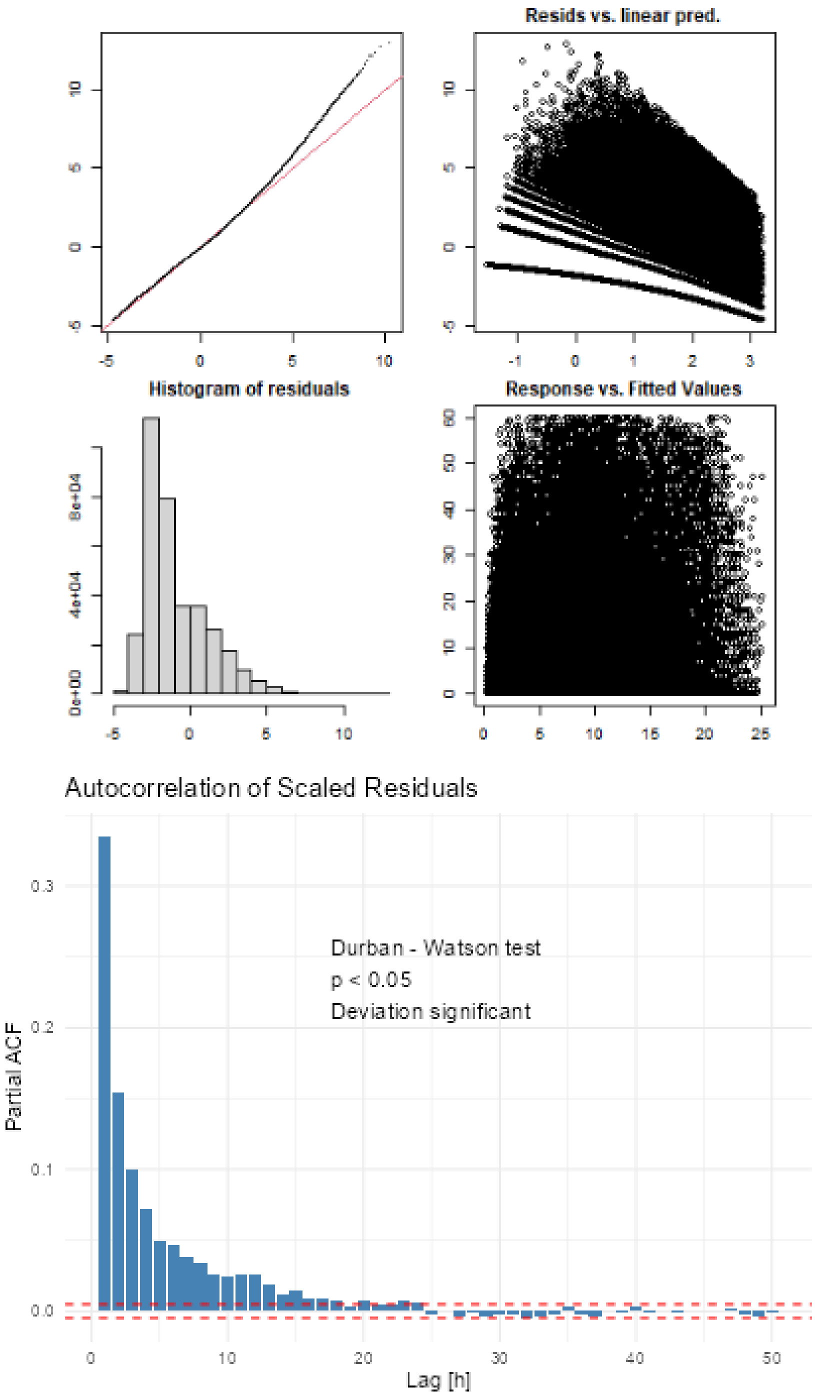

Figure A 13-7. Model diagnostic plots for GAM with porpoise positive minutes as a response and data from days with construction activity (construction model).

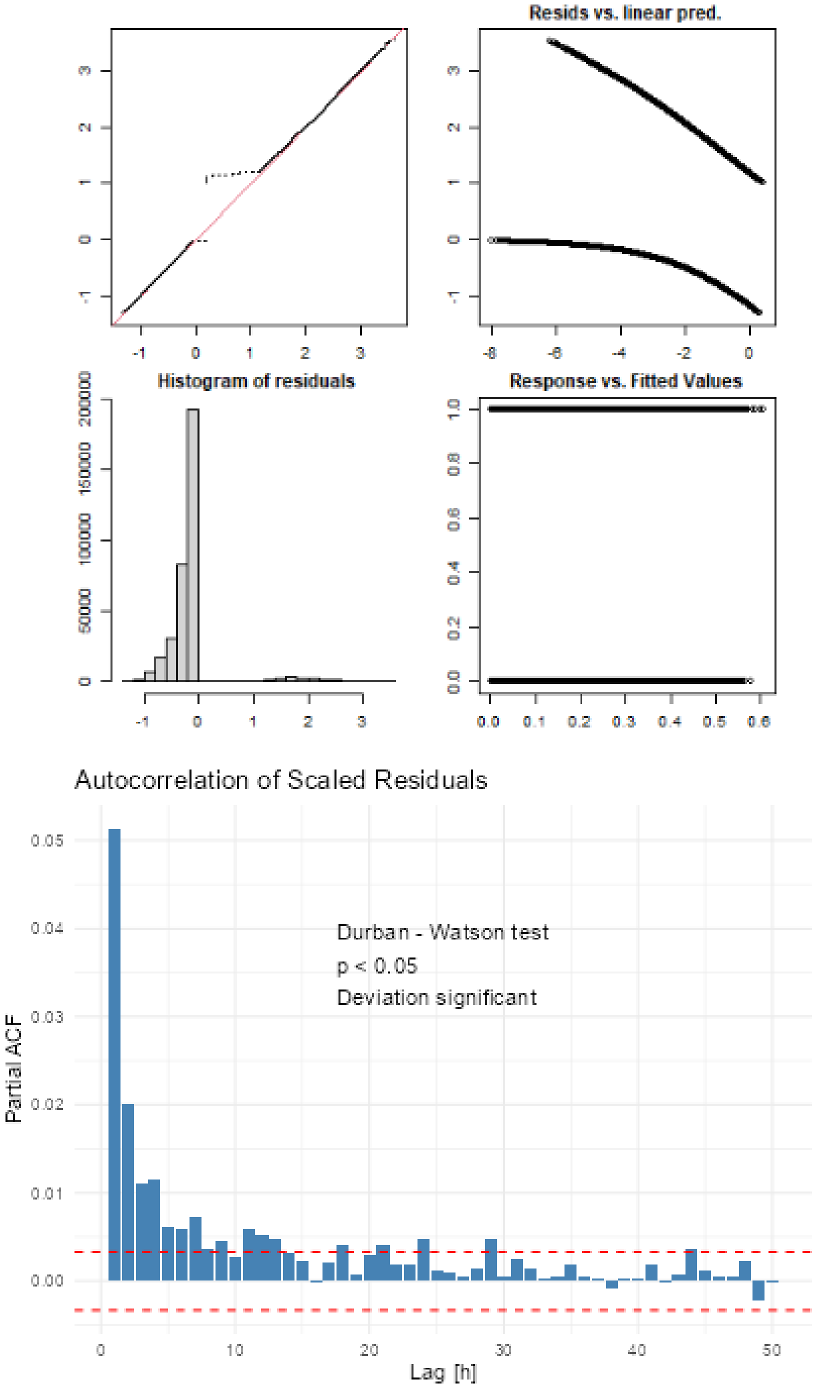

Figure A 13-8. Model diagnostic plots for GAM with dolphin presence as a response and data from 13 sites (noise model).

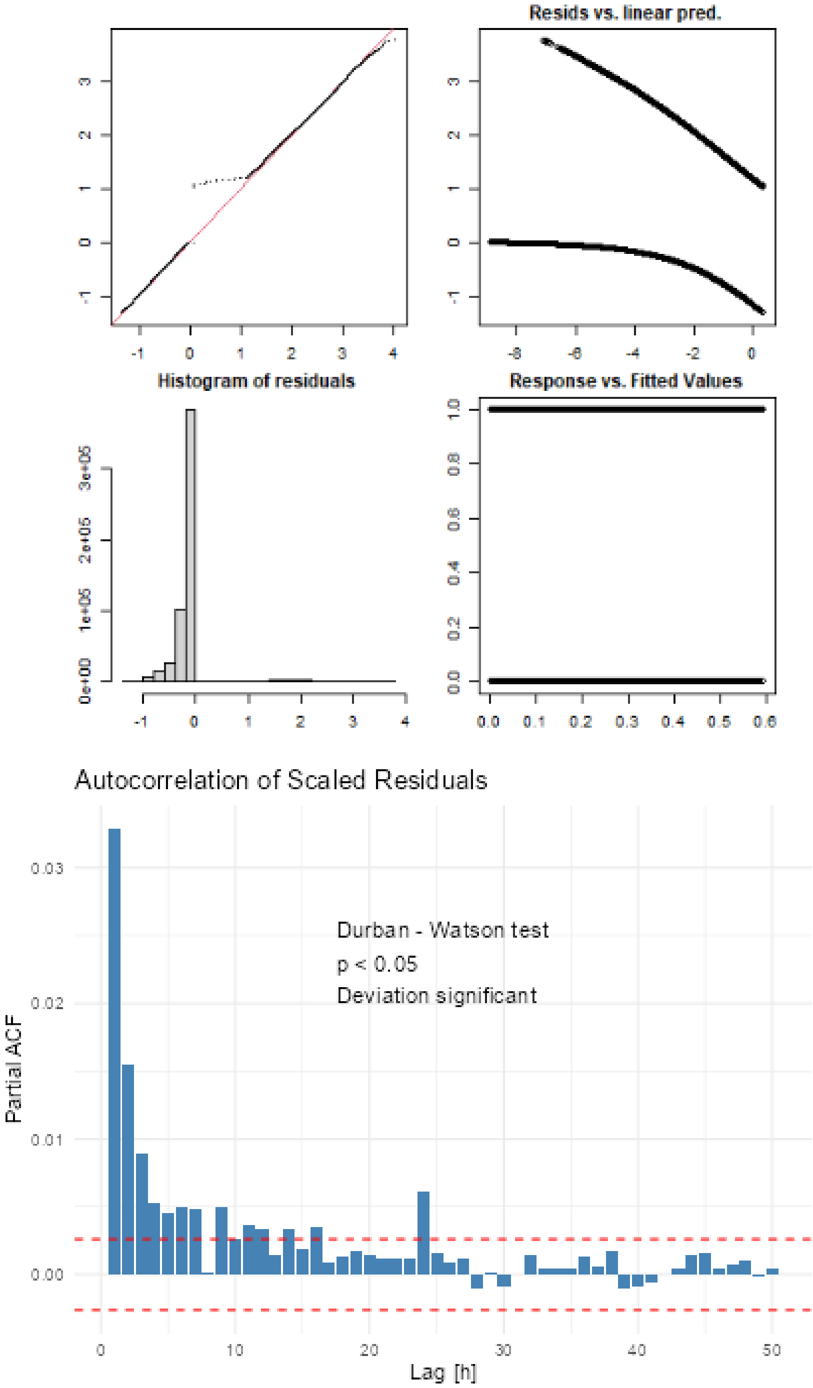

Figure A 13-9. Model diagnostic plots for GAM with dolphin presence as a response and data from 21 sites (vessel model).

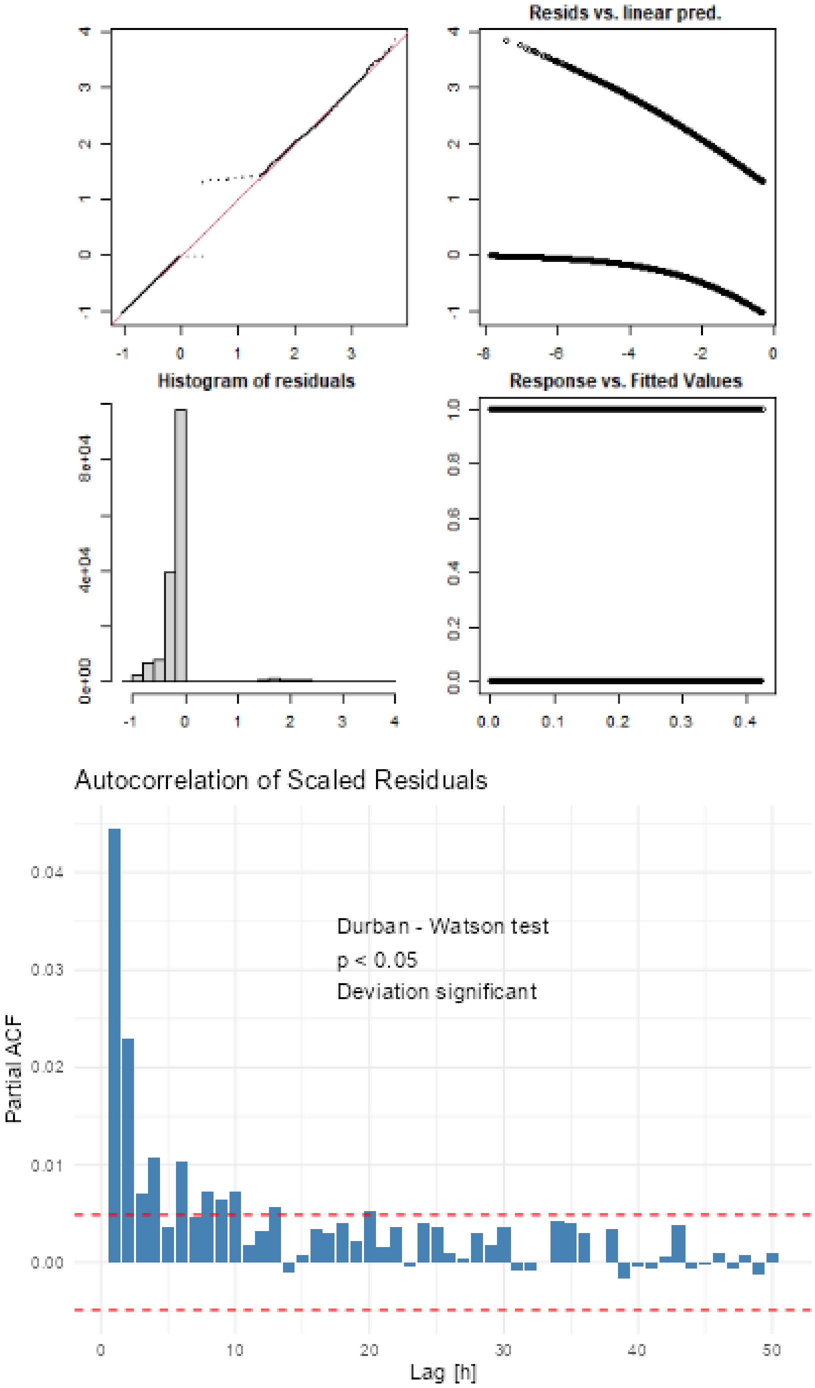

Figure A 13-10. Model diagnostic plots for GAM with dolphin presence as a response and data from days with construction activity (construction model).

Table A 13-1. Generalised Additive Model (GAM) coefficients for models of dolphin and porpoise based only on data during foundation construction (construction model). Covariates are presented in order from the highest deviance explained to the lowest deviance explained. Variables with p < 0.05 are considered statistically significant.

The F-statistic tests whether each variable contributes meaningfully to explaining the data beyond what would be expected by chance (note that F values cannot be directly compared between different types of variables or interactions). p-values indicate the probability that the observed relationship occurred by chance alone (values below 0.05 are considered statistically significant, meaning the relationship is unlikely due to random variation). Degrees of freedom (edf) reflect the complexity of each variable's relationship with the response - values close to 1 indicate a simple linear relationship, while higher values suggest more complex, non-linear patterns, common for interactions.

	Covariate	F/Chi. sq	p	(e)df	Approx. deviance explained [%]
(iii) construction model - porpoise	Distance NnG * drilling	804.9	<0.05	4	5
	Month	577.4	<0.05	6	5
	Day-night index	558.7	<0.05	2	2
	Distance Seagreen * suction	92.8	<0.05	3	1
	Dolphin presence	386.8	<0.05	1	1
	Tide index	43.2	<0.05	2	<1
	Suction	38.7	<0.05	1	<1
	Drilling	14.8	<0.05	1	<1
	Full model				**14**
(iii) construction model - dolphin	Distance NnG * drilling	2670.8	0.72	6	13
	Distance Seagreen * suction	1338.1	1.00	6	7
	Day-night index	263.1	<0.05	2	5
	Porpoise presence	164.4	<0.05	1	1
	Bottom temperature	37.9	<0.05	3	1
	Tide index	9.3	<0.05	2	<1
	Drilling	2.2	0.14	1	<1
	Suction	0.1	0.80	1	<1
	Full model				**23**

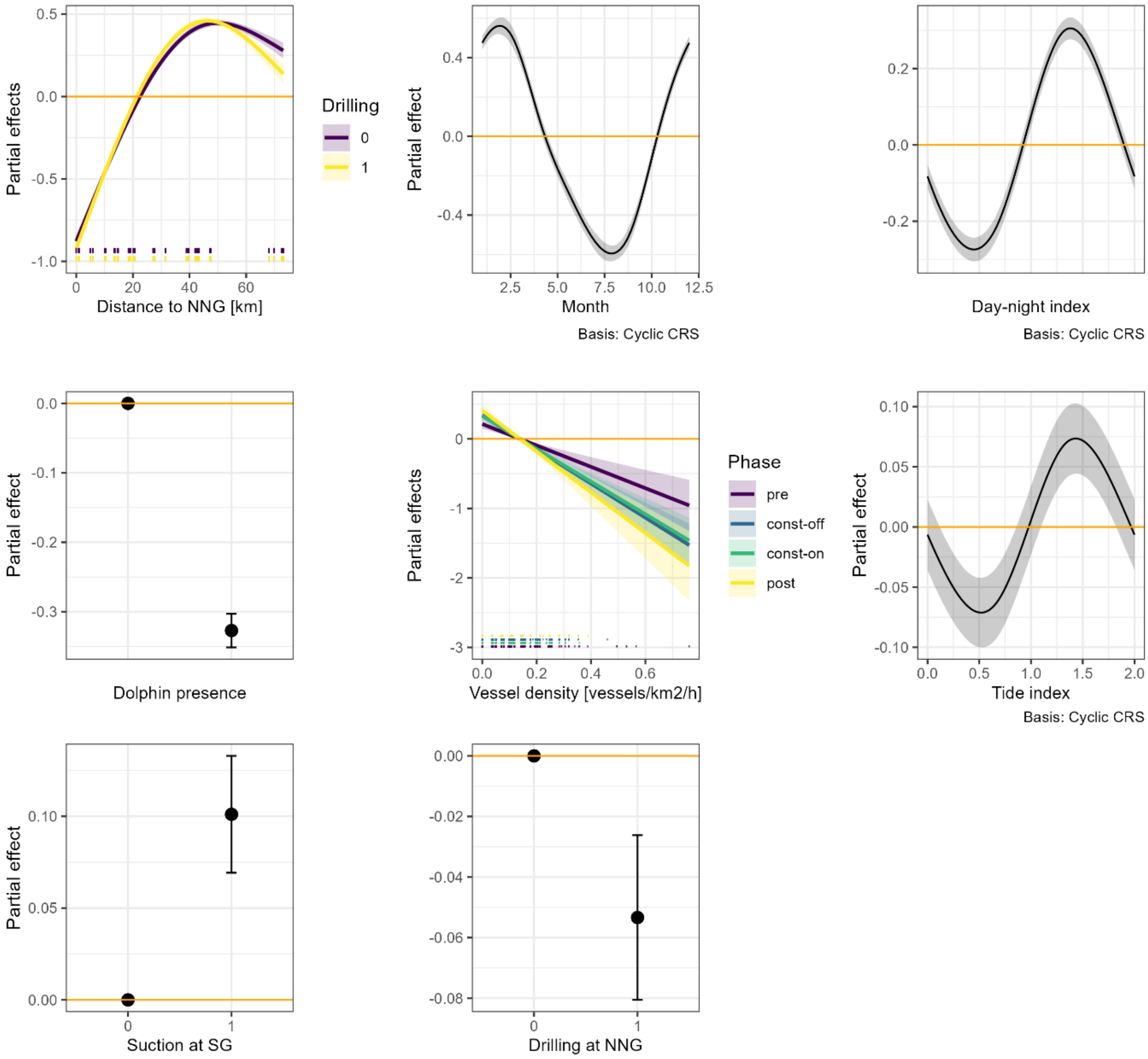

Figure A 13-11. Generalised Additive Model (GAM) predicted partial effects of covariates in the construction model for porpoise, ordered from highest to lowest deviance explained. The points above the x-axis are a rug plot, indicating the spread of noise values in the raw data used to fit the model.

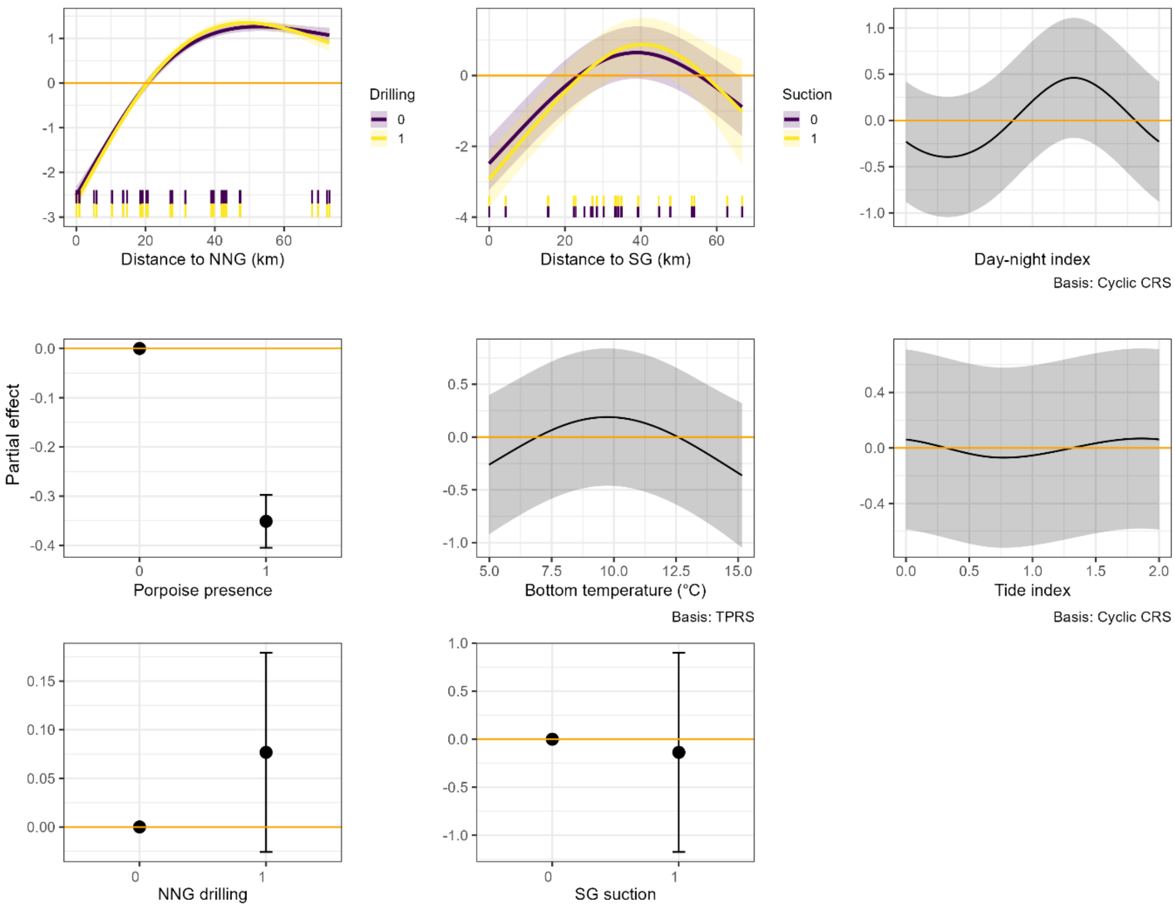

Figure A 13-12. Generalised Additive Model (GAM) predicted partial effects of covariates in the construction model for dolphins, ordered from highest to lowest deviance explained. The points above the x-axis in are a rug plot, indicating the spread of noise values in the raw data used to fit the model.

14 Appendix 6 - PEMP Compliance

14.1 PEMP objectives

The NnG and Seagreen PEMPs (NnGOWL 2023, SWEL 2019) map out the approach to monitoring for each environmental topic listed in the S36 Consent and offshore transmission works Marine Licence conditions. For marine mammals, through iterative discussions between 2015-2019 with the Forth and Tay Regional Advisory Group for Marine Mammals (FTRAG-MM), it was agreed that the primary focus species for monitoring during the pre-construction, construction and post-construction phases for NnG and Seagreen should be bottlenose dolphins and harbour porpoises. The objectives and approach to the monitoring, across both sites regionally, were presented to the FTRAG-MM and agreed in 2021[4,5]. Therefore, for marine mammals, the PEMPs objectives agreed upon are best summarised below:

"5.3.1 Marine Mammal Distribution
130. The PEMP aims to determine whether there are any significant changes in the distribution or abundance of marine mammals within the wind farm area and adjacent waters pre and during construction. This is being achieved via a broad-scale Passive Acoustic Monitoring (PAM) programme, that aims to combine the outputs of the NnG, Seagreen and ECOMMAS (East Coast Marine Mammal Acoustic Study) PAM subarrays. The findings aim to inform whether construction activities cause significant displacement of marine mammals, focusing on harbour porpoise and dolphins.

5.3.2 Improving Understanding the Bottlenose Dolphin Population Use of the Forth and Tay Region
131. The monitoring programme aims to improve our understanding of the east coast bottlenose dolphin population (i.e. abundance, demography and range)." (NnGOWL 2023)

In order to fulfil the PEMP objectives, two studies were carried out: passive acoustic monitoring, with results discussed in the main body of this report and summary provided in Section 14.2, and east coast bottlenose dolphin photo-identification (ID), detailed in Arso Civil et al. (2025) and summarised in Section 14.3.

14.2 Passive acoustic monitoring

14.2.1 Study objectives

The majority of the foundations were installed using non-impact piling methods: at Seagreen, Wind Turbine Generators (WTG) jackets were secured using suction bucket caissons, while at NnG, pin piles were installed through drilling. Impact piling was limited to the installation of a single Offshore Substation Platform (OSP) at the Seagreen site, where 12 pin piles were driven to support a jacket foundation. In discussion with the FTRAG-MM, it was agreed that given the spatial proximity of the Seagreen and NnG projects and the temporal overlaps in their construction phases, monitoring would be undertaken on a regional, rather than project-specific basis. Therefore, the monitoring and analysis

[4] https://marine.gov.scot/?q=data/ftrag-passive-acoustic-monitoring-methodology-overview-april-2021
[5] https://marine.gov.scot/sites/default/files/ftrag_minutes_-_marine_mammals_091121_-_final.pdf

presented in the main report seek to understand the impacts on marine mammal activity in the wider Forth and Tay area.

Given the PEMP elements described above, the objectives of the PAM study were:

1. To characterise baseline and installation technique-related changes in underwater noise.
2. To characterise baseline levels of detections of vocalising marine mammals and determine whether there are any significant changes in these detections pre, during and post-construction (the monitoring aim was therefore to inform whether construction activities cause significant changes in detections of marine mammals).
3. To relate any observed changes to a range of anthropogenic (level of underwater noise, construction related, vessel traffic) and non-anthropogenic factors (spatial, temporal, oceanographic, physical, tidal).

14.2.2 Study findings

This section summarises the results of the passive acoustic monitoring study, described in more detail in the main body of this report, with respect to PEMP objectives.

It is important to note that although the dolphin detections discussed in this study are most likely attributable to bottlenose dolphins (based on delphinid species distribution ranges in the area), species-level identification was not possible using either the POD or broadband acoustic data (see Section 6.5).

Marine mammal distribution

The PAM array deployed across the Forth and Tay region successfully characterised baseline levels of harbour porpoise and dolphin detections and allowed for assessment of potential changes associated with construction activity. Our analyses showed that the dominant drivers of porpoise and dolphin occurrence were natural spatio-temporal and environmental factors (including the influence of the presence of each species on one another), rather than anthropogenic influences. While drilling at NnG and suction bucket caisson installation at Seagreen modestly elevated underwater noise levels (3-5 dB) and piling increased noise by up to 25 dB locally (and 18 dB for offshore substation pin piles), these activities did not result in significant regional scale changes in detections of either species. Statistical modelling confirmed that construction-related variables explained <1% of the variance in detections compared to natural covariates. These findings demonstrate that the construction activities at both wind farms did not cause significant changes in detections of harbour porpoises or dolphins at the regional scale. As such, this study fulfilled the requirements of the objectives of the first PEMP study related to marine mammal distribution by successfully determining "*whether there are any significant changes in the distribution or abundance of marine mammals within the wind farm area and adjacent waters pre and during construction*".

Improving understanding of bottlenose dolphin population use of the Forth and Tay Region

The long-term PAM dataset analysed in this study provides the most comprehensive records of dolphin acoustic activity in the Forth and Tay region. Results confirmed strong spatial patterns, with dolphins most frequently detected at coastal sites, as well as consistent seasonal cycles, with peak occurrence in summer months. These patterns extend current knowledge of the east coast bottlenose dolphin populations use of the Tay estuary and adjacent coastal waters, as documented through previous studies (2009 – ongoing; Arso et al. 2019, Cheney et al. 2024, Arso Civil et al. 2025). Overall, this PAM study supports current evidence about presence, distribution and seasonality of the east coast dolphin population in the region. As such, this study contributed to fulfilment of the PEMP objective of *"improving understanding of bottlenose dolphin population use of the Forth and Tay Region"*.

14.3 East coast bottlenose dolphin photo-ID

14.3.1 Study objectives

The Scottish east coast bottlenose dolphin population has been studied since 1989, based on the ability to identify individual animals from photographs of the scratches, nicks and notches on their dorsal fins (e.g. Wilson et al. 1999). This work demonstrated that during the 1990s the population expanded its range from being primarily located in the Moray Firth to include frequent use of waters as far south as St Andrews Bay and the Firth of Forth (Wilson et al. 2004). Subsequently, sightings of individuals from the population have become more frequent to the south of the Tay Estuary, in the Firth of Forth but also further south along the southeast Scottish coast and off northeast England (Aynsley 2017, Sea Watch Foundation 2018). These observations were indicative of an ongoing expansion of the population's distributional range (Wilson et al. 1999, Arso Civil et al. 2019).

In order to continue providing robust estimates of population size, survival and birth rates, as well as updating understanding of movements of individuals across the (expanding) population range, a five-year programme was carried out, including four years of field work (Arso Civil et al. 2021a, Arso Civil et al. 2022, Arso Civil et al. 2023, Ellis et al. 2024) with a final year of overall data analysis, interpretation and reporting (Arso Civil et al. 2025).

The objectives of the east coast bottlenose dolphin population photo-ID study were:

1. To continue current systematic monitoring in the Tay Estuary and adjacent waters, alongside the monitoring of the Moray Firth SAC.
2. Initiate systematic monitoring in the Firth of Forth.
3. Engage with selected groups, organisations and the general public through a Citizen Science collaborative project (Citizen Fins) to complement the systematic boat-based monitoring with data on individuals from the population occurring in areas south of the Tay Estuary.

14.3.2 Study findings

This section summarises the results of the bottlenose dolphin photo ID study, described in detail in Arso Civil et al. (2025) with respect to PEMP objectives. It should be noted that this study did not aim to determine whether there are any changes in the distribution or abundance of bottlenose dolphin associated with wind farms activities. However, it improved knowledge of bottlenose dolphin population use within the Forth and Tay Region.

Improving understanding of bottlenose dolphin population use of the Forth and Tay Region

In total, 99 boat-based photo-identification trips were conducted between 2020 and 2023 in the Tay estuary and adjacent waters. It should be noted that resources available also allowed data to be collected in 2024, but these data have not yet been validated and so were not able to be included in analysis presented in Arso Civil et al 2025. A number of 234 different individuals from all age classes were identified from good quality photographs over the survey period, these included 44 animals born during 2020 to 2023.

The final report to Forth and Tay wind farm developers provides an update on estimates of population parameters (abundance of animals, survival and birth rates) (Arso Civil et al. 2025). Based on the findings of that report, the estimated number of dolphins using the Tay estuary and adjacent waters in 2009-2023 ranged from a minimum of 86 individuals (95% CI: 81 - 93) in 2011 to 226 individuals (95% CI: 179 - 284) in 2023. The number of animals using this area has increased by an estmated 5.6%

(95% CI 5.0 - 7.7%) per year between 2009 and 2023. The proporton of the total population using the Tay estuary and adjacent waters grew from 52% between 2009 and 2012, to 79% between 2020 and 2023. Photo identification results showed that 23% of identified individuals were detected only in the Firth of Forth section of the study area. This demonstrates the importance of extending surveys southward beyond Tayside and St Andrews Bay, and may account for some of the increase in abundance estimation for the Tay estuary and adjacent waters since 2019. Survival and birth rates were also evaluated using data from the Moray Firth to the Firth of Forth, with the annual probability of apparent survival between 1989 and 2023 estimated at 0.948 (95% CI: 0.938-0.957). The inter-birth interval for the total population between 2009 and 2022 was estimated at 3.52 years (95% CI: 3.20 - 3.75), resulting in an estimated annual birth rate of 0.284 (95% CI: 0.267 - 0.312).

As a part of the Citizens Fins project, several thousand images were submitted by dozens of photographers. From these data, 72 individual dolphins belonging to the east coast population were identified in North East (NE) England. An additional 27 unique individuals from NE England were recorded that have not been previously identified in Scottish waters. The project facilitated the monitoring of dolphins that were rarely or not observed in Scotland between 2020 and 2023, supported the design of dedicated photo-identification surveys in NE England, and provided a qualitative description of the current extent of the range expansion and connectivity to Scotland (Arso Civil et al. 2025).

In summary, the east coast bottlenose dolphin photo-ID study strengthens the evidence base on abundance, demography and ranging behaviour of east coast bottlenose dolphin population in the region. As such, this study contributed to fulfilment of the objectives of the second PEMP study of *"improving understanding of bottlenose dolphin population use of the Forth and Tay Region"*.

14.4 Final remarks

As such, this study fulfilled the requirements of the two PEMP studies: passive acoustic monitoring, and east coast bottlenose dolphin photo-identification. The first study concluded that there are no significant changes in the distribution or abundance of marine mammals within the wind farm area and adjacent waters pre and during construction. The second study improved significantly our understanding of bottlenose dolphin population use of the Forth and Tay Region.

15 Appendix 7 - Metadata

Table A **15-1** provides deployment and recovery metadata for all PAM mooring deployed around the Seagreen, NnG and ECOMMAS arrays over the course of this study. The collected dataset of raw acoustic recordings consists of 1,135,800 files and is 86.6 terabytes. Whilst CPOD/FPOD outputs collate data in one CP1/FP1 file per deployment (usually smaller than 1 gigabyte), a typical 31-day month of broadband acoustic recordings contains 1,488 files and is 160 gigabytes.

Table A 15-1**. Passive Acoustic Monitoring moorings deployed during this study. Timestamps are in Coordinated Universal Time (UTC) and coordinates are in decimal degrees. The second row of headings is based on proposed Darwin Core terms (https://dwc.tdwg.org/terms/) mapped for the header row of the metadata table as part of a biological data standardisation approach exploration.**

Device type	Deployment sequence	Site	Recording start (UTC)	Deployment start (UTC)	Deployment end (UTC)	Recording end (UTC)	Latitude (DD)	Longitude (DD)	Deployment number	Device number	Retrieved	Full dataset	Useable data	Notes
EventID	*EventID*	*EventID*	*RecStarteventDate (ISO 8601 YYYY-MM-DDThh:mmZ)*	*DepStarteventDate (ISO 8601 YYYY-MM-DDThh:mmZ)*	*DepEndeventDate (ISO 8601 YYYY-MM-DDThh:mmZ)*	*RecEndeventDate (ISO 8601 YYYY-MM-DDThh:mmZ)*	*decimalLatitude*	*decimalLongitude*	*EventID*	*EventID*	*EventRemarks*	*EventRemarks*	*EventRemarks*	*EventRemarks*
CPOD	2019A	Seagreen1	2019-03-23 00:00	2019-03-30 00:00	2019-07-30 00:00	2019-08-06 00:00	56.762417	-2.354617	385	3384	Y	Y	Y	
Logger	2019A	Seagreen1	NA	NA	NA	NA			NA	NA	Not deployed	Not deployed	N	Only 1 logger deployed at Seagreen1
CPOD	2019A	Seagreen2	2019-03-23 00:00	2019-03-30 00:00	2019-04-11 00:00	2019-06-21 00:00	56.715833	-2.182717	386	3392	Y	N	Y	Brought to Aberdeen by fishermen after less than three weeks
Logger	2019A	Seagreen2	NA	NA	NA	NA			NA	NA	Not deployed	Not deployed	N	Only 1 logger deployed at Seagreen1
CPOD	2019A	Seagreen3	2019-03-23 00:00	2019-03-30 00:00	2019-07-30 00:00	2019-08-06 00:00	56.66115	-2.0091	387	3386	Y	Y	Y	
Logger	2019A	Seagreen3	NA	NA	NA	NA			NA	NA	Not deployed	Not deployed	N	Only 1 logger deployed at Seagreen1
CPOD	2019A	Seagreen4	2019-03-23 00:00	2019-03-30 00:00	NA	NA	56.610017	-1.836017	388	3383	N	N	N	Not retrieved
Logger	2019A	Seagreen4	NA	NA	NA	NA			NA	NA	Not deployed	Not deployed	N	Only 1 logger deployed at Seagreen1
CPOD	2019A	Seagreen5	2019-03-23 00:00	2019-03-29 08:34	2019-07-30 00:00	2019-08-06 00:00	56.554683	-1.667317	389	3385	Y	Y	Y	
Logger	2019A	Seagreen5	2019-03-29 08:34	2019-03-30 00:00	2019-07-30 00:00	2019-06-16 00:00	56.554683	-1.667317	389	SM2M8	Y	N	Y	
CPOD	2019B	Seagreen1	2019-07-31 00:00	2019-07-31 00:00	2019-11-18 00:00	2019-11-19 00:00	56.7625	-2.35493	413	3387	Y	Y	Y	
Logger	2019B	Seagreen1	2019-07-31 00:00	2019-07-31 00:00	2019-11-18 00:00	2019-11-19 00:00	56.7625	-2.35493	413	LSeagreen1x-1s	Y	Y	Y	
CPOD	2019B	Seagreen2	2019-07-31 00:00	2019-07-31 00:00	2019-11-17 00:00	2019-11-18 00:00	56.71578	-2.18275	412	3388	Y	Y	Y	
Logger	2019B	Seagreen2	2019-07-31 00:00	2019-07-31 00:00	2019-11-17 00:00	2019-11-18 00:00	56.71578	-2.18275	412	LSeagreen1x-2s	Y	Y	Y	
CPOD	2019B	Seagreen3	2019-07-31 00:00	2019-07-31 00:00	2019-11-17 00:00	2019-11-18 00:00	56.66107	-2.009117	414	3389	Y	Y	Y	

Device type	Deployment sequence	Site	Recording start (UTC)	Deployment start (UTC)	Deployment end (UTC)	Recording end (UTC)	Latitude (DD)	Longitude (DD)	Deployment number	Device number	Retrieved	Full dataset	Useable data	Notes
Logger	2019B	Seagreen3	2019-07-31 00:00	2019-07-31 00:00	2019-11-17 00:00	2019-11-18 00:00	56.66107	-2.009117	414	LSeagreen1x-3s	Y	Y	Y	
CPOD	2019B	Seagreen4	2019-07-30 00:00	2019-07-30 00:00	2019-11-17 00:00	2019-11-18 00:00	56.60995	-1.83607	411	3390	Y	Y	Y	
Logger	2019B	Seagreen4	2019-07-30 00:00	2019-07-30 00:00	2019-11-17 00:00	2019-11-18 00:00	56.60995	-1.83607	411	LSeagreen1x-4s	Y	Y	Y	
CPOD	2019B	Seagreen5	2019-07-30 00:00	2019-07-30 00:00	2019-11-17 00:00	2019-11-18 00:00	56.55452	-1.66757	407	3391	Y	Y	Y	
Logger	2019B	Seagreen5	2019-07-30 00:00	2019-07-30 00:00	2019-11-17 00:00	2019-11-18 00:00	56.55452	-1.66757	407	LSeagreen1x-5s	Y	Y	Y	
CPOD	2019C	NnG1	2019-11-22 00:00	2019-11-22 00:00	2020-03-21 00:00	2020-03-21 00:00	56.2981	-2.31936	438	3439	Y	Y	Y	
Logger	2019C	NnG1	2019-11-22 00:00	2019-11-22 00:00	2020-03-21 00:00	2020-03-21 00:00	56.2981	-2.31936	438	NNG1	Y	Y	Y	
CPOD	2019C	NnG2	2019-11-22 00:00	2019-11-22 00:00	2020-03-21 00:00	2020-03-21 00:00	56.25208	-2.25345	439	3436	Y	Y	Y	
Logger	2019C	NnG2	2019-11-22 00:00	2019-11-22 00:00	2020-03-21 00:00	2020-03-21 00:00	56.25208	-2.25345	439	NNG2	Y	Y	Y	
CPOD	2019C	NnG3	2019-11-22 00:00	2019-11-22 00:00	2020-03-21 00:00	2020-03-21 00:00	56.27238	-2.16633	440	3437	Y	Y	Y	
Logger	2019C	NnG3	NA	NA	NA	NA	56.27238	-2.16633	440	NNG3	N	N	N	Not retrieved
CPOD	2019C	NnG4	2019-11-22 00:00	2019-11-22 00:00	NA	NA	56.27231	-2.09083	441	3438	N	N	N	Not retrieved
Logger	2019C	NnG4	NA	NA	NA	NA	56.27231	-2.09083	441	NNG4	N	N	N	Not retrieved
CPOD	2019C	Seagreen1	2019-11-20 00:00	2019-11-21 00:00	2020-03-20 00:00	2020-03-21 00:00	56.76227	-2.3548	432	2898	Y	Y	Y	
Logger	2019C	Seagreen1	2019-11-20 00:00	2019-11-21 00:00	2020-03-20 00:00	2020-03-21 00:00	56.76227	-2.3548	432	LSeagreen1x-6s	Y	Y	Y	
CPOD	2019C	Seagreen2	2019-11-19 00:00	2019-11-20 00:00	2020-03-20 00:00	2020-03-21 00:00	56.716	-2.182717	433	3372	Y	Y	Y	
Logger	2019C	Seagreen2	2019-11-19 00:00	2019-11-20 00:00	2020-03-20 00:00	2020-03-21 00:00	56.716	-2.182717	433	LSeagreen1x-8s	Y	Y	Y	
CPOD	2019C	Seagreen3	2019-11-19 00:00	2019-11-20 00:00	2020-03-20 00:00	2020-03-21 00:00	56.66115	-2.0091	434	2905	Y	Y	Y	
Logger	2019C	Seagreen3	2019-11-19 00:00	2019-11-20 00:00	2020-03-20 00:00	2020-03-21 00:00	56.66115	-2.0091	434	LSeagreen1x-7s	Y	Y	Y	
CPOD	2019C	Seagreen4	2019-11-19 00:00	2019-11-20 00:00	2020-03-20 00:00	2020-03-21 00:00	56.610017	-1.836017	435	3129	Y	Y	Y	
Logger	2019C	Seagreen4	2019-11-19 00:00	2019-11-20 00:00	2020-03-20 00:00	2020-03-21 00:00	56.610017	-1.836017	435	LSeagreen1x-9s	Y	Y	Y	
CPOD	2019C	Seagreen5	2019-11-19 00:00	2019-11-20 00:00	2020-03-20 00:00	2020-03-21 00:00	56.554683	-1.667317	436	2798	Y	Y	Y	
Logger	2019C	Seagreen5	2019-11-19 00:00	2019-11-20 00:00	2020-03-20 00:00	2020-03-21 00:00	56.554683	-1.667317	436	LSeagreen1x-10s	Y	Y	Y	
CPOD	2020A	NnG1	2020-03-22 00:00	2020-03-24 00:00	2020-07-14 00:00	2020-07-15 00:00	56.298	-2.3192	451	3434	Y	Y	Y	
Logger	2020A	NnG1	2020-03-22 00:00	2020-03-24 00:00	2020-07-14 00:00	2020-07-15 00:00	56.298	-2.3192	451	NNG1	Y	Y	Y	
CPOD	2020A	NnG2	2020-03-22 00:00	2020-03-24 00:00	2020-07-14 00:00	2020-07-15 00:00	56.25197	-2.253783	452	3433	Y	Y	Y	
Logger	2020A	NnG2	2020-03-22 00:00	2020-03-24 00:00	2020-07-14 00:00	2020-07-15 00:00	56.25197	-2.253783	452	NNG2	Y	Y	Y	
CPOD	2020A	NnG3	2020-03-22 00:00	2020-03-24 00:00	2020-07-14 00:00	2020-07-15 00:00	56.27247	-2.166783	453	3432	Y	Y	Y	
Logger	2020A	NnG3	2020-03-22 00:00	2020-03-24 00:00	2020-07-14 00:00	2020-06-20 00:00	56.27247	-2.166783	453	NNG3	Y	Y	Y	
CPOD	2020A	NnG4	2020-03-22 00:00	2020-03-24 00:00	2020-07-14 00:00	2020-07-15 00:00	56.27243	-2.090567	454	3435	Y	Y	Y	
Logger	2020A	NnG4	2020-03-22 00:00	2020-03-24 00:00	2020-07-14 00:00	2020-07-15 00:00	56.27243	-2.090567	454	NNG4	Y	Y	Y	

Device type	Deployment sequence	Site	Recording start (UTC)	Deployment start (UTC)	Deployment end (UTC)	Recording end (UTC)	Latitude (DD)	Longitude (DD)	Deployment number	Device number	Retrieved	Full dataset	Useable data	Notes
CPOD	2020A	Seagreen1	NA	NA	NA	NA	56.76225	-2.3545	446	NA	N	N	N	Not retrieved
Logger	2020A	Seagreen1	NA	NA	NA	NA	56.76225	-2.3545	446	NA	N	N	N	Not retrieved
CPOD	2020A	Seagreen2	2020-03-22 00:00	2020-03-23 00:00	2020-07-13 00:00	2020-07-13 00:00	56.7158	-2.182667	447	3389	Y	Y	Y	
Logger	2020A	Seagreen2	2020-03-22 00:00	2020-03-23 00:00	2020-07-13 00:00	2020-07-14 00:00	56.7158	-2.182667	447	LSeagreen1x-3S	Y	Y	Y	
CPOD	2020A	Seagreen3	2020-03-22 00:00	2020-03-23 00:00	2020-07-13 00:00	2020-07-13 00:00	56.66112	-2.009083	448	3391	Y	Y	Y	
Logger	2020A	Seagreen3	2020-03-22 00:00	2020-03-23 00:00	2020-07-13 00:00	2020-07-14 00:00	56.66112	-2.009083	448	LSeagreen1x-4S	Y	Y	Y	
CPOD	2020A	Seagreen4	2020-03-22 00:00	2020-03-23 00:00	2020-07-13 00:00	2020-07-13 00:00	56.60992	-1.836133	449	3387	Y	Y	Y	
Logger	2020A	Seagreen4	2020-03-22 00:00	2020-03-23 00:00	2020-07-13 00:00	2020-07-14 00:00	56.60992	-1.836133	449	LSeagreen1x-5S	Y	Y	Y	
CPOD	2020A	Seagreen5	2020-03-22 00:00	2020-03-23 00:00	2020-07-13 00:00	2020-07-13 00:00	56.55455	-1.667817	450	3390	Y	Y	Y	
Logger	2020A	Seagreen5	2020-03-22 00:00	2020-03-23 00:00	2020-07-13 00:00	2020-06-20 00:00	56.55455	-1.667817	450	LSeagreen1x-1S	Y	Y	Y	
CPOD	2020B	NnG1	2020-07-14 00:00	2020-07-14 00:00	2020-11-09 00:00	2020-11-09 00:00	56.29797	-2.319233	476	3431	Y	Y	Y	
Logger	2020B	NnG1	2020-07-16 00:00	2020-07-09 00:00	2020-11-11 00:00	2020-11-08 00:00	56.29797	-2.319233	476	437882	Y	Y	Y	
CPOD	2020B	NnG2	2020-07-14 00:00	2020-07-14 00:00	2020-11-09 00:00	2020-11-09 00:00	56.25197	-2.253783	477	3439	Y	Y	Y	
Logger	2020B	NnG2	2020-07-16 00:00	2020-07-09 00:00	2020-11-11 00:00	2020-11-08 00:00	56.25197	-2.253783	477	437883	Y	Y	Y	
CPOD	2020B	NnG3	2020-07-14 00:00	2020-07-14 00:00	NA	NA	56.27247	-2.166783	478	3437	N	N	N	Unusable data
Logger	2020B	NnG3	2020-07-16 00:00	2020-07-09 00:00	2020-11-11 00:00	2020-11-08 00:00	56.27247	-2.166783	478	437885	Y	Y	Y	
CPOD	2020B	NnG4	2020-07-11 00:00	2020-07-11 00:00	NA	NA	56.27258	-2.090567	479	3436	N	N	N	Unusable data
Logger	2020B	NnG4	2020-07-16 00:00	2020-07-09 00:00	2020-11-11 00:00	2020-11-08 00:00	56.27258	-2.090567	479	437886	Y	Y	Y	
CPOD	2020B	Seagreen1	2020-07-14 00:00	2020-07-15 00:00	2020-11-06 00:00	2020-11-09 00:00	56.76225	-2.354467	468	3388	Y	Y	Y	
Logger	2020B	Seagreen1	2020-07-09 00:00	2020-07-15 00:00	2020-11-06 00:00	2020-11-11 00:00	56.76225	-2.354467	468	LSeagreen1x-6s	Y	Y	Y	
CPOD	2020B	Seagreen2	2020-07-10 00:00	2020-07-15 00:00	2020-11-06 00:00	2020-11-08 00:00	56.7158	-2.182667	469	3389	Y	Y	Y	
Logger	2020B	Seagreen2	2020-07-15 00:00	2020-07-15 00:00	2020-11-06 00:00	2020-10-09 00:00	56.7158	-2.182667	469	LSeagreen1x-SG11	Y	Y	Y	
CPOD	2020B	Seagreen3	2020-07-14 00:00	2020-07-15 00:00	2020-11-06 00:00	NA	56.66112	-2.009233	470	3391	N	N	N	Not retrieved
Logger	2020B	Seagreen3	2020-07-09 00:00	2020-07-15 00:00	2020-11-06 00:00	2020-11-06 00:00	56.66112	-2.009233	470	LSeagreen1x-10s	Y	N	Y	
CPOD	2020B	Seagreen4	2020-07-14 00:00	2020-07-15 00:00	2020-11-06 00:00	NA	56.60992	-1.836117	471	3387	N	N	N	Not retrieved
Logger	2020B	Seagreen4	2020-07-09 00:00	2020-07-15 00:00	2020-11-06 00:00	2020-11-11 00:00	56.60992	-1.836117	471	LSeagreen1x-7s	Y	Y	Y	
CPOD	2020B	Seagreen5	2020-07-14 00:00	2020-07-15 00:00	2020-11-06 00:00	2020-11-09 00:00	56.55457	-1.66785	472	3390	Y	Y	Y	
Logger	2020B	Seagreen5	2020-07-10 00:00	2020-07-15 00:00	2020-11-06 00:00	2020-10-09 00:00	56.55457	-1.66785	472	LSeagreen1x-9s	Y	Y	Y	
CPOD	2020C	NnG1	2020-10-30 00:00	2020-11-09 00:00	2021-03-19 00:00	2021-03-05 00:00	56.298	-2.319267	493	3369	Y	Y	Y	
Logger	2020C	NnG1	2020-10-30 00:00	2020-11-09 00:00	2021-03-19 00:00	2021-03-18 00:00	56.298	-2.319267	493	NNG8	Y	Y	Y	
CPOD	2020C	NnG2	2020-10-30 00:00	2020-11-09 00:00	2021-03-19 00:00	2021-03-25 00:00	56.25198	-2.25365	494	3432	Y	Y	Y	

Device type	Deployment sequence	Site	Recording start (UTC)	Deployment start (UTC)	Deployment end (UTC)	Recording end (UTC)	Latitude (DD)	Longitude (DD)	Deployment number	Device number	Retrieved	Full dataset	Useable data	Notes
Logger	2020C	NnG2	2020-10-30 00:00	2020-11-09 00:00	2021-03-19 00:00	2021-03-25 00:00	56.25198	-2.25365	494	NNG7	Y	Y	Y	
CPOD	2020C	NnG3	2020-10-30 00:00	2020-11-09 00:00	2021-03-19 00:00	2021-03-25 00:00	56.27228	-2.166717	495	3435	Y	Y	Y	
Logger	2020C	NnG3	2020-10-30 00:00	2020-11-09 00:00	2021-03-19 00:00	2021-03-25 00:00	56.27228	-2.166717	495	NNG6	Y	Y	Y	
CPOD	2020C	NnG4	2020-10-30 00:00	2020-11-09 00:00	2021-03-19 00:00	2021-03-25 00:00	56.27243	-2.09025	496	3433	Y	Y	Y	
Logger	2020C	NnG4	2020-10-30 00:00	2020-11-09 00:00	2021-03-19 00:00	2021-01-31 00:00	56.27243	-2.09025	496	NNG5	Y	Y	Y	
CPOD	2020C	Seagreen1	2020-10-30 00:00	2020-11-07 00:00	2021-03-18 00:00	2021-03-25 00:00	56.76168	-2.354567	487	3387	Y	Y	Y	
Logger	2020C	Seagreen1	2020-11-07 00:00	2020-11-07 00:00	2021-03-18 00:00	2021-03-18 00:00	56.76168	-2.354567	487	LSeagreen1x-4s	Y	Y	Y	
CPOD	2020C	Seagreen2	2020-10-30 00:00	2020-11-07 00:00	2021-03-18 00:00	2021-03-25 00:00	56.7159	-2.182617	488	3390	Y	Y	Y	
Logger	2020C	Seagreen2	2020-11-07 00:00	2020-11-07 00:00	2021-03-18 00:00	2021-03-18 00:00	56.7159	-2.182617	488	LSeagreen1x-1s	Y	Y	Y	
CPOD	2020C	Seagreen3	2020-10-30 00:00	2020-11-07 00:00	2021-03-17 00:00	2021-02-20 00:00	56.66108	-2.009167	489	3533	Y	Y	Y	
Logger	2020C	Seagreen3	2020-11-07 00:00	2020-11-07 00:00	2021-03-17 00:00	2021-03-17 00:00	56.66108	-2.009167	489	SG12	Y	Y	Y	
CPOD	2020C	Seagreen4	2020-10-30 00:00	2020-11-07 00:00	2021-03-17 00:00	2021-03-25 00:00	56.60995	-1.83605	490	3389	Y	Y	Y	
Logger	2020C	Seagreen4	2020-11-07 00:00	2020-11-07 00:00	2021-03-17 00:00	2021-03-17 00:00	56.60995	-1.83605	490	LSeagreen1x-3s	Y	Y	Y	
CPOD	2020C	Seagreen5	2020-10-30 00:00	2020-11-07 00:00	2021-03-17 00:00	2021-03-25 00:00	56.55472	-1.66755	491	3391	Y	Y	Y	
Logger	2020C	Seagreen5	2020-11-07 00:00	2020-11-07 00:00	2021-03-17 00:00	2021-03-17 00:00	56.55472	-1.66755	491	LSeagreen1x-5s	Y	Y	Y	
CPOD	2021A	NnG1	2021-03-20 00:00	2021-03-20 00:00	2021-06-08 00:00	2021-06-14 00:00	56.298	-2.31931667	526	3436	Y	Y	Y	
Logger	2021A	NnG1	2021-03-20 00:00	2021-03-20 00:00	2021-06-08 00:00	2021-06-14 00:00	56.298	-2.31931667	526	NNG1	Y	Y	Y	
CPOD	2021A	NnG2	2021-03-20 00:00	2021-03-20 00:00	2021-06-08 00:00	2021-06-14 00:00	56.2524167	-2.25398333	527	3437	Y	Y	Y	
Logger	2021A	NnG2	2021-03-20 00:00	2021-03-20 00:00	2021-06-08 00:00	2021-06-14 00:00	56.2524167	-2.25398333	527	NNG2	Y	Y	Y	
CPOD	2021A	NnG3	2021-03-20 00:00	2021-03-20 00:00	2021-06-08 00:00	2021-05-16 00:00	56.2727	-2.16695	528	3438	Y	Y	Y	
Logger	2021A	NnG3	2021-03-20 00:00	2021-03-20 00:00	2021-06-08 00:00	2021-06-14 00:00	56.2727	-2.16695	528	NNG9	Y	Y	Y	
CPOD	2021A	NnG4	2021-03-20 00:00	2021-03-20 00:00	2021-06-08 00:00	2021-06-14 00:00	56.272333	-2.0901	529	3439	Y	Y	Y	
Logger	2021A	NnG4	2021-03-20 00:00	2021-03-20 00:00	2021-06-08 00:00	2021-06-14 00:00	56.272333	-2.0901	529	NNG10	Y	Y	Y	
CPOD	2021A	Seagreen1	2021-02-25 00:00	2021-03-19 00:00	2021-06-08 00:00	2021-06-14 00:00	56.76258	-2.3538	518	3129	Y	Y	Y	
Logger	2021A	Seagreen1	2021-03-18 00:00	2021-03-19 00:00	2021-06-08 00:00	2021-06-08 00:00	56.76258	-2.3538	518	SG11	Y	Y	Y	
CPOD	2021A	Seagreen2	2021-02-25 00:00	2021-03-19 00:00	2021-06-08 00:00	2021-06-14 00:00	56.7164	-2.18208	519	3534	Y	Y	Y	
Logger	2021A	Seagreen2	2021-03-18 00:00	2021-03-19 00:00	2021-06-08 00:00	2021-06-08 00:00	56.7164	-2.18208	519	LSeagreen1x-10s	Y	Y	Y	
CPOD	2021A	Seagreen3	2021-02-20 00:00	2021-03-18 00:00	2021-06-08 00:00	2021-06-14 00:00	56.6611167	-2.00908333	520	3372	Y	Y	Y	
Logger	2021A	Seagreen3	2021-03-18 00:00	2021-03-18 00:00	2021-06-08 00:00	2021-06-08 00:00	56.6611167	-2.00908333	520	LSeagreen1x-9s	Y	Y	Y	

Device type	Deployment sequence	Site	Recording start (UTC)	Deployment start (UTC)	Deployment end (UTC)	Recording end (UTC)	Latitude (DD)	Longitude (DD)	Deployment number	Device number	Retrieved	Full dataset	Useable data	Notes
CPOD	2021A	Seagreen4	2021-02-22 00:00	2021-03-19 00:00	2021-06-08 00:00	2021-06-11 00:00	56.60961	-1.83611667	521	3386	Y	Y	Y	
Logger	2021A	Seagreen4	2021-03-18 00:00	2021-03-19 00:00	2021-06-08 00:00	2021-06-08 00:00	56.60961	-1.83611667	521	LSeagreen1x-7s	Y	Y	Y	
CPOD	2021A	Seagreen5	2021-02-27 00:00	2021-03-18 00:00	2021-06-06 00:00	2021-06-16 00:00	56.556333	-1.68451667	522	3385	Y	Y	Y	
Logger	2021A	Seagreen5	2021-03-18 00:00	2021-03-18 00:00	2021-06-06 00:00	2021-06-08 00:00	56.556333	-1.68451667	522	LSeagreen1x-8s	Y	Y	Y	
CPOD	2021B	NnG1	2021-05-22 00:00	2021-06-09 00:00	2021-11-22 00:00	2021-11-22 00:00	56.2981	-2.3189	590	3431	Y	Y	Y	
Logger	2021B	NnG1	2021-05-22 00:00	2021-06-09 00:00	2021-11-22 00:00	2021-07-05 00:00	56.2981	-2.3189	590	NNG5	Y	Y	Y	
CPOD	2021B	NnG2	2021-05-22 00:00	2021-06-09 00:00	2021-11-22 00:00	NA	56.2520167	-2.25381667	591	3433	Y	N	N	No data
Logger	2021B	NnG2	2021-05-22 00:00	2021-06-09 00:00	2021-11-22 00:00	2021-07-05 00:00	56.2520167	-2.25381667	591	NNG6	Y	Y	Y	
CPOD	2021B	NnG3	2021-05-21 00:00	2021-06-09 00:00	2021-11-22 00:00	NA	56.2722667	-2.16658333	592	3434	Y	N	N	No data
Logger	2021B	NnG3	2021-05-21 00:00	2021-06-09 00:00	2021-11-22 00:00	2021-07-07 00:00	56.2722667	-2.16658333	592	NNG7	Y	Y	Y	
CPOD	2021B	NnG4	2021-05-21 00:00	2021-06-09 00:00	2021-11-22 00:00	2021-09-12 00:00	56.2724	-2.09051667	593	3435	Y	N	Y	Stopped recording early
Logger	2021B	NnG4	2021-05-21 00:00	2021-06-09 00:00	2021-11-22 00:00	2021-07-05 00:00	56.2724	-2.09051667	593	NNG8	Y	Y	Y	
CPOD	2021B	Seagreen1	2021-05-21 00:00	2021-06-09 00:00	2021-11-17 00:00	2021-09-23 00:00	56.7626167	-2.35371667	585	3533	Y	N	Y	Stopped recording early
Logger	2021B	Seagreen1	2021-06-09 00:00	2021-06-09 00:00	2021-11-17 00:00	2021-07-05 00:00	56.7626167	-2.35371667	585	SG12	Y	Y	Y	
CPOD	2021B	Seagreen2	2021-05-21 00:00	2021-06-09 00:00	2021-11-17 00:00	NA	56.7158	-2.18271667	586	3384	N	N	N	No data
Logger	2021B	Seagreen2	2021-06-09 00:00	2021-06-09 00:00	2021-11-17 00:00	2021-08-21 00:00	56.7158	-2.18271667	586	LSeagreen1x-1s	Y	Y	Y	
CPOD	2021B	Seagreen3	2021-05-21 00:00	2021-06-09 00:00	2021-11-17 00:00	2021-11-19 00:00	56.6610833	-2.00921667	587	3389	Y	Y	Y	
Logger	2021B	Seagreen3	2021-06-09 00:00	2021-06-09 00:00	2021-11-17 00:00	2021-10-06 00:00	56.6610833	-2.00921667	587	LSeagreen1x-3s	Y	Y	Y	
CPOD	2021B	Seagreen4	2021-05-21 00:00	2021-06-09 00:00	NA	2021-06-25 00:00	56.6099667	-1.8356	588	3387	Y	N	Y	TRAWLED
Logger	2021B	Seagreen4	2021-06-09 00:00	2021-06-09 00:00	NA	2021-07-05 00:00	56.6099667	-1.8356	588	LSeagreen1x-6s	N	N	Y	TRAWLED
CPOD	2021B	Seagreen5	2021-05-21 00:00	2021-06-07 00:00	2021-11-17 00:00	2021-11-19 00:00	56.55625	-1.69368333	589	3391	Y	Y	Y	
Logger	2021B	Seagreen5	2021-06-09 00:00	2021-06-07 00:00	2021-11-17 00:00	2021-07-05 00:00	56.55625	-1.69368333	589	LSeagreen1x-4s	Y	Y	Y	
CPOD	2021C	NnG1	2021-11-05 00:00	2021-11-23 00:00	2022-03-15 00:00	2022-03-16 00:00	56.3	-2.32	632	3439	Y	Y	Y	

Device type	Deployment sequence	Site	Recording start (UTC)	Deployment start (UTC)	Deployment end (UTC)	Recording end (UTC)	Latitude (DD)	Longitude (DD)	Deployment number	Device number	Retrieved	Full dataset	Useable data	Notes
Logger	2021C	NnG1	2021-11-05 00:00	2021-11-23 00:00	2022-03-15 00:00	2022-03-16 00:00	56.3	-2.32	632	NNG9	Y	Y	Y	
CPOD	2021C	NnG2	2021-11-05 00:00	2021-11-23 00:00	2022-03-15 00:00	2022-12-19 00:00	56.252016	-2.253416	633	3438	Y	N	Y	
Logger	2021C	NnG2	2021-11-05 00:00	2021-11-23 00:00	2022-03-15 00:00	2022-03-16 00:00	56.252016	-2.253416	633	NNG10	Y	Y	Y	
CPOD	2021C	NnG3	2021-11-05 00:00	2021-11-23 00:00	2022-03-15 00:00	2022-03-16 00:00	56.2725	-2.166	634	3436	Y	Y	Y	
Logger	2021C	NnG3	2021-11-05 00:00	2021-11-23 00:00	2022-03-15 00:00	2022-03-16 00:00	56.2725	-2.166	634	NNG2	Y	Y	Y	
CPOD	2021C	NnG4	2021-11-05 00:00	2021-11-23 00:00	2022-03-15 00:00	2022-03-16 00:00	56.27188	-2.09005	635	3437	Y	Y	Y	
Logger	2021C	NnG4	2021-11-05 00:00	2021-11-23 00:00	2022-03-15 00:00	2022-03-16 00:00	56.27188	-2.09005	635	NNG1	Y	Y	Y	
CPOD	2021C	Seagreen1	2021-11-05 00:00	2021-11-18 00:00	2022-03-14 00:00	2022-03-16 00:00	56.7625	-2.353833	636	3129	Y	Y	Y	
Logger	2021C	Seagreen1	2021-11-18 00:00	2021-11-18 00:00	2022-03-14 00:00	2022-03-14 00:00	56.7625	-2.353833	636	SG11	Y	Y	Y	
CPOD	2021C	Seagreen2	2021-11-05 00:00	2021-11-18 00:00	2022-03-14 00:00	2022-03-16 00:00	56.716683	-2.181283	637	3386	Y	Y	Y	
Logger	2021C	Seagreen2	2021-11-18 00:00	2021-11-18 00:00	2022-03-14 00:00	2022-03-14 00:00	56.716683	-2.181283	637	LSeagreen1x-10s	Y	Y	Y	
CPOD	2021C	Seagreen3	2021-11-05 00:00	2021-11-18 00:00	2022-03-14 00:00	2022-03-16 00:00	56.6625	-2.008667	638	3492	Y	Y	Y	
Logger	2021C	Seagreen3	2021-11-18 00:00	2021-11-18 00:00	2022-03-14 00:00	2022-03-14 00:00	56.6625	-2.008667	638	LSeagreen1x-7s	Y	Y	Y	
CPOD	2021C	Seagreen4	2021-11-05 00:00	2021-11-18 00:00	2022-03-15 00:00	2022-03-16 00:00	56.61	-1.8365	639	3385	Y	Y	Y	
Logger	2021C	Seagreen4	2021-11-18 00:00	2021-11-18 00:00	2022-03-15 00:00	2022-03-15 00:00	56.61	-1.8365	639	LSeagreen1x-8s	Y	Y	Y	
CPOD	2021C	Seagreen5	2021-11-05 00:00	2021-11-18 00:00	2022-03-15 00:00	2022-03-16 00:00	56.55602	-1.693967	640	3534	Y	Y	Y	
Logger	2021C	Seagreen5	2021-11-18 00:00	2021-11-18 00:00	2022-03-15 00:00	2022-03-15 00:00	56.55602	-1.693967	640	LSeagreen1x-6s	Y	Y	Y	
CPOD	2022A	NnG1	2022-02-22 00:00	2022-03-16 00:00	2022-07-19 00:00	2022-07-22 00:00	56.2979	-2.31916	678	3434	Y	N	N	Did not record data
Logger	2022A	NnG1	2022-02-22 00:00	2022-03-16 00:00	2022-07-19 00:00	2022-07-18 00:00	56.2979	-2.31916	678	NNG8	Y	Y	Y	
CPOD	2022A	NnG2	2022-02-22 00:00	2022-03-16 00:00	2022-07-19 00:00	2022-07-22 00:00	56.25205	-2.25383	679	3431	Y	Y	Y	
Logger	2022A	NnG2	2022-02-22 00:00	2022-03-16 00:00	2022-07-19 00:00	2022-07-19 00:00	56.25205	-2.25383	679	NNG6	Y	Y	Y	
CPOD	2022A	NnG3	2022-02-16 00:00	2022-03-16 00:00	2022-07-19 00:00	2022-07-22 00:00	56.272317	-2.16675	680	3433	Y	Y	Y	
Logger	2022A	NnG3	2022-02-22 00:00	2022-03-16 00:00	2022-07-19 00:00	2022-07-13 00:00	56.272317	-2.16675	680	NNG7	Y	Y	Y	
CPOD	2022A	NnG4	2022-02-16 00:00	2022-03-16 00:00	2022-07-19 00:00	2022-07-22 00:00	56.272333	-2.09033	681	3435	Y	Y	Y	
Logger	2022A	NnG4	2022-02-22 00:00	2022-03-16 00:00	2022-07-19 00:00	2022-07-29 00:00	56.272333	-2.09033	681	NNG5	Y	Y	Y	
CPOD	2022A	Seagreen1	2022-02-12 00:00	2022-03-15 00:00	2022-07-17 00:00	2022-07-22 00:00	56.76243	-2.3544	673	3372	Y	Y	Y	
Logger	2022A	Seagreen1	2022-02-22 00:00	2022-03-15 00:00	2022-07-17 00:00	2022-07-17 00:00	56.76243	-2.3544	673	LSeagreen1x-3s	Y	Y	Y	
CPOD	2022A	Seagreen2	2022-02-16 00:00	2022-03-15 00:00	2022-07-18 00:00	2022-07-22 00:00	56.71583	-2.182667	674	3392	Y	Y	Y	
Logger	2022A	Seagreen2	2022-02-22 00:00	2022-03-15 00:00	2022-07-18 00:00	NA	56.71583	-2.182667	674	SG12	Y	N	N	Water ingress, no data, device retired
CPOD	2022A	Seagreen3	2022-02-12 00:00	2022-03-15 00:00	2022-07-17 00:00	2022-07-22 00:00	56.66108	-2.009017	675	3390	Y	Y	Y	
Logger	2022A	Seagreen3	2022-02-22 00:00	2022-03-15 00:00	2022-07-17 00:00	2022-07-14 00:00	56.66108	-2.009017	675	LSeagreen1x-9s	Y	Y	Y	

Device type	Deployment sequence	Site	Recording start (UTC)	Deployment start (UTC)	Deployment end (UTC)	Recording end (UTC)	Latitude (DD)	Longitude (DD)	Deployment number	Device number	Retrieved	Full dataset	Useable data	Notes
CPOD	2022A	Seagreen4	2022-02-16 00:00	2022-03-16 00:00	2022-07-17 00:00	2022-07-22 00:00	56.61	-1.836	676	3389	Y	Y	Y	
Logger	2022A	Seagreen4	2022-02-22 00:00	2022-03-16 00:00	2022-07-17 00:00	2022-07-17 00:00	56.61	-1.836	676	LSeagreen1x-1s	Y	Y	Y	
CPOD	2022A	Seagreen5	2022-02-22 00:00	2022-03-16 00:00	2022-07-18 00:00	2022-07-26 00:00	56.55633	-1.69367	677	3533	Y	Y	Y	
Logger	2022A	Seagreen5	2022-02-22 00:00	2022-03-16 00:00	2022-07-18 00:00	2022-07-17 00:00	56.55633	-1.69367	677	LSeagreen1x-4s	Y	Y	Y	
CPOD	2022B	NnG1	2022-06-23 00:00	2022-07-20 00:00	2022-11-26 00:00	2022-11-26 00:00	56.2979	-2.31916	707	3433	Y	Y	Y	
Logger	2022B	NnG1	2022-06-23 00:00	2022-07-20 00:00	2022-11-26 00:00	2022-12-02 00:00	56.2979	-2.31916	707	NNG-7	Y	Y	Y	
CPOD	2022B	NnG2	2022-06-23 00:00	2022-07-20 00:00	2022-11-26 00:00	2022-11-26 00:00	56.25306	-2.25388	708	3431	Y	Y	Y	
Logger	2022B	NnG2	2022-06-23 00:00	2022-07-20 00:00	2022-11-26 00:00	2022-12-02 00:00	56.25306	-2.25388	708	NNG-5	Y	Y	Y	
CPOD	2022B	NnG3	2022-06-23 00:00	2022-07-20 00:00	2022-11-26 00:00	2022-11-26 00:00	56.27233	-2.1667	709	3434	Y	Y	Y	
Logger	2022B	NnG3	2022-06-23 00:00	2022-07-20 00:00	2022-11-26 00:00	2022-11-26 00:00	56.27233	-2.1667	709	NNG-8	Y	Y	Y	
CPOD	2022B	NnG4	2022-06-23 00:00	2022-07-20 00:00	2022-11-26 00:00	2022-11-26 00:00	56.27228	-2.09016	710	3435	Y	Y	Y	
Logger	2022B	NnG4	2022-06-23 00:00	2022-07-20 00:00	2022-11-26 00:00	2022-12-02 00:00	56.27228	-2.09016	710	LSeagreen1-38	Y	Y	Y	
CPOD	2022B	Seagreen1	2022-06-23 00:00	2022-07-18 00:00	2022-11-25 00:00	2022-11-26 00:00	56.76255	-2.3543	711	3391	Y	Y	Y	
Logger	2022B	Seagreen1	2022-07-18 00:00	2022-07-18 00:00	2022-11-25 00:00	2022-11-15 00:00	56.76255	-2.3543	711	LSeagreen1x-8s	Y	Y	Y	
CPOD	2022B	Seagreen2	2022-07-08 00:00	2022-07-18 00:00	2022-11-25 00:00	2022-11-26 00:00	56.7158333	-2.18283333	727	3388	Y	Y	Y	
Logger	2022B	Seagreen2	2022-06-23 00:00	2022-07-18 00:00	2022-11-25 00:00	2022-12-02 00:00	56.7158333	-2.18283333	727	LSeagreen1x-10s	Y	Y	Y	
CPOD	2022B	Seagreen3	2022-06-23 00:00	2022-07-18 00:00	2022-11-25 00:00	2022-11-26 00:00	56.66033	-2.00923	712	3585	Y	Y	Y	
Logger	2022B	Seagreen3	2022-06-23 00:00	2022-07-18 00:00	2022-11-25 00:00	2022-12-02 00:00	56.66033	-2.00923	712	SG11	Y	Y	Y	
CPOD	2022B	Seagreen4	2022-06-23 00:00	2022-07-18 00:00	2022-11-25 00:00	2022-11-26 00:00	56.60958	-1.8357	713	3534	Y	Y	Y	
Logger	2022B	Seagreen4	2022-06-23 00:00	2022-07-18 00:00	2022-11-25 00:00	2022-12-02 00:00	56.60958	-1.8357	713	LSeagreen1x-7s	Y	Y	Y	
CPOD	2022B	Seagreen5	2022-06-23 00:00	2022-07-18 00:00	2022-11-25 00:00	2022-11-26 00:00	56.55578	-1.69465	714	3386	Y	Y	Y	
Logger	2022B	Seagreen5	2022-06-23 00:00	2022-07-18 00:00	2022-11-25 00:00	2022-12-02 00:00	56.55578	-1.69465	714	LSeagreen1x-6s	Y	Y	Y	
CPOD	2022C	NnG1	2022-11-04 00:00	2022-11-27 00:00	2023-03-28 00:00	2023-04-03 00:00	56.2981333	-2.31931667	732	3433	Y	Y	Y	
Logger	2022C	NnG1	2022-11-03 00:00	2022-11-27 00:00	2023-03-28 00:00	2023-03-31 00:00	56.2981333	-2.31931667	732	NNG-7	Y	Y	Y	
CPOD	2022C	NnG2	2022-11-04 00:00	2022-11-27 00:00	2023-03-28 00:00	2023-04-03 00:00	56.2521333	-2.2538	733	3431	Y	Y	Y	
Logger	2022C	NnG2	2022-11-03 00:00	2022-11-27 00:00	2023-03-28 00:00	2023-03-28 00:00	56.2521333	-2.2538	733	NNG-5	Y	Y	Y	
CPOD	2022C	NnG3	2022-11-04 00:00	2022-11-27 00:00	2023-03-28 00:00	2023-04-03 00:00	56.2722833	-2.16668333	734	3434	Y	Y	Y	
Logger	2022C	NnG3	2022-11-03 00:00	2022-11-27 00:00	2023-03-28 00:00	2022-11-04 00:00	56.2722833	-2.16668333	734	NNG-8	Y	N	N	No data

Device type	Deployment sequence	Site	Recording start (UTC)	Deployment start (UTC)	Deployment end (UTC)	Recording end (UTC)	Latitude (DD)	Longitude (DD)	Deployment number	Device number	Retrieved	Full dataset	Useable data	Notes
CPOD	2022C	NnG4	2022-11-04 00:00	2022-11-27 00:00	2023-03-28 00:00	2023-04-03 00:00	56.2724	-2.09051667	735	3435	Y	Y	Y	
Logger	2022C	NnG4	2022-11-03 00:00	2022-11-27 00:00	2023-03-28 00:00	2023-03-28 00:00	56.2724	-2.09051667	735	LSeagreen1-3	Y	Y	Y	
CPOD	2022C	Seagreen1	2022-11-04 00:00	2022-11-26 00:00	2023-03-27 00:00	2023-03-27 00:00	56.7622667	-2.35451667	738	3492	Y	Y	Y	
Logger	2022C	Seagreen1	2022-11-03 00:00	2022-11-26 00:00	2023-03-27 00:00	2023-03-31 00:00	56.7622667	-2.35451667	738	LSeagreen1x-4s	Y	Y	Y	
CPOD	2022C	Seagreen2	2022-11-04 00:00	2022-11-26 00:00	2023-03-29 00:00	2023-04-04 00:00	56.7158667	-2.1825	728	3372	Y	Y	Y	
Logger	2022C	Seagreen2	2022-11-03 00:00	2022-11-26 00:00	2023-03-29 00:00	2023-03-27 00:00	56.7158667	-2.1825	728	LSeagreen1x-24	Y	Y	Y	
CPOD	2022C	Seagreen3	2022-11-04 00:00	2022-11-26 00:00	2023-03-29 00:00	2023-04-04 00:00	56.6608833	-2.00873333	729	3390	Y	Y	Y	
Logger	2022C	Seagreen3	2022-11-03 00:00	2022-11-26 00:00	2023-03-29 00:00	NA	56.6608833	-2.00873333	729	LSeagreen1x-9s	Y	N	N	No data
CPOD	2022C	Seagreen4	2022-11-04 00:00	2022-11-26 00:00	2023-03-29 00:00	2023-04-04 00:00	56.60995	-1.83596667	730	3392	Y	Y	Y	
Logger	2022C	Seagreen4	2022-11-05 00:00	2022-11-26 00:00	2023-03-29 00:00	2023-03-28 00:00	56.60995	-1.83596667	730	LSeagreen1x-3s	Y	Y	Y	
CPOD	2022C	Seagreen5	2022-11-04 00:00	2022-11-26 00:00	2023-03-29 00:00	2023-04-04 00:00	56.55625	-1.69383333	731	3389	Y	Y	Y	
Logger	2022C	Seagreen5	2022-11-03 00:00	2022-11-26 00:00	2023-03-29 00:00	2023-03-28 00:00	56.55625	-1.69383333	731	LSeagreen1x-1s	Y	Y	Y	
CPOD	2023A	NnG1	2023-02-21 00:00	2023-03-29 00:00	2023-06-17 00:00	2023-06-21 00:00	56.29813	-2.31931	796	3436	Y	Y	Y	
Logger	2023A	NnG1	2023-03-10 00:00	2023-03-29 00:00	2023-06-17 00:00	2023-06-21 00:00	56.29813	-2.31931	796	NNG-1	Y	Y	Y	
CPOD	2023A	NnG2	2023-02-21 00:00	2023-03-29 00:00	2023-06-17 00:00	2023-06-21 00:00	56.25213	-2.2538	801	3439	Y	Y	Y	
Logger	2023A	NnG2	2023-03-10 00:00	2023-03-29 00:00	2023-06-17 00:00	2023-06-21 00:00	56.25213	-2.2538	801	NNG-10	Y	Y	Y	
CPOD	2023A	NnG3	2023-02-21 00:00	2023-03-29 00:00	2023-06-17 00:00	2023-06-21 00:00	56.27228	-2.16668	802	3430	Y	Y	Y	
Logger	2023A	NnG3	2023-03-10 00:00	2023-03-29 00:00	2023-06-17 00:00	2023-06-21 00:00	56.27228	-2.16668	802	NNG-9	Y	Y	Y	
CPOD	2023A	NnG4	2023-02-21 00:00	2023-03-29 00:00	2023-06-17 00:00	2023-06-21 00:00	56.2724	-2.09051	803	3437	Y	Y	Y	
Logger	2023A	NnG4	2023-03-10 00:00	2023-03-29 00:00	2023-06-17 00:00	2023-06-21 00:00	56.2724	-2.09051	803	NNG-2	Y	Y	Y	
CPOD	2023A	Seagreen1	2023-02-22 00:00	2023-03-28 00:00	2023-06-15 00:00	2023-06-21 00:00	56.76226	-2.35451	804	3386	Y	Y	Y	
Logger	2023A	Seagreen1	2023-03-10 00:00	2023-03-28 00:00	2023-06-15 00:00	2023-06-21 00:00	56.76226	-2.35451	804	LSeagreen1x-6s	Y	Y	Y	
CPOD	2023A	Seagreen2	2023-02-22 00:00	2023-03-28 00:00	2023-06-15 00:00	2023-06-21 00:00	56.71585	-2.18246	805	3534	Y	Y	Y	
Logger	2023A	Seagreen2	2023-03-10 00:00	2023-03-28 00:00	2023-06-15 00:00	2023-06-21 00:00	56.71585	-2.18246	805	LSeagreen1x-8s	Y	Y	Y	
CPOD	2023A	Seagreen3	2023-02-22 00:00	2023-03-30 00:00	2023-06-15 00:00	2023-06-21 00:00	56.66088	-2.00873	806	3391	Y	Y	Y	
Logger	2023A	Seagreen3	2023-03-10 00:00	2023-03-30 00:00	2023-06-15 00:00	2023-06-21 00:00	56.66088	-2.00873	806	SG11	Y	Y	Y	
CPOD	2023A	Seagreen4	2023-02-22 00:00	2023-03-30 00:00	2023-06-15 00:00	2023-06-21 00:00	56.60995	-1.83596	807	3129	Y	Y	Y	

Device type	Deployment sequence	Site	Recording start (UTC)	Deployment start (UTC)	Deployment end (UTC)	Recording end (UTC)	Latitude (DD)	Longitude (DD)	Deployment number	Device number	Retrieved	Full dataset	Useable data	Notes
Logger	2023A	Seagreen4	2023-03-10 00:00	2023-03-30 00:00	2023-06-15 00:00	2023-06-21 00:00	56.60995	-1.83596	807	LSeagreen1x-10s	Y	Y	Y	
CPOD	2023A	Seagreen5	2023-02-22 00:00	2023-03-30 00:00	2023-06-15 00:00	2023-06-21 00:00	56.55625	-1.69383	789	3389	Y	Y	Y	
Logger	2023A	Seagreen5	2023-03-09 00:00	2023-03-30 00:00	2023-06-15 00:00	2023-06-21 00:00	56.55625	-1.69383	789	LSeagreen1x-7s	Y	Y	N	
CPOD	2023B	NnG1	2023-06-02 00:00	2023-06-18 00:00	2024-02-01 00:00	2024-01-13 00:00	56.29815	-2.31928	852	3435	Y	N	Y	
Logger	2023B	NnG1	2023-06-02 00:00	2023-06-18 00:00	2024-02-01 00:00	2023-12-03 00:00	56.29815	-2.31928	852	LSeagreen1x-24	Y	N	Y	
CPOD	2023B	NnG2	2023-06-02 00:00	2023-06-18 00:00	2024-02-01 00:00	2024-01-08 00:00	56.25211	-2.25371	853	3431	Y	N	Y	
Logger	2023B	NnG2	2023-06-02 00:00	2023-06-18 00:00	2024-02-01 00:00	2023-12-03 00:00	56.25211	-2.25371	853	NNG-8	Y	N	Y	
CPOD	2023B	NnG3	2023-06-02 00:00	2023-06-18 00:00	2024-02-01 00:00	2024-01-13 00:00	56.27231	-2.16656	854	3433	Y	N	Y	
Logger	2023B	NnG3	2023-06-02 00:00	2023-06-18 00:00	2024-02-01 00:00	2023-12-03 00:00	56.27231	-2.16656	854	NNG-7	Y	N	Y	
CPOD	2023B	NnG4	2023-06-03 00:00	2023-06-18 00:00	2024-02-01 00:00	2024-01-11 00:00	56.27231	-2.09073	855	3434	Y	N	Y	
Logger	2023B	NnG4	2023-06-02 00:00	2023-06-18 00:00	2024-02-01 00:00	2023-12-03 00:00	56.27231	-2.09073	855	NNG-5	Y	N	Y	
CPOD	2023B	Seagreen1	2023-06-01 00:00	2023-06-16 00:00	2024-02-07 00:00	2023-12-09 00:00	56.76	-2.35	856	3392	Y	N	Y	
Logger	2023B	Seagreen1	2023-06-16 00:00	2023-06-16 00:00	2024-02-07 00:00	2023-12-11 00:00	56.76	-2.35	856	LSeagreen1-3	Y	N	Y	
CPOD	2023B	Seagreen2	2023-06-01 00:00	2023-06-16 00:00	NA	NA	56.72	-2.18	857	NA	N	N	N	Mooring missing
Logger	2023B	Seagreen2		2023-06-16 00:00	NA	NA	56.72	-2.18	857	LSeagreen1x-23	N	N	N	Mooring missing
CPOD	2023B	Seagreen3	2023-06-01 00:00	2023-06-16 00:00	2024-02-07 00:00	2024-01-08 00:00	56.66	-2.01	858	3492	Y	N	Y	
Logger	2023B	Seagreen3	2023-06-16 00:00	2023-06-16 00:00	2024-02-07 00:00	2023-12-11 00:00	56.66	-2.01	858	LSeagreen1x-1s	Y	N	Y	
CPOD	2023B	Seagreen4	2023-06-01 00:00	2023-06-16 00:00	2024-02-07 00:00	2023-12-18 00:00	56.61	-1.84	859	3390	Y	N	Y	
Logger	2023B	Seagreen4	2023-06-16 00:00	2023-06-16 00:00	2024-02-07 00:00	2023-12-11 00:00	56.61	-1.84	859	LSeagreen1x-9s	Y	N	Y	
CPOD	2023B	Seagreen5	2023-06-01 00:00	2023-06-16 00:00	2024-02-07 00:00	2024-01-15 00:00	56.55	-1.67	860	3372	Y	N	Y	
Logger	2023B	Seagreen5	2023-06-16 00:00	2023-06-16 00:00	2024-02-07 00:00	2023-12-11 00:00	56.55	-1.67	860	LSeagreen1x-3s	Y	N	Y	
CPOD	2023C	NnG1	2023-11-02 00:00	2024-02-02 00:00	NA	NA	56.2979	-2.31955	892	3439	N	N	N	Mooring missing
Logger	2023C	NnG1	2023-01-25 00:00	2024-02-02 00:00	NA	NA	56.2979	-2.31955	892	NNG-9	N	N	N	Mooring missing
CPOD	2023C	NnG2	2023-11-02 00:00	2024-02-02 00:00	2024-06-30 00:00	2024-06-29 00:00	56.25227	-2.25346	893	3430	Y	Y	Y	
Logger	2023C	NnG2	2023-01-25 00:00	2024-02-02 00:00	2024-06-30 00:00	2024-07-04 00:00	56.25227	-2.25346	893	NNG-1	Y	Y	Y	
CPOD	2023C	NnG3	2023-11-02 00:00	2024-02-02 00:00	2024-06-30 00:00	2024-06-29 00:00	56.27267	-2.16656	894	3437	Y	Y	Y	
Logger	2023C	NnG3	2023-01-25 00:00	2024-02-02 00:00	2024-06-30 00:00	NA	56.27267	-2.16656	894	NNG-2	Y	N	N	No data provided for this deployment
CPOD	2023C	NnG4	2023-11-02 00:00	2024-02-02 00:00	2024-06-30 00:00	2024-06-25 00:00	56.27237	-2.09075	895	3436	Y	Y	Y	
Logger	2023C	NnG4	2023-01-25 00:00	2024-02-02 00:00	2024-06-30 00:00	2024-07-04 00:00	56.27237	-2.09075	895	NNG-10	Y	Y	Y	
CPOD	2023C	Seagreen1	2023-11-02 00:00	2024-02-08 00:00	NA	NA	56.76228	-2.3547	905	3533	N	N	N	Mooring missing
Logger	2023C	Seagreen1	2023-01-25 00:00	2024-02-08 00:00	NA	NA	56.76228	-2.3547	905	SG11	N	N	N	Mooring missing

Device type	Deployment sequence	Site	Recording start (UTC)	Deployment start (UTC)	Deployment end (UTC)	Recording end (UTC)	Latitude (DD)	Longitude (DD)	Deployment number	Device number	Retrieved	Full dataset	Useable data	Notes
CPOD	2023C	Seagreen2	2023-11-02 00:00	2024-02-08 00:00	2024-06-06 00:00	2024-05-26 00:00	56.70136	-2.18263	902	3391	Y	N	Y	Handed in by fisherman, probably trawled 2024-05-26
Logger	2023C	Seagreen2	2023-01-25 00:00	2024-02-08 00:00	2024-06-06 00:00	2024-05-26 00:00	56.70136	-2.18263	902	LSeagreen1x-8s	Y	N	Y	Handed in by fisherman, probably trawled 2024-05-26
CPOD	2023C	Seagreen3	2023-11-02 00:00	2024-02-08 00:00	NA	NA	56.66151	-2.00901	903	3534	N	N	N	Mooring missing
Logger	2023C	Seagreen3	2023-01-25 00:00	2024-02-08 00:00	NA	NA	56.66151	-2.00901	903	LSeagreen1x-7x	N	N	N	Mooring missing
CPOD	2023C	Seagreen4	2023-11-02 00:00	2024-02-08 00:00	NA	NA	56.61003	-1.83621	904	3386	N	N	N	Mooring missing
Logger	2023C	Seagreen4	2023-01-25 00:00	2024-02-08 00:00	NA	NA	56.61003	-1.83621	904	LSeagreen1x-10	N	N	N	Mooring missing
CPOD	2023C	Seagreen5	2023-11-02 00:00	2024-02-08 00:00	2024-06-26 00:00	2024-07-04 00:00	56.55418	-1.66721	901	3385	Y	Y	Y	
Logger	2023C	Seagreen5	2023-01-25 00:00	2024-02-08 00:00	2024-06-26 00:00	2024-07-04 00:00	56.55418	-1.66721	901	LSeagreen1x-6s	Y	Y	Y	
CPOD	2024A	NnG1	2024-05-24 00:00	2024-07-01 00:00	2024-12-11 00:00	2024-12-11 00:00	56.29829	-2.32254	929	3435	Y	Y	Y	
Logger	2024A	NnG1	2024-05-31 00:00	2024-07-01 00:00	2024-12-11 00:00	2024-12-01 00:00	56.29829	-2.32254	929	NNG-5	Y	N	Y	Logger ran out of memory
CPOD	2024A	NnG2	2024-05-24 00:00	2024-07-01 00:00	2024-12-11 00:00	2024-12-11 00:00	56.25221	-2.25403	930	3431	Y	Y	Y	
Logger	2024A	NnG2	2024-05-31 00:00	2024-07-04 00:00	2024-12-11 00:00	2024-12-01 00:00	56.25221	-2.25403	930	NNG-8	Y	N	Y	Logger ran out of memory
CPOD	2024A	NnG3	2024-05-24 00:00	2024-07-01 00:00	2024-12-11 00:00	2024-12-11 00:00	56.2722	-2.16652	931	3434	Y	Y	Y	
Logger	2024A	NnG3	2024-05-31 00:00	2024-07-01 00:00	2024-12-11 00:00	2024-12-01 00:00	56.2722	-2.16652	931	NNG-6	Y	N	Y	Logger ran out of memory
CPOD	2024A	NnG4	2024-05-24 00:00	2024-07-01 00:00	2024-12-11 00:00	2024-12-11 00:00	56.27245	-2.09094	932	3433	Y	Y	Y	
Logger	2024A	NnG4	2024-05-31 00:00	2024-07-01 00:00	2024-12-11 00:00	2024-12-01 00:00	56.27245	-2.09094	932	NNG-7	Y	N	Y	Logger ran out of memory
CPOD	2019	St Abbs 5	2019-03-28 10:56:00	2019-03-28 14:04:00	2019-07-29 08:33:00	2019-08-06 10:57:00	55.92915	-2.17695	373	3121		Y	Y	
Logger	2019	St Abbs 5	2019-03-29 00:00:00	2019-03-28 14:04:00	2019-07-29 08:33:00	2019-07-29 00:00:00	55.92915	-2.17695	373	LS1-4	Y	Y	Y	
CPOD	2019	St Abbs 10	2019-03-11 11:23:00	2019-03-28 13:37:00	2019-07-29 09:31:00	2019-08-06 10:27:00	55.96345	-2.16195	374	3371		Y	Y	Led was off when opened.
CPOD	2019	St Abbs 15	2019-03-11 11:23:00	2019-03-28 12:59:00	2019-07-29 11:06:00	2019-08-06 10:27:00	56.033367	-2.075433	375	3369		Y	Y	
CPOD	2019	St Andrews 5	2019-03-11 11:33:00	2019-03-28 10:31:00			56.265333	-2.571217	376	3368		N	N	Missing mooring
CPOD	2019	St Andrews 10	2019-03-11 11:33:00	2019-03-28 09:53:00	2019-07-28 14:40:00	2019-08-06 10:48:00	56.258267	-2.501817	377	2427		Y	Y	
Logger	2019	St Andrews 10	2019-03-29 00:00:00	2019-03-28 09:53:00	2019-07-28 14:40:00	2019-07-28 00:00:00	56.258267	-2.501817	377	LS1-3	Y	Y	Y	
CPOD	2019	St Andrews 15	2019-03-01 11:47:00	2019-03-28 09:30:00	2019-07-28 13:48:00	2019-08-06 10:48:00	56.29	-2.432983	378	1909		Y	Y	
CPOD	2019	Arbroath 15	2019-03-11 11:23:00	2019-03-28 08:13:00	2019-07-28 12:02:00	2019-08-06 10:48:00	56.459683	-2.29855	379	3370		Y	Y	
CPOD	2019	Arbroath 10	2019-03-22 11:49:00	2019-03-27 17:57:00	2020-07-15 00:00:00	2019-07-28 00:00:00	56.499783	-2.380133	380	3122		Y	Y	Late recovery, not initially surfaced. Actual end of recording 2019-10-18 03:42:00 but changed to day before following deployment at same site (dep_num 397) to avoid overlapping data from same days at same site

Device type	Deployment sequence	Site	Recording start (UTC)	Deployment start (UTC)	Deployment end (UTC)	Recording end (UTC)	Latitude (DD)	Longitude (DD)	Deployment number	Device number	Retrieved	Full dataset	Useable data	Notes
Logger	2019	Arbroath 10	2019-03-28 00:00:00	2019-03-27 17:57:00	2020-07-15 00:00:00	2019-07-15 00:00:00	56.499783	-2.380133	380	LS1-2	Y	Y	Y	Late recovery, not initially surfaced
CPOD	2019	Arbroath 5	2019-03-01 11:47:00	2019-03-27 17:04:54	2019-07-28 09:19:00	2019-08-06 11:07:00	56.553983	-2.48335	381	3128		Y	Y	
CPOD	2019	Stonehaven 5	2019-03-01 11:47:00	2019-03-27 14:24:54	2019-07-27 17:02:00	2019-08-06 10:48:00	56.947233	-2.177117	382	1898		Y	Y	
Logger	2019	Stonehaven 5	2019-03-28 00:00:00	2019-03-27 14:24:54	2019-07-27 17:02:00	2019-07-27 00:00:00	56.947233	-2.177117	382	LS1-1	Y	Y	Y	
CPOD	2019	Stonehaven 15	2019-03-11 11:33:00	2019-03-27 13:43:00	2019-07-27 14:42:00	2019-08-06 11:14:00	56.980633	-2.02175	383	2904		Y	Y	
CPOD	2019	Stonehaven 10	2019-03-01 11:47:00	2019-03-27 14:07:00	2019-07-27 00:00:00	2019-07-27 19:56:00	56.959383	-2.113383	384	2795		Y	Y	Late recovery
CPOD	2019	St Abbs 15	2019-07-19 15:42:00	2019-07-29 11:28:00	2019-11-20 12:34:00	2019-12-04 14:40:00	56.03335	-2.075117	392	2896		Y	Y	
CPOD	2019	St Andrews 15	2019-07-19 15:42:00	2019-07-28 14:11:00			56.29005	-2.433067	393	1894		N	N	Mooring missing
CPOD	2019	Arbroath 5	2019-07-19 14:29:00	2019-07-28 09:46:00	2020-07-15 00:00:00	2020-02-14 16:23:00	56.554067	-2.483267	396	2906		Y	Y	Late recovery using ROV
CPOD	2019	Arbroath 10	2019-07-19 14:29:00	2019-07-28 11:28:00	2019-11-19 10:28:00	2019-12-04 15:05:00	56.49987	-2.3799	397	2196		Y	Y	
Logger	2019	Arbroath 10	2019-07-29 00:00:00	2019-07-28 11:28:00	2019-11-19 10:28:00	2019-11-19 00:00:00	56.49987	-2.3799	397	LS1x-5	Y	Y	Y	
CPOD	2019	St Abbs 5	2019-07-19 14:29:00	2019-07-29 09:08:00	2020-07-15 00:00:00	2019-10-08 11:13:00	55.92947	-2.16933	399	2897		N	Y	Stopped early
Logger	2019	St Abbs 5	2019-07-30 00:00:00	2019-07-29 09:08:00	2020-07-15 00:00:00	2019-10-08 00:00:00	55.92947	-2.16933	399	LS1x-3	Y	N	Y	Data exists but device was trawled - WAV folder named 'trawled' was excluded from the analysis
CPOD	2019	Arbroath 15	2019-07-19 13:23:00	2019-07-28 12:26:00	2020-07-15 00:00:00	2020-01-26 09:07:00	56.459683	-2.29855	400	2188		Y	Y	Late recovery using ROV
CPOD	2019	Stonehaven 15	2019-07-19 13:23:00	2019-07-27 15:07:00	2019-11-18 08:31:00	2019-12-04 15:32:00	56.98061	-2.0217	401	2800		Y	Y	
CPOD	2019	St Abbs 10	2019-07-19 13:23:00	2019-07-29 09:56:00	2019-11-20 13:22:00	2019-12-04 15:39:00	55.9635	-2.161912	402	2901		Y	Y	
CPOD	2019	St Andrews 5	2019-07-18 15:04:00	2019-07-28 16:21:00	2019-11-19 14:50:00	2019-12-04 15:46:00	56.265283	-2.57125	403	1913		Y	Y	
CPOD	2019	St Andrews 10	2019-07-18 15:04:00	2019-07-28 15:04:00	2019-11-19 00:00:00	2019-12-04 15:56:00	56.25835	-2.50163	404	2485		Y	Y	
Logger	2019	St Andrews 10	2019-07-29 00:00:00	2019-07-28 15:04:00	2019-11-19 00:00:00	2019-11-19 00:00:00	56.25835	-2.50163	404	LS1x-13	Y	Y	Y	
CPOD	2019	Stonehaven 5	2019-07-18 15:04:00	2019-07-27 17:40:00	2019-11-18 09:40:00	2019-12-04 14:16:00	56.94727	-2.17693	408	2902		Y	Y	
Logger	2019	Stonehaven 5	2019-07-28 00:00:00	2019-07-27 17:40:00	2019-11-18 09:40:00	2019-11-18 00:00:00	56.94727	-2.17693	408	LS1x-12	Y	Y	Y	

Device type	Deployment sequence	Site	Recording start (UTC)	Deployment start (UTC)	Deployment end (UTC)	Recording end (UTC)	Latitude (DD)	Longitude (DD)	Deployment number	Device number	Retrieved	Full dataset	Useable data	Notes
CPOD	2019	Stonehaven 10	2019-07-17 15:27:00	2019-07-27 16:35:00	2019-11-18 09:13:00	2019-12-04 05:57:00	56.95948	-2.113217	410	1901		N	Y	Stopped early
CPOD	2019	Arbroath 10	2019-11-12 14:32:00	2019-11-19 10:38:00	2020-03-23 11:19:00	2020-03-23 12:09:00	56.49965	-2.37921	437	2430		Y	Y	
Logger	2019	Arbroath 10	2019-11-20 00:00:00	2019-11-19 10:38:00	2020-03-23 11:19:00	2020-03-23 00:00:00	56.49965	-2.37921	437	LS1-4	Y	N	Y	
CPOD	2020	Stonehaven 5	2020-03-19 16:52:00	2020-03-21 10:19:00	2020-07-14 11:36:00	2020-03-21 10:05:00	56.94713	-2.177667	443	2428		N	N	Stopped before deployment
Logger	2020	Stonehaven 5	2020-03-22 00:00:00	2020-03-21 10:19:00	2020-07-14 11:36:00	2020-07-14 00:00:00	56.94713	-2.177667	443	LS1X-12	Y	Y	Y	
CPOD	2020	Stonehaven 10	2020-03-19 17:11:00	2020-03-21 10:01:00	2020-07-14 10:50:00	2020-07-20 14:57:00	56.95938	-2.1132	444	3134		Y	Y	
CPOD	2020	Stonehaven 15	2020-03-19 17:50:00	2020-03-21 09:24:00			56.9805	-2.021733	445	2484		N	N	Data missing (Unkown reasons), Stopped early
CPOD	2020	St Abbs 15	2020-03-19 17:34:00	2020-03-22 12:39:00	2020-09-21 19:43:00	2021-06-14 00:00:00	56.03517	-2.081667	455	2794		Y	Y	
CPOD	2020	St Abbs 10	2020-03-19 16:50:00	2020-03-22 13:15:00	2020-07-15 16:25:00	2020-07-20 16:25:00	55.96343	-2.161783	456	2465		Y	Y	
CPOD	2020	St Abbs 5	2020-03-19 16:48:00	2020-03-22 13:32:00	2020-07-15 16:51:00	2020-07-20 15:19:00	55.929	-2.177167	457	3128		Y	Y	
Logger	2020	St Abbs 5	2020-03-23 00:00:00	2020-03-22 13:32:00	2020-07-15 16:51:00	2020-07-15 00:00:00	55.929	-2.177167	457	LS1-15	Y	Y	Y	
CPOD	2020	St Andrews 5	2020-03-19 17:46:00	2020-03-23 08:54:00	2020-07-16 11:02:00	2020-07-20 15:19:00	56.26533	-2.57115	458	3123		Y	Y	
CPOD	2020	St Andrews 10	2020-03-19 16:42:00	2020-03-23 09:12:00	2020-07-16 10:23:00	2020-07-20 15:19:00	56.2584	-2.501417	459	3370		Y	Y	
Logger	2020	St Andrews 10	2020-03-24 00:00:00	2020-03-23 09:12:00	2020-07-16 10:23:00	2020-06-20 00:00:00	56.2584	-2.501417	459	LS1-10	Y	N	Y	
CPOD	2020	St Andrews 15	2020-03-19 17:50:00	2020-03-23 09:33:00	2020-07-16 12:02:00	2020-07-20 15:22:00	56.29015	-2.432817	460	2803		Y	Y	
CPOD	2020	Arbroath 15	2020-03-19 16:55:00	2020-03-23 10:49:00	2020-07-15 10:03:00	2020-07-20 16:36:00	56.45973	-2.29865	461	3121		Y	Y	
CPOD	2020	Arbroath 10	2020-03-19 17:41:00	2020-03-23 11:29:00	2020-07-15 09:01:00	2020-07-20 14:49:00	56.49885	-2.380867	462	3369		Y	Y	
Logger	2020	Arbroath 10	2020-03-19 17:41:00	2020-03-23 11:29:00	2020-07-15 09:01:00		56.49885	-2.380867	462	LS1x-13		N	N	No data or additional metadata provided for this mooring
CPOD	2020	Arbroath 5	2020-03-19 16:58:00	2020-03-23 12:08:00	2020-07-15 07:30:00	2020-11-09 14:26:00	56.55455	-2.483833	463	2896		Y	Y	
CPOD	2020	Stonehaven 15	2020-07-09 15:13:00	2020-07-14 10:28:00	2020-11-03 15:47:00	2020-11-09 14:26:00	56.97492	-2.019767	465	3373		Y	Y	
CPOD	2020	Stonehaven 10	2020-07-09 14:57:00	2020-07-14 11:13:00	2020-11-04 13:33:00	2020-11-09 14:23:00	56.95937	-2.113667	466	2904		Y	Y	

Device type	Deployment sequence	Site	Recording start (UTC)	Deployment start (UTC)	Deployment end (UTC)	Recording end (UTC)	Latitude (DD)	Longitude (DD)	Deployment number	Device number	Retrieved	Full dataset	Useable data	Notes
CPOD	2020	Stonehaven 5	2020-07-09 15:09:00	2020-07-14 11:44:00	2020-11-04 13:58:00	2020-11-09 14:27:00	56.94708	-2.177633	467	3127		Y	Y	
Logger	2020	Stonehaven 5	2020-07-15 00:00:00	2020-07-14 11:44:00	2020-11-04 13:58:00	2020-10-01 00:00:00	56.94708	-2.177633	467	LS1-9	Y	N	Y	
CPOD	2020	Arbroath 5	2020-07-08 12:17:00	2020-07-15 08:11:00	2020-11-07 13:48:00	2020-11-09 14:14:00	56.55365	-2.48353	473	2798		Y	Y	
CPOD	2020	Arbroath 10	2020-07-13 14:55:00	2020-07-15 09:37:00	2020-11-07 13:03:00	2020-11-09 00:00:00	56.49972	-2.38	474	2485		N	N	Data stopped 3 hours before deployment. Card dislodged.
Logger	2020	Arbroath 10	2020-07-16 00:00:00	2020-07-15 09:37:00	2020-11-07 13:03:00	2020-11-07 00:00:00	56.49972	-2.38	474	LS1-8	Y	Y	Y	
CPOD	2020	Arbroath 15	2020-07-13 15:11:00	2020-07-15 10:39:00	2020-11-07 12:25:00	2020-07-13 19:39:00	56.45965	-2.286517	475	3124		N	N	Data stopped after 4 hours 28 (time when loading on the boat)
CPOD	2020	St Abbs 15	2020-07-13 16:14:00	2020-07-15 15:51:00	2020-09-16 20:00:00	2020-10-29 12:38:00	56.03512	-2.081667	480	1909		Y	Y	Recovered by trawler
CPOD	2020	St Abbs 10	2020-07-13 15:47:00	2020-07-15 16:33:00	2020-11-09 13:00:00	2020-11-09 14:05:00	55.96342	-2.161783	481	2482		Y	Y	
CPOD	2020	St Abbs 5	2020-07-10 11:28:00	2020-07-15 16:58:00			55.92902	-2.177133	482	2898		N	N	Mooring Missing
Logger	2020	St Abbs 5	2020-07-10 11:28:00	2020-07-15 16:58:00			55.92902	-2.177133	482	LS1-7	N	N	N	Mooring Missing
CPOD	2020	St Andrews 10	2020-07-13 15:08:00	2020-07-16 10:36:00	2020-11-07 10:36:00	2020-11-09 13:29:00	56.2584	-2.501417	483	2897		Y	Y	
Logger	2020	St Andrews 10	2020-07-17 00:00:00	2020-07-16 10:36:00	2020-11-07 10:36:00	2020-11-07 00:00:00	56.2584	-2.501417	483	LS1-1	Y	Y	Y	
CPOD	2020	St Andrews 5	2020-07-10 10:44:00	2020-07-16 11:25:00	2020-11-07 10:12:00	2020-07-13 07:00:00	56.26528	-2.571133	484	2430		N	N	Data stopped 0700 13/7/20 (before deployment)
CPOD	2020	St Andrews 15	2020-07-13 15:01:00	2020-07-16 12:19:00	2020-11-07 11:06:00	2020-11-09 14:06:00	56.29015	-2.432817	485	3131		Y	Y	
CPOD	2020	Arbroath 10	2020-10-29 16:21:00	2020-11-07 13:00:00	2021-03-18 14:10:00	2021-03-25 10:43:00	56.49978	-2.381383	492	3434		Y	Y	
Logger	2020	Arbroath 10	2020-11-08 00:00:00	2020-11-07 13:00:00	2021-03-18 14:10:00	2021-03-18 00:00:00	56.49978	-2.381383	492	LS1x-3	Y	Y	Y	Gain set to 2.05 dB instead of default 12.4
CPOD	2021	St Abbs 5	2021-02-24 13:30:00	2021-03-20 12:45:00	2021-06-07 09:26:00	2021-06-14 15:36:00	55.9289833	-2.1772833	536	3392		Y	Y	
Logger	2021	St Abbs 5	2021-03-21 00:00:00	2021-03-20 12:45:00	2021-06-07 09:26:00	2021-06-07 00:00:00	55.9289833	-2.1772833	536	LS1x-18	Y	Y	Y	
CPOD	2021	St Abbs 10	2021-02-24 12:53:00	2021-03-20 12:31:00	2021-06-07 10:04:00	2021-06-14 16:02:00	55.9632667	-2.16235	537	2905		Y	Y	
CPOD	2021	St Abbs 15	2021-02-24 12:53:00	2021-03-20 12:05:00	2021-06-07 11:05:00	2021-06-14 15:31:00	56.0333	-2.0750333	538	2904		Y	Y	
CPOD	2021	Stonehaven 5	2021-02-24 14:13:00	2021-03-16 13:10:00	2021-12-13 00:00:00	2021-09-27 14:57:00	56.9471333	-2.17751667	539	3127		Y	Y	Missing Initially, Late recovery by trawler.

Device type	Deployment sequence	Site	Recording start (UTC)	Deployment start (UTC)	Deployment end (UTC)	Recording end (UTC)	Latitude (DD)	Longitude (DD)	Deployment number	Device number	Retrieved	Full dataset	Useable data	Notes
Logger	2021	Stonehaven 5	2021-03-17 00:00:00	2021-03-16 13:10:00	2021-12-13 00:00:00	2021-08-30 00:00:00	56.9471333	-2.17751667	539	LS1x-32	Y	N	Y	Missing Initially, Late recovery by trawler. Gain set to 2.05 dB instead of default 12.4
CPOD	2021	Stonehaven 10	2021-02-24 13:36:00	2021-03-16 12:56:00	2021-06-09 08:08:00	2021-06-14 15:56:00	56.95931	-2.11286	540	3121		Y	Y	
CPOD	2021	Stonehaven 15	2021-02-24 13:48:00	2021-03-16 12:35:00	2021-06-09 08:54:00	2021-06-14 15:59:00	56.9755667	-2.02195	541	3131		Y	Y	
CPOD	2021	St Andrews 5	2021-02-24 13:23:00	2021-03-20 13:34:00	2021-06-07 14:43:00	2021-06-14 16:08:00	56.2650167	-2.57143333	542	3128		Y	Y	
CPOD	2021	St Andrews 10	2021-02-24 13:23:00	2021-03-20 12:31:00	2021-06-06 17:18:00	2021-06-14 16:10:00	56.257894	-2.499312	543	3134		Y	Y	
Logger	2021	St Andrews 10	2021-03-21 00:00:00	2021-03-20 12:31:00	2021-06-06 17:18:00	2021-06-06 00:00:00	56.257894	-2.499312	543	LS1x-21	Y	Y	Y	Gain set to 2.05 dB instead of default 12.4
CPOD	2021	St Andrews 15	2021-02-24 13:48:00	2021-03-19 12:55:00	2021-06-06 15:55:00	2021-06-14 15:24:00	56.2902333	-2.4309667	544	2467		Y	Y	
CPOD	2021	Arbroath 5	2021-02-25 14:58:00	2021-03-14 14:41:00	2021-06-06 12:30:00	2021-06-14 15:22:00	56.5538	-2.48498	545	2795		N	N	Corrupted SD card
CPOD	2021	Arbroath 10	2021-02-24 13:30:00	2021-03-14 14:20:00	2021-06-06 13:35:00	2021-06-14 16:13:00	56.4998333	-2.348178	546	3535		Y	Y	
Logger	2021	Arbroath 10	2021-02-24 13:30:00	2021-03-19 00:00:00	2021-06-06 13:35:00	2021-04-12 00:00:00	56.4998333	-2.348178	546	LS1x-28	Y	N	Y	Gain set to 2.05 dB instead of default 12.4
CPOD	2021	Arbroath 15	2021-02-24 13:26:00	2021-03-18 13:40:00	2021-06-06 14:16:00	2021-06-14 15:28:00	56.4598333	-2.29845	547	3125		Y	N	Data missing (Unkown reasons)
CPOD	2021	Stonehaven 10	2021-05-21 08:59:00	2021-06-09 08:27:00	2021-11-18 09:03:00	2021-11-18 12:26:00	56.9593833	-2.11331667	576	3122		Y	Y	
FPOD	2021	Stonehaven 15	2021-05-25 10:11:00	2021-06-09 09:14:00	2022-06-19 16:39:00	2021-11-05 12:53:00	56.9806	-2.0216	577	6488		Y	Y	Appeared in Denmark, opened on the 19/06/2022.
FPOD	2021	Arbroath 5	2021-05-25 10:15:00	2021-06-06 12:49:00	2021-10-27 01:16:00	2022-08-24 13:11:00	56.554	-2.4832333	578	6489		Y	Y	Appeared in St.Cyrus, probaly trawled
CPOD	2021	Arbroath 10	2021-05-21 12:17:00	2021-06-06 13:46:00	2021-11-20 08:50:00	2021-11-20 10:38:00	56.4999	-2.3807	579	2465		Y	Y	
Logger	2021	Arbroath 10	2021-05-21 12:17:00	2021-06-06 13:46:00	2021-11-20 08:50:00		56.4999	-2.3807	579	LS1-15			N	No further information available for this deployment
CPOD	2021	Arbroath 15	2021-05-21 13:54:00	2021-06-06 14:33:00	2021-11-20 09:59:00	2021-11-20 10:15:00	56.45965	-2.298667	580	1907		Y	Y	
CPOD	2021	St Andrews 10	2021-05-21 08:20:00	2021-06-06 17:45:00			56.2767333	-2.50528333	581	2428		N	N	Mooring missing
Logger	2021	St Andrews 10	2021-05-21 08:20:00	2021-06-06 17:45:00			56.2767333	-2.50528333	581	LS1x-30	N	N	N	Mooring missing
FPOD	2021	St Andrews 15	2021-06-03 14:43:00	2021-06-06 16:15:00	2021-11-21 09:27:00	2021-11-06 16:11:00	56.29005	-2.43308333	582	6462		N	Y	Stopped early
FPOD	2021	St Abbs 10	2021-05-25 10:26:00	2021-06-07 10:18:00	2021-11-20 14:12:00	2021-10-20 09:27:00	55.9634833	-2.16198333	583	6492		N	Y	Stopped early

Device type	Deployment sequence	Site	Recording start (UTC)	Deployment start (UTC)	Deployment end (UTC)	Recording end (UTC)	Latitude (DD)	Longitude (DD)	Deployment number	Device number	Retrieved	Full dataset	Useable data	Notes
CPOD	2021	St Abbs 15	2021-05-21 07:54:00	2021-06-07 12:04:00	2021-11-20 13:24:00	2021-11-20 13:40:00	56.03335	-2.07545	584	2896		Y	Y	
CPOD	2021	Stonehaven 5	2021-05-21 11:58:00	2021-06-09 07:44:00	2021-11-18 09:30:00	2021-11-18 10:45:00	56.9478	-2.17668333	596	2907		Y	Y	O-ring deformed (bulging out) silica packet ripped and spilled inside. Some water ingress and some batteries corroded
Logger	2021	Stonehaven 5	2021-05-21 11:58:00	2021-06-09 07:44:00	2021-11-18 09:30:00	2021-07-06 00:00:00	56.9478	-2.17668333	596	LS1x-25	Y	N	N	Data available but not useable due to temporal overlap with deployment 539
CPOD	2021	St Andrews 5	2021-05-21 12:57:00	2021-06-07 15:11:00	2021-11-21 08:03:00	2021-06-14 01:21:00	56.2652833	-2.5712333	597	1915		N	Y	Stopped early, only 1 week of data
CPOD	2021	St Abbs 5	2021-05-21 11:30:00	2021-06-07 09:39:00		2021-09-29 09:23:00	55.9291167	-2.1770667	598	2797		N	N	Data missing (Unkown reasons), Trawled, Stopped early, Late recovery
Logger	2021	St Abbs 5	2021-05-21 11:30:00	2021-06-07 09:39:00			55.9291167	-2.1770667	598	LS1-3	N	N	N	Labelled as trawled by MD-SEDD, with data missing for unknown reasons
CPOD	2021	Arbroath 10	2021-11-04 09:10:00	2021-11-20 09:10:00	2022-03-16 11:02:00	2022-03-16 13:22:00	56.49913	-2.381416	641	3373		Y	Y	
Logger	2021	Arbroath 10	2021-11-21 00:00:00	2021-11-20 09:10:00	2022-03-16 11:02:00	2022-03-16 00:00:00	56.49913	-2.381416	641	LS1x-26	Y	Y	Y	
CPOD	2022	Stonehaven 5	2022-02-15 11:41:00	2022-03-14 13:55:00	2022-07-17 11:44:00	2022-07-22 12:15:00	56.947333	-2.177233	661	2188		Y	Y	
Logger	2022	Stonehaven 5	2022-03-15 00:00:00	2022-03-14 13:55:00	2022-07-17 11:44:00	2022-07-17 00:00:00	56.947333	-2.177233	661	LS1x-24	Y	Y	Y	
CPOD	2022	Stonehaven 10	2022-02-15 11:28:00	2022-03-14 13:39:00	2022-07-17 11:08:00	2022-08-12 10:47:00	56.959333	-2.113333	662	3124		Y	Y	
CPOD	2022	Stonehaven 15	2022-02-11 17:43:00	2022-03-14 13:16:00	2022-07-17 10:10:00	2022-07-22 12:06:00	56.98067	-2.02167	663	2794		Y	Y	
CPOD	2022	St Andrews 5	2022-02-15 11:54:00	2022-03-15 15:32:00	2022-07-18 13:49:00	2022-08-12 11:54:00	56.265316	-2.57115	664	1907		Y	Y	
CPOD	2022	St Andrews 10	2022-02-15 11:22:00	2022-03-15 15:15:00	2022-07-18 13:18:00	2022-07-22 13:15:00	56.258983	-2.50096	665	2905		Y	Y	
Logger	2022	St Andrews 10	2022-03-16 00:00:00	2022-03-15 15:15:00	2022-07-18 13:18:00	2022-07-18 00:00:00	56.258983	-2.50096	665	LS1x-18	Y	Y	Y	
CPOD	2022	St Andrews 15	2022-02-11 17:35:00	2022-03-15 14:55:00	2022-07-18 12:52:00	2022-08-12 12:06:00	56.29005	-2.4331	666	2196		Y	Y	
CPOD	2022	St Abbs 5	2022-02-15 11:22:00	2022-03-15 18:42:00	2022-07-18 16:26:00	2022-07-22 13:15:00	55.929133	-2.177217	667	2902		Y	Y	
Logger	2022	St Abbs 5	2022-03-16 00:00:00	2022-03-15 18:42:00	2022-07-18 16:26:00	2022-04-14 00:00:00	55.929133	-2.177217	667	LS1-1	Y	N	Y	
CPOD	2022	St Abbs 10	2022-02-15 11:25:00	2022-03-15 18:27:00	2022-07-18 15:56:00	2022-07-22 11:52:00	55.96345	-2.164933	668	3123		Y	Y	
CPOD	2022	St Abbs 15	2022-02-15 11:34:00	2022-03-15 17:54:00	2022-07-19 10:51:00	2022-08-12 11:39:00	56.03335	-2.07543	669	1910		Y	Y	
CPOD	2022	Arbroath 5	2022-03-16 06:45:00	2022-03-16 11:40:00	2022-07-18 11:00:00	2022-03-16 18:20:00	56.55402	-2.483333	670	1906		N	N	Did not start recording

Device type	Deployment sequence	Site	Recording start (UTC)	Deployment start (UTC)	Deployment end (UTC)	Recording end (UTC)	Latitude (DD)	Longitude (DD)	Deployment number	Device number	Retrieved	Full dataset	Useable data	Notes
CPOD	2022	Arbroath 10	2022-02-15 11:26:00	2022-03-16 11:07:00	2022-07-18 09:15:00	2022-08-12 11:54:00	56.49683	-2.38216	671	2901		Y	Y	
Logger	2022	Arbroath 10	2022-03-17 00:00:00	2022-03-16 11:07:00	2022-07-18 09:15:00	2022-07-18 00:00:00	56.49683	-2.38216	671	LS1x-23	Y	Y	Y	
CPOD	2022	Arbroath 15	2022-02-15 11:26:00	2022-03-16 10:29:00	2022-07-18 10:00:00	2022-08-12 11:41:00	56.459683	-2.28863315	672	1892		Y	Y	
FPOD	2022	Arbroath 5	2022-06-24 10:41:00	2022-07-18 08:33:00	2022-11-26 14:09:00	2022-10-23 17:21:00	56.55395	-2.48335	689	6517			Y	Stopped early
CPOD	2022	Arbroath 10	2022-06-22 15:14:00	2022-07-18 09:27:00	2022-11-26 09:27:00	2022-11-26 18:13:00	56.4998	-2.38132	690	2485			Y	
Logger	2022	Arbroath 10	2022-07-01 00:00:04	2022-07-18 09:27:00	2022-11-26 09:27:00	2022-11-15 14:00:00	56.4998	-2.38132	690	RT-5	Y	Y	Y	
FPOD	2022	Arbroath 15	2022-06-24 10:31:00	2022-07-18 10:10:00	2022-11-26 12:41:00	2022-11-24 23:32:00	56.45968	-2.29865	691	6478			Y	Stopped early
FPOD	2022	St Abbs 15	2022-06-24 10:41:00	2022-07-19 11:00:00	2023-06-17 12:57:00	2022-01-29 11:21:00	56.02001	-2.04526	720	6520		N	N	Not useable - data only exists for 2022-12-12
FPOD	2022	St Andrews 10	2022-06-24 10:41:00	2022-07-18 13:28:00	2022-11-27 09:03:00	2022-11-27 18:12:00	56.2579	-2.4993	721	6519			Y	
Logger	2022	St Andrews 10	2022-07-19 00:00:00	2022-07-18 13:28:00	2022-11-27 09:03:00	2022-11-27 00:00:00	56.2579	-2.4993	721	LS1x-22	Y	Y	Y	
CPOD	2022	St Andrews 15	2022-06-22 15:02:00	2022-07-18 12:52:00	2022-11-27 08:26:00	2022-11-27 18:23:00	56.29066	-2.43265	722	1915			Y	
CPOD	2022	St Andrews 5	2022-06-22 14:11:00	2022-07-18 13:28:00	2022-11-27 09:49:00	2022-11-27 18:04:00	56.26571	-2.57145	723	3134			Y	
FPOD	2022	Stonehaven 10	2022-06-24 11:31:00	2022-07-17 11:20:00	2023-03-21 14:50:00	2022-12-03 01:21:00	56.959415	-2.113388	724	6478			Y	Stopped early
CPOD	2022	Stonehaven 15	2022-06-22 15:02:00	2022-07-17 10:10:00	2023-06-16 14:09:00	2023-01-10 01:13:00	56.98066	-2.02166	725	1913			Y	
FPOD	2022	Stonehaven 5	2022-06-24 11:31:00	2022-07-17 11:52:00	2023-01-30 12:00:00	2022-11-17 12:56:00	56.94695	-2.17668	726	6479			Y	Late recovery (OK)
Logger	2022	Stonehaven 5	2022-07-18 00:00:00	2022-07-17 11:52:00	2023-01-30 12:00:00	2022-11-11 00:00:00	56.94695	-2.17668	726	LS1x-27	Y	Y	Y	
CPOD	2022	Arbroath 10	2022-11-02 16:27:00	2022-11-26 13:30:00	2023-03-28 08:10:00	2023-04-03 09:44:00	56.4998667	-2.38135	736	3369			Y	
Logger	2022	Arbroath 10	2022-11-27 00:00:00	2022-11-26 13:30:00	2023-03-28 08:10:00	2023-03-28 00:00:00	56.4998667	-2.38135	736	LS1x-18	Y	Y	Y	
CPOD	2023	Arbroath 5	2023-02-21 12:26:00	2023-03-28 07:30:00	2023-06-16 07:04:00	2023-06-06 18:33:00	56.55406	-2.48328	769	3536			Y	
CPOD	2023	Arbroath 10	2023-02-21 12:36:00	2023-03-28 08:17:00	2023-06-16 07:51:00	2023-06-21 08:08:00	56.49986	-2.38145	770	3128			Y	
Logger	2023	Arbroath 10	2023-03-13 00:00:04	2023-03-28 08:17:00	2023-06-16 07:51:00	2023-06-22 11:00:05	56.49986	-2.38145	770	RT114	Y	Y		

Device type	Deployment sequence	Site	Recording start (UTC)	Deployment start (UTC)	Deployment end (UTC)	Recording end (UTC)	Latitude (DD)	Longitude (DD)	Deployment number	Device number	Retrieved	Full dataset	Useable data	Notes
CPOD	2023	Arbroath 15	2023-02-20 16:49:00	2023-03-28 08:43:00	2023-06-16 08:29:00	2023-06-21 10:26:00	56.45983	-2.29845	771	3489			N	Data corrupt
CPOD	2023	St Andrews 5	2023-02-21 12:00:00	2023-03-28 13:59:00	2023-06-18 09:48:00	2023-06-21 08:47:00	56.26498	-2.5721	772	2485			Y	
CPOD	2023	St Andrews 10	2023-02-21 12:36:00	2023-03-28 13:41:00	2023-06-18 09:17:00	2023-06-21 08:21:00	56.2579	-2.4993	773	3491			Y	
Logger	2023	St Andrews 10	2023-03-29 00:00:00	2023-03-28 13:41:00	2023-06-18 09:17:00	2023-03-18 00:00:00	56.2579	-2.4993	773	LS1-15	Y	Y	Y	
CPOD	2023	St Andrews 15	2023-02-21 12:36:00	2023-03-21 12:36:00	2023-06-18 10:40:00	2023-03-25 18:22:00	56.29008	-2.43303	774	2906			N	Data corrupt
CPOD	2023	St Abbs 5	2023-02-20 17:08:00	2023-03-28 17:12:00	2023-06-17 15:10:00	2023-06-21 10:27:00	55.92898	-2.17728	775	2484			N	Data corrupt
Logger	2023	St Abbs 5	2023-03-29 00:00:00	2023-03-28 17:12:00	2023-06-17 15:10:00	2023-06-17 00:00:00	55.92898	-2.17728	775	LS1-1	Y	Y	Y	
CPOD	2023	St Abbs 15	2023-02-20 17:10:00	2023-03-29 07:16:00	2023-06-17 12:36:00	2023-06-21 10:26:00	56.03668	-2.04526	777	2197			Y	
CPOD	2023	Stonehaven 5	2023-02-20 17:08:00	2023-03-21 16:08:00	2023-06-16 13:06:00	2023-06-21 09:47:00	56.94695	-2.17668	795	2467			Y	
Logger	2023	Stonehaven 5	2023-03-10 12:17:00	2023-03-21 16:08:00	2023-06-16 13:06:00	2023-05-16 10:00:07	56.94695	-2.17668	795	RT103	Y	Y		No useful data - problems with the device upon retrieval a little water inside and 'popped' when opened, though memory cards are fine.
CPOD	2023	Stonehaven 10	2023-02-20 17:09:00	2023-03-21 15:40:00	2023-06-16 13:31:00	2023-06-22 10:17:00	56.95943	-2.11335	797	3535			Y	
CPOD	2023	Stonehaven 15	2023-02-21 12:39:00	2023-03-21 14:50:00	2023-06-16 14:18:00	2023-06-21 08:47:00	56.98063	-2.02175	798	1898			Y	
Logger	2023	Arbroath 10	2023-06-09 00:00:04	2023-06-16 08:00:00	2024-01-30 13:13:00	2024-01-29 00:00:00	56.4998	-2.3799	835	RT135	Y	N	N	Faulty sensor, can't use the data
CPOD	2023	Arbroath 10	2023-06-01 12:24:00	2023-06-16 08:00:00	2024-01-30 13:13:00	2023-09-25 00:00:00	56.4998	-2.3799	835	2465			Y	
CPOD	2023	Arbroath 15	2023-06-01 12:24:00	2023-06-16 08:37:00	2024-01-30 14:14:00	2023-12-30 00:00:00	56.45968	-2.29865	836	2794			Y	Unplanned retrieval, end date recommended by MD-SEDD
CPOD	2023	Stonehaven 15	2023-06-01 12:38:00	2023-06-16 14:33:00			56.9806	-2.02173	839	3370			N	Unplanned recovery, unusable data
Logger	2023	St Abbs 5	2023-06-09 00:00:05	2023-06-17 15:16:00	2023-10-15 00:00:00	2023-10-14 00:00:00	55.92898	-2.17728	840	RT147	Y	N	N	Faulty sensor, can't use the data
FPOD	2023	St Abbs 5	2023-06-02 12:54:00	2023-06-17 15:16:00	2023-10-15 00:00:00	2023-08-22 00:00:00	55.92898	-2.17728	840	6491		N	Y	840 was trawled - going by angle changes it looksl like data should be cropped on 22nd Augus
CPOD	2023	St Abbs 10	2023-06-02 10:10:00	2023-06-18 07:09:00	2024-01-31 12:06:00	2024-01-03 00:00:00	55.96405	-2.16398	841	1905			Y	
CPOD	2023	St Abbs 15	2023-06-01 11:05:00	2023-06-17 13:07:00	2024-01-30 16:19:00	2024-01-09 00:00:00	56.03335	-2.07541	842	2196			Y	
CPOD	2023	St Andrews 5	2023-06-01 11:05:00	2023-06-18 10:02:00	2024-06-29 14:22:00	2023-09-04 00:00:00	56.26498	-2.5721	843	3841			Y	

Device type	Deployment sequence	Site	Recording start (UTC)	Deployment start (UTC)	Deployment end (UTC)	Recording end (UTC)	Latitude (DD)	Longitude (DD)	Deployment number	Device number	Retrieved	Full dataset	Useable data	Notes
CPOD	2024	St Andrews 10	2023-11-01 11:56:00	2024-01-30 13:33:00	2024-06-29 16:30:15	2024-06-29 00:00:00	56.25777	-2.49933	899	3543			Y	
CPOD	2024	St Abbs 15	2023-11-01 12:03:00	2024-02-01 13:57:00	2024-06-30 09:58:00	2024-06-30 00:00:00	56.03333	-2.07541	900	3432			Y	
CPOD	2024	Arbroath 10	2023-11-01 13:53:00	2024-01-30 13:33:00	2024-06-29 14:22:00	2024-06-29 00:00:00	56.499908	-2.380135	917	2795			Y	
Logger	2024	Arbroath 10	2024-01-31 00:00:00	2024-01-30 13:33:00	2024-06-29 14:22:00	2024-06-29 00:00:00	56.499908	-2.380135	917	LS1-6	Y	Y	Y	
CPOD	2024	Stonehaven 5	2024-05-23 11:02:00	2024-06-29 11:57:00	2024-09-10 12:30:00	2024-09-19 11:57:00	56.9469	-2.17686	959	1894	Y		Y	
CPOD	2024	Stonehaven 10	2024-05-23 12:10:00	2024-06-29 11:42:00	2024-09-12 15:04:00	2024-09-16 14:13:00	56.95936	-2.11339	960	1915	Y		Y	
CPOD	2024	Arbroath 5	2024-05-23 11:01:00	2024-06-29 13:39:00	*2024-09-13 00:00:00*	2024-09-16 13:49:00	56.93488	-2.88461	962	3369	Y		Y	
CPOD	2024	Arbroath 10	2024-05-23 13:17:00	2024-06-29 14:22:00	2024-09-13 08:27:00	2024-09-16 14:14:00	56.49977	-2.38	963	3489	Y		Y	
Logger	2024	Arbroath 10	2024-06-30 00:00:00	2024-06-29 14:22:00	2024-09-13 08:27:00	2024-09-13 00:00:00	56.49977	-2.38	963	LS1x-26	Y	Y	Y	
CPOD	2024	Arbroath 15	2024-05-23 12:21:00	2024-06-29 14:36:00	2024-09-13 09:04:00	2024-09-16 14:14:00	56.45975	-2.45325	964	2196	Y		Y	
CPOD	2024	St Andrews 5	2024-05-23 11:01:00	2024-06-29 15:36:00	2024-09-14 16:22:00	2024-09-16 13:49:00	56.93488	-2.88461	965	2465	Y		Y	
CPOD	2024	St Andrews 10	2024-05-23 14:29:00	2024-06-29 16:35:00	2024-09-14 15:23:00	2024-09-16 13:54:00	56.25777	-2.49941	966	3123	Y		Y	
Logger	2024	St Andrews 10	2024-06-30 00:00:00	2024-06-29 16:35:00	2024-09-14 15:23:00	2024-09-14 00:00:00	56.25777	-2.49941	966	LS1x-27	Y	Y	Y	
CPOD	2024	St Andrews 15	2024-06-29 14:50:00	2024-06-29 16:50:00	2024-09-13 15:14:00		56.93488	-2.88461	967	1892	Y		N	Data missing
CPOD	2024	St Abbs 5	2024-06-30 05:28:00	2024-06-30 07:28:00			55.92911	-2.24393	968	3536	N		N	Mooring missing
CPOD	2024	St Abbs 10	2024-05-23 14:21:00	2024-06-30 09:23:00	2024-09-14 11:28:00	2024-09-16 14:14:00	55.96349	-2.16002	969	3538	Y		Y	
Logger	2024	St Abbs 15	2024-06-30 08:12:00	2024-06-30 10:12:00	2024-09-14 10:03:00		56.03323	-2.07563	970	RT159	Y	Y	N	Electric self noise prevented this dataset from being processed
CPOD	2024	St Abbs 15	2024-05-23 14:03:00	2024-06-30 10:12:00	2024-09-14 10:03:00	2024-09-16 13:55:00	56.03323	-2.07563	970	1910	Y		Y	

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