Moray Firth Marine Mammal Monitoring Programme

Work Package 3 – Minke Whale Monitoring Report

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6th February 2024

Summary

- Limited information on minke whale spatial and temporal distribution in the Moray Firth contributed to uncertainties during Moray West impact assessment. Thus, digital aerial surveys (DAS) conducted to survey seabirds and passive acoustic recordings were analysed to collect additional data on minke whale occurrence.

- Minke whales were sited on over 50% of the 16 DAS conducted in 2021 and 2022. Whales were located across the development but, with only 11 sightings in each year, these data were insufficient for more detailed analysis of variation in occurrence across the DAS area.

- Broad-band recordings were also obtained from a site within Moray West during the summers of 2021 and 2022. Processing of acoustic monitoring is often constrained by the time it takes to manually process acoustic recordings. Thus, we developed a collaboration to develop and train an automatic detector for minke whale calls. Archive data collected through the MMMP contributed >800 minke whale calls and >1M noise samples towards the training dataset for the automatic detector.

- Manual annotations of minke whale calls during 2021 and 2022 were used to explore differences in occurrence between the DAS and passive acoustic monitoring (PAM) surveys. This highlighted how the two methodologies can complement each other, providing information on spatio-temporal variability of minke whale occurrence across the study site.

- Colleagues at NOAA are currently optimising the minke whale detector using data from the Moray Firth, Scottish West Coast and US East Coast. This will be tested using the 2022 manual detections from Moray West. Once finalised, this automatic detector promises to provide a valuable tool for assessing patterns of occurrence across ScotWind developments and in other North Atlantic waters.

1. Introduction

Previously, minke whales (*Balaenoptera acutorostrata*) have not been considered a priority species in environmental assessments for offshore windfarms in Scottish coastal waters (eg. Beatrice Offshore Windfarm Limited 2017; Moray Offshore Windfarm (East) Limited 2018). However, during the consenting of Moray West, concerns were raised over potential injury or disturbance to minke whales using the Southern Trench Marine Protected Area following its designation in December 2020 (see Figure 1). Consequently, minke whales were identified as a key receptor species in the environmental impact assessment and subsequent piling strategy for Moray West, requiring assessment of the number of individuals potentially injured or disturbed during piling operations (Moray Offshore Windfarm (West) Limited 2023). Similarly, minke whales are anticipated to be a key receptor species for many of the other developments currently being planned, following the ScotWind leasing round.

During the development of Moray West's piling strategy, it became clear that limitations in the baseline distribution of minke whales within the Moray Firth contributed to significant uncertainty in estimates of the number of animals that might be impacted by piling noise. First, available density surfaces for modelling were based on data from large scale surveys such as the Small Cetaceans in European Atlantic waters and the North Sea (SCANS) surveys (SCANS-III - Lacey *et al.* 2022). As a result, detail on finer-scale density variation in those areas closest to the development was lacking. Second, large scale survey data were based upon summer surveys. It is recognised that minke whale occurrence in these areas is seasonal and that these survey data are likely to represent peak local abundances (Robinson *et al.* 2009; Risch *et al.* 2019). However, detail on the nature of seasonal changes in local density was lacking, and assumptions about this may have significant impacts on model predictions. Finally, large scale surveys are infrequent (>6 years apart), and there is also limited information on inter-annual variation in local densities and what may drive this variation.

Moray West offshore windfarm was therefore asked to collect additional data on minke whale occurrence as part of the pre-construction phase of the project environmental monitoring programme. In discussion with the Statutory Nature Conservation Bodies (SNCBs), it was agreed that digital aerial surveys being undertaken to monitor seabirds could obtain additional data to characterise spatial and temporal variation in minke whale sightings across the development area. In addition, it was agreed that passive acoustic monitoring (PAM) data should be collected to explore how the greater temporal coverage of PAM data might complement visual sightings to improve understanding of seasonal and inter-annual variation in occurrence. The PAM work built upon previous studies using broad band sound recordings from the Marine Directorate East Coast Marine Mammal Acoustic Study (ECOMMAS) array, which confirmed the presence of minke whale calls in this region (Risch *et al.* 2019). However, previous work was based on time-consuming manual identification of calls from broad band recordings, which constrains the extent to which these techniques can be scaled up and used across larger survey areas or longer study periods. Given the likely need to improve methods for monitoring minke whale occurrence, both within the new MPAs and across ScotWind sites, a key aspect of the work within this work package has been on technique development and evaluation. In particular, we aimed to integrate broad band data collected within Moray West with other available data from the region to support collaborations that are using Artificial Intelligence (AI) to detect minke whale vocalisations.

Minke whales produce a large variety of vocalizations, including boings, downsweeps, bio-ducks and pulse trains (Edds-Walton 2012; Risch *et al.* 2014b; Nikolich & Towers 2020; Filun & van Opzeeland 2023). In the North Atlantic, pulsed trains are the dominant vocalization used by minke whales (Nieukirk *et al.* 2004; Risch *et al.* 2013), which makes them a good candidate for an automatic detector to study their occurrence in this region. They have been detected during migration and in summer feeding grounds (Nieukirk *et al.* 2004; Risch *et al.* 2013) but the specific behavioural function of pulse trains remains unknown. To date, various automatic detectors for minke whale pulse trains have been developed, showing varying degrees of success. For instance, (Kiehbadroudinezhad *et al.* 2021) designed a detector based on MATLAB, which exhibited varying false positive rates (17 - 96 %) and false negative rates (0 – 40 %) depending on the specific location of the recorders. Another detector, developed by Popescu *et al.* (2013), employed machine learning techniques and was trained on western North Atlantic minke vocalizations, but it yielded a relatively low true positive rate (60 %). Notably, when this detector was applied to data from the North Sea, anthropogenic noise resulted in a relatively high false positive rate (11 %; Risch *et al.* 2019). Therefore, if PAM is to be used in the monitoring of minke whales, there remains a need for the development of an automatic detector trained on a comprehensive dataset, ensuring accurate detection of minke whale pulse trains across entire marine regions.

This report outlines the methodology and results of the field data collected within this work package and describes progress within the collaboration developing methods to detect minke whale vocalisations using AI. These results are, first, discussed in relation to regional baselines used within the Moray West piling strategy. Second, we discuss how these approaches could be used to support further monitoring of minke whales in Scottish waters.

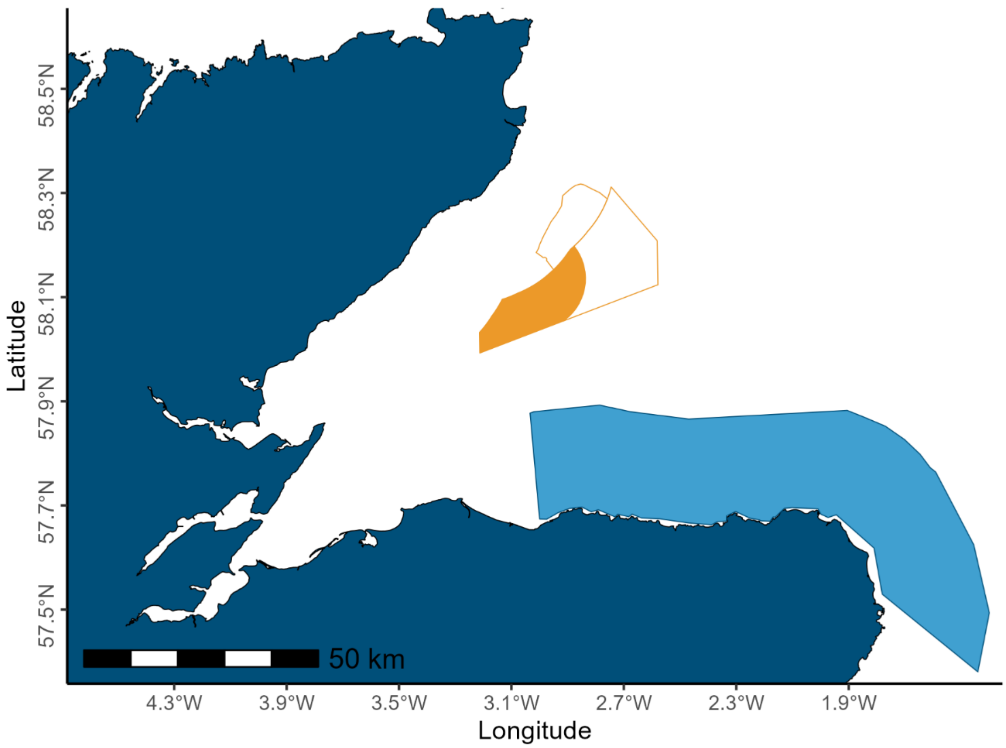

Figure 1. Map of the Moray Firth including the Southern Trench MPA (light blue) and windfarm developments (Moray West: filled orange polygon; Beatrice and Moray East windfarms: empty orange polygons).

2. Methodology

2.1 Digital aerial surveys

Digital aerial surveys were carried out approximately once each month between March and October of 2021 and 2022 for a total of 16 surveys (8 in each year). Surveys were conducted only in favourable weather conditions which were determined based on cloud base (> 1,700 ft), visibility (> 5 km), wind speed (< 30 knots) and sea state (4 or less on the Beaufort scale). Each survey covered the survey areas displayed in Figure 2. These surveys aimed to identify both seabirds and marine mammals within the Moray West windfarm site and within a buffer surrounding area covering a total area of approximately 1065 km^2. The surveys used three cameras to collect data along a transect survey design at 1.5 cm resolution. Due to the presence of existing windfarms at Beatrice and Moray East, surveys were conducted at variable heights of between 428 and 671 m, at times limiting the imagery resolution at 2 cm. Images were analysed by APEM following procedures documented in their ornithology reports (Moray Offshore

Windfarm (West) Limited 2021). Locations of marine mammal sightings were also provided by APEM, where possible, to the species level, also noting the presence of unidentified marine mammals within different size classes.

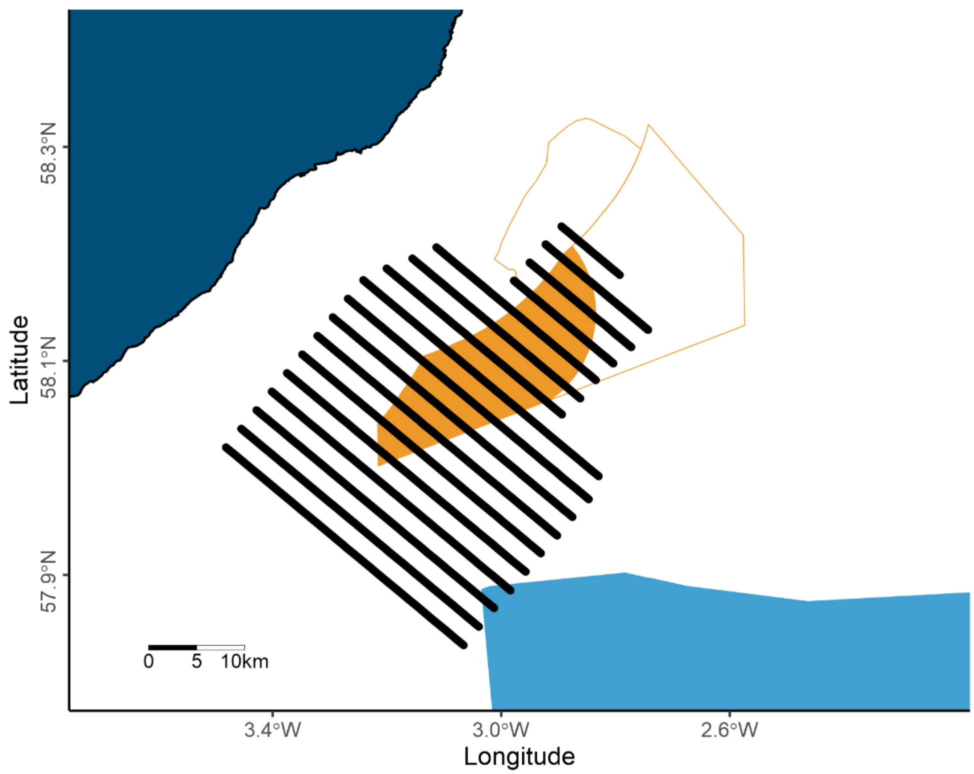

Figure 2: Digital aerial survey lines (black lines) over Moray West windfarm site (filled orange polygon). Map includes Beatrice and Moray East windfarms (empty orange polygons) and the Southern Trench MPA (light blue).

2.2 Passive Acoustic Monitoring

Under this Work Package, the University of Aberdeen collected broad band sound recordings at sites within Moray West in the summers of 2021 and 2022 (Figure 3). Data were collected using SoundTrap recorders (ST300 and ST500, Ocean Instruments NZ). In 2021, the recorder sampled at 96 kHz with a duty cycle of 10 mins recording in every 60 mins. In 2022, the recorder sampled at 48 kHz with a duty cycle of 10 mins recording in every 20 mins. Recorders were moored approximately 2 m above the seabed using methods previously used to record noise within Beatrice and Moray East Offshore Windfarms (Benhemma-Le Gall *et al.* 2021). Archived data from previous Marine Mammal Monitoring Programme (MMMP) (Graham *et al.* 2017; Graham *et al.* 2021) and Marine Directorate's ECOMMAS project recordings were also collated for the development of AI detection algorithms).

2.2.1 Minke whale call detector

The development of an automatic detector for minke whales has been carried out through a collaboration with the Scottish Association for Marine Science (SAMS) and the US National Oceanic and Atmospheric Administration (NOAA). Given the sensitivities of automatic detectors to differences in calls and background noise (Kirsebom *et al.* 2020; Madhusudhana *et al.* 2020), this work aimed to train a detector that could be used across the whole North Atlantic, thus incorporating calls and noise samples from different regions.

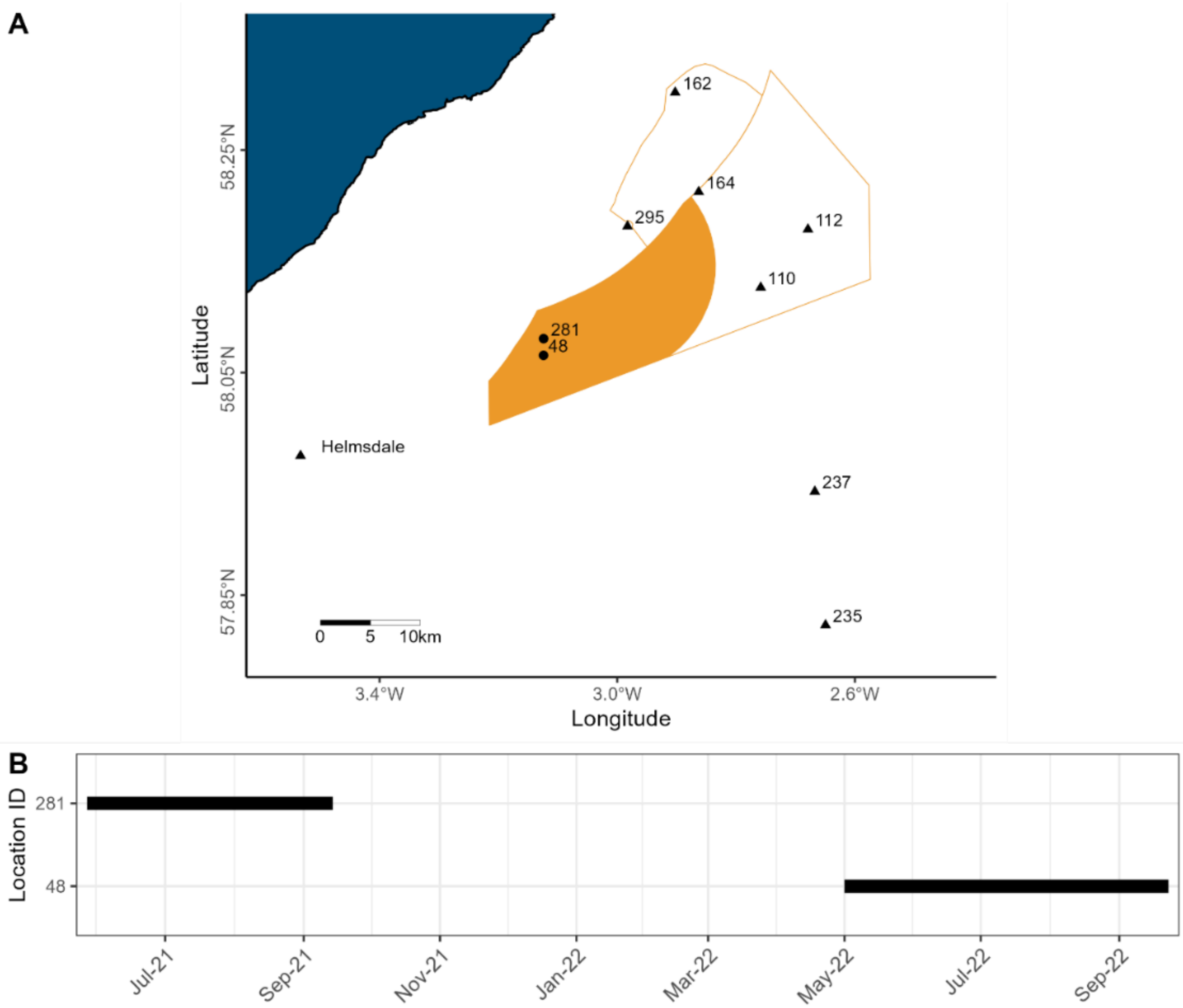

Figure 3: A) Map showing the locations of the SoundTraps deployed at Moray West (circles), and additional sites where archive data were available for training the NOAA minke whale detection algorithm (triangles), see also Table S1B) Plot showing the temporal coverage of the recordings made in 2021 and 2022 at sites within Moray West windfarm.

After initial trials using a detector developed for work on Moray Firth dolphins (Fernandez-Betelu *et al.* 2023), we subsequently worked within the Ketos framework that has been developed at Dalhousie University (Kirsebom *et al.* 2021). Colleagues at NOAA have led the adaptation and training of the detector.

The Ketos algorithm downsamples any given sound recording to a frequency of 2 kHz, enabling collaborators to unify their noise samples under one combined dataset. The first version of the detector was produced by NOAA in February 2023, having been trained using minke whale calls from the East coast of the USA and noise samples from both the East coast of the USA and the Moray Firth. A second version of the detector is currently being developed using minke whale vocalization and noise samples from the East coast of the USA (NOAA), West coast of Scotland (SAMS) and additional University of Aberdeen and Marine Directorate ECOMMAS training data from the Moray Firth. Details of the detection algorithm are being prepared for a publication led by NOAA colleagues.

To develop the training data set from the Moray Firth, selected recordings (see Table S1) were processed using NOAA's first algorithm for the automatic detection of minke whale vocalizations. This approach was taken to identify those recording periods that were most likely to contain minke whale vocalisations. All these detections were then visually inspected using RAVEN Pro 1.6 (K. Lisa Yang Center for Conservation Bioacoustics 2019) to identify any false positives and annotate any missed minke whale calls. The resulting confirmed minke whale detections were then incorporated into the training dataset for the second algorithm. Additional false positives were available from the 2016 Helmsdale recordings, part of the larger ECOMMAS data collection, which had been processed by Risch *et al.* (2019) (Table S1).

Data resulting from the 2021 deployments in Moray West deployments (Table S1) were processed following the steps outlined above for archived data. Confirmed minke whale calls and noise data were added to the training dataset for the second NOAA algorithm.

Data collected from Moray West during the summer of 2022 (Table S1) will be used to validate this second algorithm once it has been optimised. To prepare this validation dataset, we reviewed the 2022 digital aerial survey to identify the survey date with peak minke whale sightings (02/06/22) and selected a 10-day period around this where we expected acoustic detections to be most frequent (01/06/2022 and 10/06/2022). We manually inspected all acoustic recordings in this 10-day period using RAVEN and annotated these calls ready for later validation of the final algorithm.

2.3 Methodology comparison

To compare detections from digital aerial survey and PAM, we also selected recordings from any days on which aerial surveys were also completed in either 2021 or 2022. RAVEN was then used to manually inspect every 10-minute recording from each of those days to identify and annotate any minke whale calls.

3. Results

3.1 Digital aerial surveys

There were 22 minke whale sightings across the 16 surveys carried out in 2021 and 2022 (Table 1). These included sightings both within the Moray West site and in the buffer area both to the north and south of the site (Figure 4). There were no other detections of unidentified large marine mammals that could represent additional minke whale sightings during these surveys.

Table 1. Digital Aerial surveys conducted during 2021 and 2022 with the number of minke whale sightings in each survey.

Year	Survey	Date	# minke whale sightings
2021	1	02/04/2021	2
	2	19/04/2021	0
	3	17/05/2021	0
	4	10/06/2021	2
	5	19/07/2021	0
	6	03/08/2021	1
	7	07/09/2021	3
	8	04/10/2021	3
2022	1	06/03/2022	0
	2	01/04/2022	0
	3	02/06/2022	7
	4	03/07/2022	2
	5	20/07/2022	0
	6	10/08/2022	1
	7	11/09/2022	0
	8	27/10/2022	1

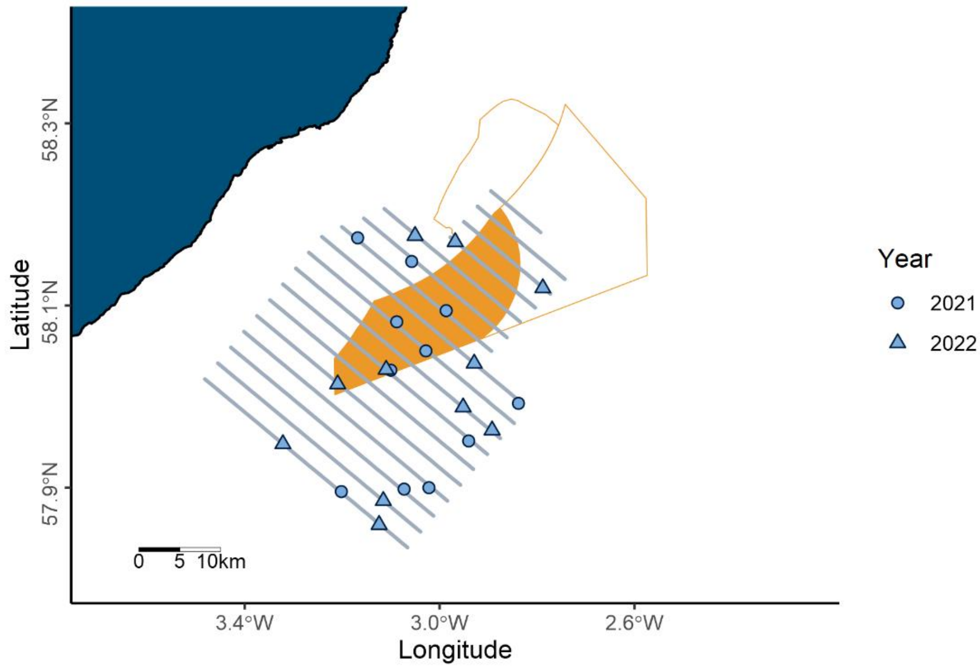

Figure 4. Locations of minke whale sightings around Moray West offshore windfarm site during 2021 and 2022 digital aerial surveys.

3.2 Passive Acoustic Monitoring

3.2.1 Analysis of archive PAM data

Archived broadband recordings suitable for analysis of minke whale calls were available from a series of deployments in the Moray Firth (Figure 1, Table S1). These data included those collected during early phases of the MMMP (2017-2019) and the ECOMMAS project (2016-2019).

Analysis of these recordings resulted in a total of 620 visually identified and extracted minke whale calls (Table 2). All recordings which contained only false positive detections were subsequently subsampled to be included as 5-second noise samples in the training dataset, this resulted in a total 266,514 5-seconds noise samples (Table 2).

Table 2. Total number of manually inspected recordings for each deployment and number of minke whale calls annotated or noise samples generated from each deployment (see Figure 3A).

Deployment	Location	Project	Minutes manually inspected	# of minke whale calls	# of noise samples created
887	162	MMMP	20	0	240
986	110	MMMP	30	0	1,080
987	112	MMMP	240	12	2,880
1027	235	MMMP	30	0	1,080
1029	237	MMMP	30	0	1,080
1032	164	MMMP	1,140	0	82,080
1092	112	MMMP	370	0	3,240
1093	164	MMMP	260	0	3,120
1101	164	MMMP	70	6	1,200
1102	112	MMMP	10	1	120
1136	164	MMMP	160	0	1,440
1137	112	MMMP	210	0	1,440
1160	112	MMMP	470	3	5,400
1190	295	MMMP	5,520	73	90,720
MSS 181	Helmsdale	ECOMMAS	12,690	0	32,994
MSS 274	Helmsdale	ECOMMAS	660	18	1,560
MSS 360	Helmsdale	ECOMMAS	2,220	54	6,240
MSS 421	Helmsdale	ECOMMAS	9,690	453	30,600
		Total:	***33,820***	***620***	***266,514***

3.2.2 Analysis of Moray West PAM data

In 2021, the SoundTrap deployed in Moray West collected data between the 27th of May and the 14th of September. All recordings were run through the first algorithm developed by NOAA, which identified twenty-five 10-minutes audio files with possible minke whale detections. These recordings were selected for manual inspection and 216 individual minke whale calls were identified and annotated (example in Figure 5). These calls were integrated with those from our archived data to provide a final training data set of 836 calls (>20% of which were from 2021 recordings within the Moray West site). False positive detections and recordings with no calls were used to generate a further 3,000 5-second noise samples that were added to the noise training dataset.

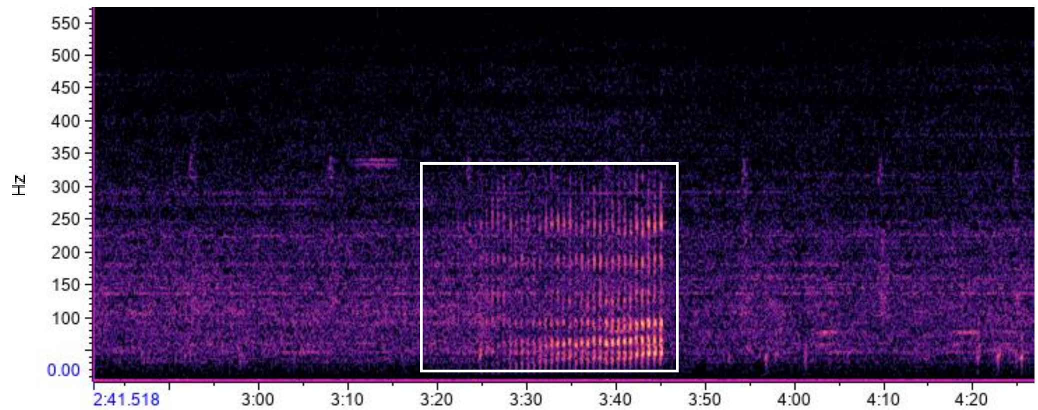

Figure 5. Example of minke whale call detection recorded at site 281 (see map in Figure 3) on the 10th of June 2021 at 10:03:20.

In 2022, minke whale calls were detected on 80% of the days in early June selected for analysis. (Figure 6).

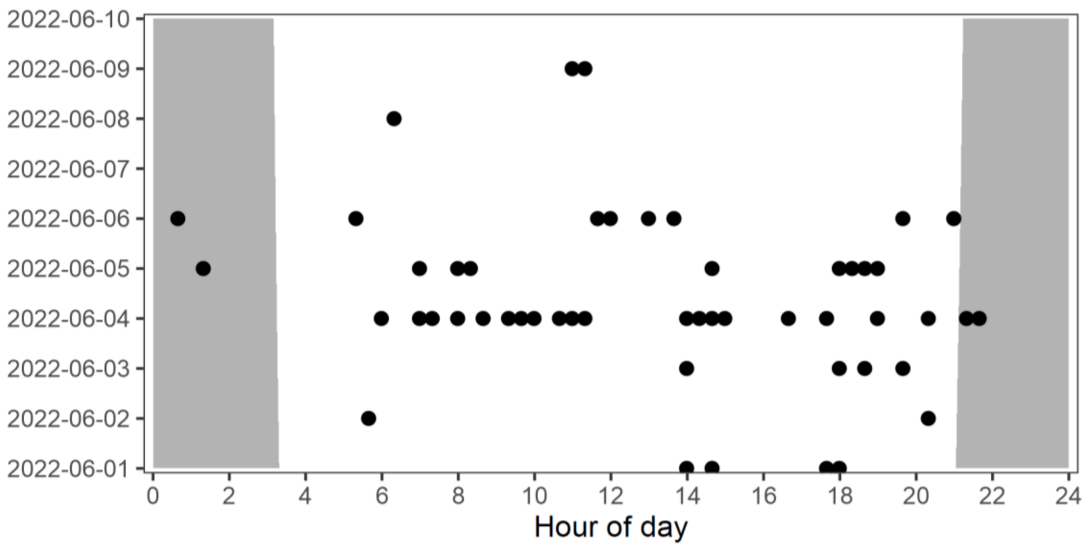

Figure 6: Minke call detections during the manual annotation of the recordings collected between the 1st and 10th of June 2022. Night-time periods are indicated by shaded areas. Recordings obtained from the SoundTrap deployed at Moray West (Location 48, see map in Figure 3).

3.3 Acoustic detections and DAS sightings

During 2021 and 2022, eight digital aerial surveys were conducted on days when the SoundTraps were recording at Moray West (Table 3). Due to differences in duty cycling, acoustic effort varied between years, with three times more data being collected on days in 2022 compared to 2021.

Based upon manual inspection of the acoustic data, minke whale vocalisations were detected on all days on which minke whales were sighted during the DAS. Additionally, vocalisations were detected on two days when minke whales were not visually observed during the DAS (Table 3). There was only one day on which no vocalisations were detected, and no sightings were recorded on that day's DAS.

Table 3. Comparison of the DAS sightings and minke whale call manual detections in the SoundTrap recordings. Colours indicate agreement between DAS sightings and acoustic detections (agreement: green, disagreement: red).

Date	DAS sightings		SoundTrap recordings	
	# of sighting	Presence	# of 10-minutes recordings with calls	Presence
10/06/2021	2	**1**	2	**1**
19/07/2021	0	**0**	0	**0**
03/08/2021	1	**1**	2	**1**
07/09/2021	3	**1**	2	**1**
02/06/2022	7	**1**	2	**1**
03/07/2022	2	**1**	2	**1**
20/07/2022	0	**0**	7	**1**
10/08/2022	1	**1**	1	**1**
11/09/2022	0	**0**	2	**1**

4. Discussion

Information on seasonal patterns of abundance and distribution of minke whales has been required to support assessments of potential injury from impulsive noise that underpinned the piling strategy for Moray West (Moray Offshore Windfarm Limited 2023). In this piling strategy, a combination of sources was used to support this assessment. Paxton *et al.* (2016)'s analysis of JNCC's the Joint Cetacean Protocol (JCP) dataset, which incorporates survey data from a variety of historic sources, provided information on spatial variation in relative abundance within part of the region. However, their analysis was restricted to more inshore areas and, furthermore, did not provide the information on absolute abundance required to estimate how many individual whales might be impacted by piling noise. Required estimates of minke whale density were therefore taken from the larger-scale summer surveys conducted through SCANS (Hammond *et al.* 2002; Hammond *et al.* 2013; Hammond *et al.* 2017). Given the proximity of the Southern Trench Marine Protected Area, Moray West were asked to develop pre-construction surveys of minke whales to reduce these uncertainties.

This requirement has been addressed within the MMMP programme in two ways. First, digital aerial surveys undertaken for ornithological pre-construction baseline were analysed to record marine mammals, including minke whales. Minke whales were detected on just over half of the sixteen DAS conducted between spring and autumn of 2021 and 2022 (Table 1). However, survey effort was relatively low, and the number of sightings small. These data are valuable for future integration into larger datasets such as the JCP but, taken on their own, they cannot be used to provide independent information on relative distribution across the DAS area. Furthermore, to be usefully incorporated into any assessments of the impact of piling, information on spatial variation in occurrence is required over much larger areas that those used for the digital aerial surveys. This highlights the need for larger scale, more strategic, surveys of species such as minke whale to support assessment and regulation.

Another key area of uncertainty during the development of the Moray West Piling Strategy was the nature of seasonal changes in occurrence of minke whales within the Moray Firth (Risch *et al.* 2019). Here too, small sample sizes in different months meant that the DAS data could not be used to estimate seasonal variation in occurrence (Table 1). Our second approach, within the MMMP, was therefore to explore whether passive acoustic monitoring could provide longer and more detailed time-series of data on minke whale detections, therefore offering potential to characterise seasonal patterns of occurrence. Previous work in this area had shown that broadband recordings from the ECOMMAS array could detect minke whale vocalizations in this region (Risch *et al.* 2019). Yet whilst these methods therefore have potential to monitor 24 hours a day over several months, they remain constrained by the amount of time required to manually detect vocalizations from archive recordings.

In this study, we successfully used archive broad-band recordings from the Moray Firth, together with new data collected within Moray West, to contribute towards the development of new AI tools to detect minke whale vocalizations. This was made possible through collaboration with ongoing work in the area by colleagues at SAMS and NOAA, on a project that aims to develop an automatic detector of minke whale vocalizations for the North Atlantic region. Critically, the MMMP provided an opportunity to develop training data sets of minke whale calls and background noise from a North Sea site that support optimization of this tool's performance in UK waters. The first version of the NOAA detector provided a valuable tool for focussing our manual analysis effort on those recording periods where minke whale calls might be present. This allowed us to develop a large training database of > 800 minke whale calls and > 1M five seconds noise samples from the Moray Firth, which are now being used to optimise a second version of the detector. This work also confirmed that minke whale calls could be detected from the Moray West site during both 2021 and 2022 and in each month of the summer sampling periods (Table 3; Figure 6).

Although PAM surveys have the potential to collect temporal series of minke whale occurrence, we recognise that these acoustic methods come with limitations. In several whale species only males are known to vocalise (Croll *et al.* 2002; Oleson *et al.* 2007) and there is some evidence that suggest that minke whale pulse trains may be produced by males during breeding season (Risch *et al.* 2013). Further, their vocalisation rates may vary with factors such as the presence of other conspecifics (Silber 1986; Martin *et al.* 2022), movement patterns (Risch *et al.* 2013) and anthropogenic disturbance (Risch *et al.* 2012; Erbe *et al.* 2018). There is also uncertainty over the detection range of different recorders. This latter point makes it difficult to draw inferences from our comparison of acoustic and visual detections on those days on which DAS were conducted. Visual sightings on many of the days on which whales were detected acoustically suggest that some acoustic detections were of individuals occurring within the Moray West site. However, Risch *et al.* (2014a) estimated that calls in the western North Atlantic could be detected at distances > 25 km. Thus, some acoustic detections may be of individuals calling from outside the area covered by DAS, and a lack of visual sightings on days on which whales were acoustically detected does not necessarily reflect differences in the performance of the two different survey approaches. Instead, we suggest the techniques should be seen as complementary, with DAS providing information on spatial variation in occurrence within a clearly defined survey footprint, and PAM providing opportunities to characterise both fine (e.g., diel) and broader (e.g., seasonal and interannual) scale variation in occurrence. Ultimately, the challenge will be to integrate both visual and acoustic detections to jointly model spatio-temporal variation in occurrence or even density, but this will likely require significant advances in both analysis frameworks and sampling designs (eg. DenMod project led by CREEM - https://denmod.wp.st-andrews.ac.uk/about/).

4.1 Future work

This work is supporting the development of an algorithm for automatic detection of minke whales in Scottish waters. Once the final version of the detector has been developed, this will be validated using the 2022 minke whale calls that have been manually annotated and archived during this project. As part of our collaboration with NOAA and SAMS, the second algorithm will also be validated on recordings from the West Coast of Scotland, North-East coast of the USA and recordings from Central America. This process will be reported in a separate technical paper led by NOAA.

Whilst it may yet require several further iterations of this process, once finalised, this automated detector provides enormous opportunities for more detailed analyses of these and other broad-band recordings from UK waters. Once this analysis bottleneck has been overcome, there will be value in collective discussion on key questions that can be addressed through joint analysis of existing datasets from Scottish waters. Critically, there is also a need to explore how future data collection could be co-ordinated to maximise information on the baseline ecology of minke whales in Scottish waters. Such work could better inform understanding of seasonal and interannual variation the use in key areas such as the Southern Trench MPA, and how minke whales may interact and respond to future ScotWind developments. Finally, once completed, pipelines are already in place to import detectors developed within this framework into PAMGUARD (Gillespie *et al.* 2009), an open-source passive acoustic monitoring software, which will enable other organizations and developers across the North Atlantic.

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Supplementary materials

Table S1. Table summarizing available SoundTrap data from the Moray Firth, with those recordings used for the training dataset for the first NOAA minke whale detection algorithm highlighted in bold and available data for the validation of the final.

Deployment	Location	Device	Recording start date	Data end date	Duty cycle (min)
Training					
Archived data from previous Marine Mammal Monitoring Programmes					
887	162	SoundTrap	28/07/2017	22/10/2017	10 out of 30
986	110	SoundTrap	31/03/2019	23/04/2019	Continuous
987	112	SoundTrap	31/03/2019	11/06/2019	Continuous
1027	235	SoundTrap	30/03/2019	16/04/2019	Continuous
1029	237	SoundTrap	30/03/2019	10/04/2019	Continuous
1032	164	SoundTrap	31/03/2019	23/05/2019	Continuous
1092	112	SoundTrap	06/11/2019	29/04/2020	10 out of 60
1093	164	SoundTrap	06/11/2019	29/04/2020	10 out of 60
1101	164	SoundTrap	01/05/2020	27/07/2020	10 out of 60
1102	112	SoundTrap	01/05/2020	16/10/2020	10 out of 60
1136	164	SoundTrap	15/10/2020	23/04/2021	10 out of 60
1137	112	SoundTrap	15/10/2020	22/03/2021	10 out of 60
1160	112	SoundTrap	01/05/2021	29/09/2021	10 out of 60
1190	295	SoundTrap	28/06/2021	30/09/2021	Continuous
Archived data from Marine Directorate ECOMASS project					
MSS 181	Helmsdale	SM2M	31/07/2016	19/11/2016	Continuous
MSS 274	Helmsdale	Loggerhead	05/04/2018	15/08/2018	Continuous
MSS 360	Helmsdale	Loggerhead	01/04/2019	25/08/2019	Continuous
MSS 421	Helmsdale	Loggerhead	25/08/2019	07/12/2019	Continuous
Data collected under Moray West pre-construction Monitoring Programme					
1173	281	SoundTrap	24/05/2021	28/09/2021	10 out of 60
Validation					
Data collected under Moray West pre-construction Monitoring Programme					
1206	48	SoundTrap	01/05/2022	28/09/2022	10 out of 20