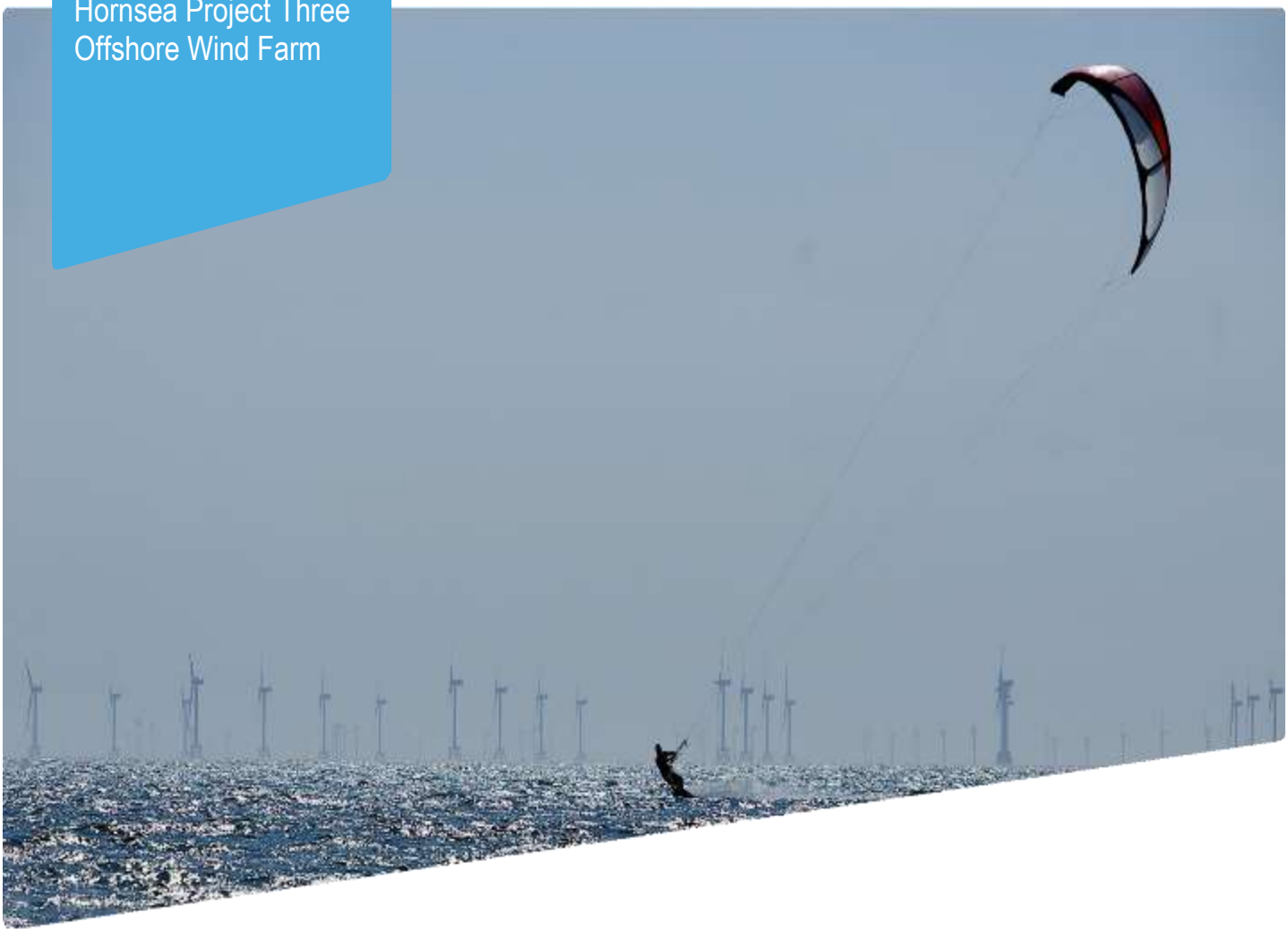
Hornsea Project Three
Offshore Wind Farm



Hornsea Project Three

Offshore Wind Farm

Appendix 5 to Deadline 2 Submission – Seabird Flight Height Trial Report

Date: 21st November 2018

Hornsea 3
Offshore Wind Farm

Ørsted

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Front cover picture: Kite surfer near a UK offshore wind farm © Ørsted Hornsea Project Three (UK) Ltd., 2018.

Seabird Flight Height Field Trial

Using airborne LiDAR to measure the flight height of seabirds species at HOW03

ØRSTED

19 NOVEMBER 2018

Contents

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Verified by JKE
Approved by TNO

1 Introduction

1.1 Background to the study

Ørsted (formerly DONG Energy) commissioned marine ornithology digital aerial surveys of the proposed Hornsea Three Offshore Wind Farm (HOW03) project area, including a 4 km buffer around the site. This comprised of a series of monthly high-resolution digital video aerial surveys, which started in April 2016 (undertaken by Hi-Def). The purpose of these digital video aerial surveys were to provide information to inform the HOW03 Environmental Impact Assessments ("EIA") and Habitats Regulations Assessments ("HRA").

One of the key factors in understanding the interaction of birds with offshore wind farms is assessing the collision risk posed by individuals flying at given heights in the vicinity of a project. The survey contractor developed a computational approach to compute the height of an object directly from video. However, during the course of digital video aerial surveys of the HOW03 project area, this technique was found to be in need of further refinement to be able to meet expectations of the precision and accuracy necessary for determining bird flight heights.

The limitations of the current survey technique could potentially be mitigated by using a survey aircraft equipped with a LiDAR scanner synchronised with digital still cameras. NIRAS Consulting Ltd was commissioned by Ørsted to undertake a pilot study that used data obtained from a combined LiDAR and digital aerial survey undertaken for topographic mapping purposes (NIRAS 2015). Neither LiDAR nor photographic equipment were specifically calibrated for bird detection purposes. Nevertheless, the results indicated that integration of LiDAR and digital camera records is technically feasible and, provided adequate optimisation and calibration of the equipment and survey methodology is applied, this technique would be an effective new approach to bird monitoring at offshore wind farms, particularly in circumstances where it is important to obtain accurate data on the flight heights of birds.

1.2 Purpose and scope

NIRAS Consulting Ltd has been commissioned by Ørsted to undertake a study to test the feasibility of the use of airborne LiDAR (light detection and ranging) technology and digital still camera to describe the flight height distributions of key seabird species within the HOW03 project area in July/August 2017.

This report details the findings of the study together with recommendations on where further refinements to the approach would benefit repeat surveys of the project area surveyed by aircraft.

2 Aims and objectives

The study was a trial of using a survey aircraft equipped with a LiDAR scanner synchronised with digital still cameras as an approach to provide evidence to describe the flight height distributions of key seabird species within the HOW03 project area in July/August 2017.

The objective of the study was to test the feasibility of the use of airborne LiDAR and digital still camera in measuring the flight height of key seabird species within the HOW03 project area. In doing so, the LiDAR and digital aerial survey data

would be used to produce a single flight height distribution for the key species for HOW03 project area in July/August 2017 utilising all of the data collected.

3 Method

3.1 The study area

Previous experience with digital aerial survey data suggests that a minimum sample size of 100 records is necessary in order to derive a robust flight height distribution (Johnston & Cook 2016). Consequently, choice of survey areas is likely to be extremely important in enabling robust distributions to be derived. The key species of greatest interest to HOW03 EIA and HRA is Kittiwake.

Examination of HiDef's digital video aerial survey for July 2016 identifies areas of higher density for kittiwake within the HOW03 project area. The survey recorded 1,099 (194 flying) kittiwake observations at HOW03 (15th July 2016). In doing so, the HiDef's digital video aerial survey covered 10% of the project area including a 4 km buffer around the site. Analysis of observations used data from two of the four video cameras, each camera covering a width of 125 m of sea surface, i.e. 250 m in total. A repeat survey by HiDef in August 2016 reported 132 kittiwake at HOW03.

The review of digital aerial survey for July 2016 identified that the surveying in HOW03 project area of the transects shown in Figure 3.1, could be expected to achieve a minimum sample size of 100 records for Kittiwake. The HOW03 transect are four of approximately 30 km length and two of approximately 20 km length. Within the project area, the transect spacing is approximately 2.5 km. The start and end grid co-ordinates for the relevant transects are in Table 3.1.

3.2 Survey protocol and equipment specifications

The six transects were flown once during each of two consecutive days of survey, 1st and 2nd August 2017. The surveying started at the east end of the six transects and sequentially worked through the transects from east to west. The flying time available on survey, allowed the first transect to be re-surveyed on both days and the second transect on day two. The time duration between re-surveying of a transect was considered to be sufficient to allow for the two samples to be considered independent.

The survey was carried out with a Cessna 337 equipped with a LiDAR Riegl 480i system at an altitude of approximately 325 m above sea level ("ASL") (~1066') and a flight speed approximately of 170 km/h. Flying at 325 m ensures that there is no risk of flushing those species which have been proven to be easily disturbed by aircraft noise (Thaxter *et al*., 2015). Digital imagery was collected using a Phase One Camera (iXA1000) set up with a 1.5 seconds repetition rate. The surveying altitude and camera chosen gave a Ground Sample Distance (GSD) of approximately 3 cm. The camera swath on the ground was approximately 350 m wide. The point density of the LiDAR from an altitude of 325 m was approximately 7.5 points/m^2 (at sea level).

Figure 3.1: Transects flown for LiDAR and digital aerial survey over HOW03 including a 4 km buffer around each site on 1st and 2nd August 2017

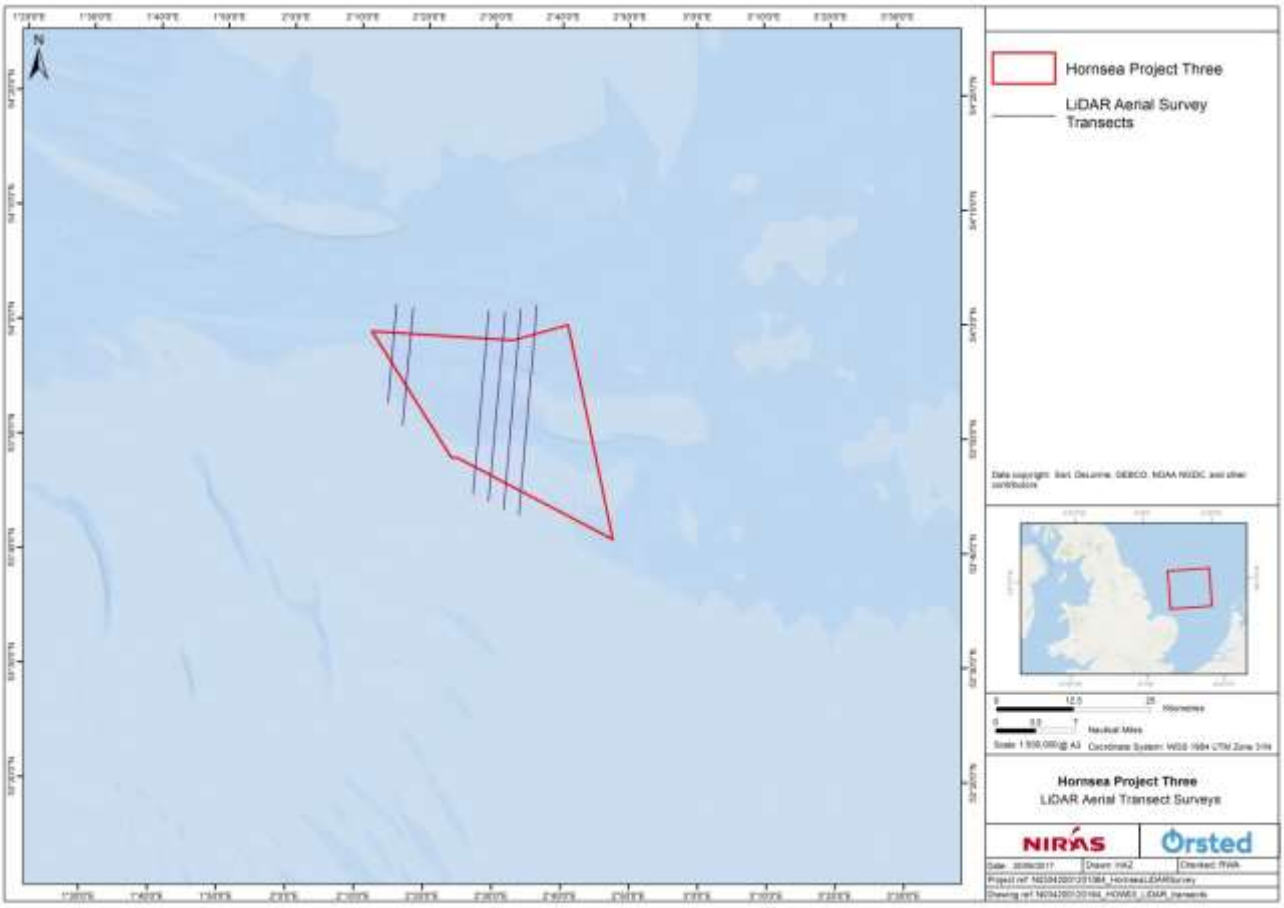


Table 3.1: Start and end points of the transects flown for the LiDAR and digital aerial survey over HOW03 project area

Project Area	Transect	Transect start		Transect end	
		Latitude	Longitude	Latitude	Longitude
HOW03	1	54.029449	2.603929	53.724123	2.562612
	2	53.732302	2.525340	54.023484	2.563958
	3	54.018898	2.525828	53.744168	2.488170
	4	54.024788	2.298181	53.853156	2.274771
	5	53.753182	2.450061	54.020721	2.484985
	6	53.886300	2.238879	54.029485	2.256896

3.3 Data analysis and processing

The data analysis and processing method included the following four components:

- Identification of potential bird records in point cloud;
- Determination of flight height and position of birds;
- Identification of birds in the simultaneously recorded imagery by using the same geo-referencing of images and point cloud; and
- Interpretation of bird species/behavioural traits from camera records.

The data analysis and processing method included the following four components

3.3.1 Identification of potential bird records in point cloud

The internal geometry (angle and distance to points) of the LiDAR dataset was analysed in order to isolate single points or groups of points, that could be the reflections of birds in flight. In the analysis the relative measures between ground classified points and default/unclassified points are used. This means that the height above ground is used in the analysis. All points at an altitude 1.5 metres above sea level or more are selected as potential points for birds. A further qualification of the points is used by selecting groups of points with a maximum count of 25 points within 2 metres, in order to omit groups of points that are "too large" to represent single birds. It is estimated that birds normally fly too far apart from each other to be grouped in the same group of points when applying the above set of selection criteria.

Note that for the purposes of this study LiDAR data positioned at heights lower than 1.5 m from sea level were not considered in the analysis due too many "false positives" originating from sea swell.

3.3.2 Determination of flight heights and position of birds

Once potential birds were identified in point cloud, flight heights and positions were determined based on the average coordinate values of the selected point clusters.

In order to estimate flight height, points which were classified as birds were compared to those which were classified as sea. The height of each point in the LiDAR cloud was measured in relation to the European Terrestrial Reference

System 89 (ETRS89), the EU recommended frame of reference for European geo-data. Flight height estimates made using LiDAR are made in relation to the position of the sea surface, generating a precise measurement of seabird height above sea-level which was independent of the height of the survey aircraft. The flight speed of the plane meant that any individual bird could not be captured by more than one set of LiDAR points.

Cook *et al.* (2018) as part of a recently published trial of using LiDAR scanner synchronised with digital still cameras as an approach to measuring the flight height of seabirds, carried out an exercise to validate measurements of flight height gained from LiDAR. The validation exercise demonstrated the efficacy and accuracy of a LiDAR capture approach by comparing estimated seabird flight heights using airborne LiDAR to objects of known height. Drones were flown at known heights and varying speeds. The validation exercise demonstrated that the height of birds in flight could be measured using LiDAR to an accuracy of within 1m.

Absolute accuracy of images and point cloud can be expected to be within 0.5m. Relative accuracy of height – related to water surface - of LiDAR beams representing birds to be within 0.5m. For the camera orientation the accuracies in X,Y will be in the same magnitude as the camera and the LiDAR instrument are both attached in a fixed position to the IMU on board the aircraft. The IMU measures all accelerations in 3 directions to a survey grade accuracy and is "state of the art" equipment.

For a project like this where the LiDAR data is used to point out where in the image database to find an image subset, and from there make a manual visual interpretation of species, the geometric accuracy of the equipment is found not to be a bottleneck for achieving good results. The image ground sample distance, the image repetition rate, as well as the LiDAR point density is key to finding the optimal results.

3.3.3 Identification of birds from digital still camera records- LiDAR-camera data integration

Based on the positions of the selected groups of reflections aerial images corresponding to the timing of the selected LiDAR points were identified. The two aerial images acquired before and after the exact timing of the selected LiDAR points provide an image subset which allows for visual inspection and bird species classification. In the selection of image subsets the EO (exterior orientation) data of the images is used to find the subsets around the birds. Subset sizes are chosen with respect to an evaluation of the time gap between the image acquisition timestamps and the average timing of the selected group/cluster of points as well as an assumed maximum flight speed of 22 m/s for the potential detected birds.

3.3.4 Interpretation of bird species/behavioural traits from camera records

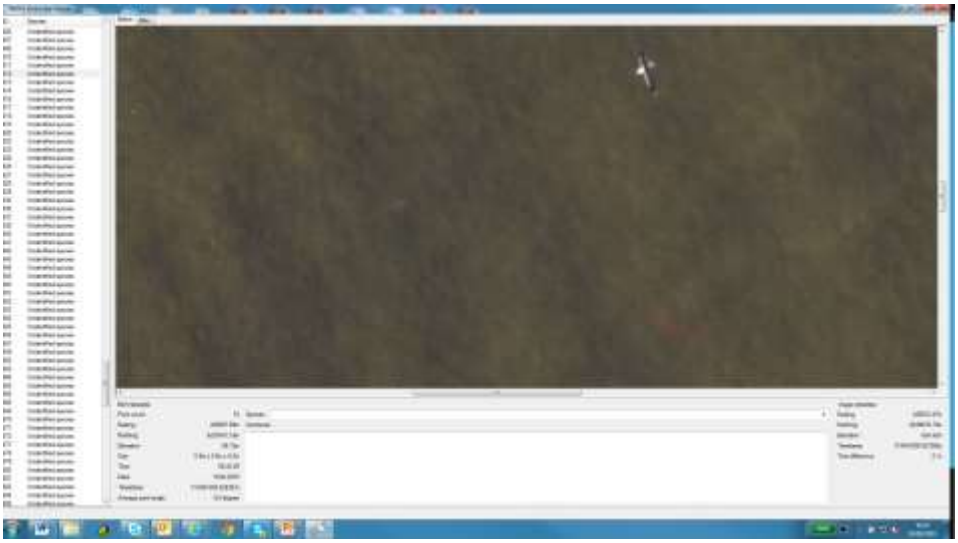
A Viewer integrating and displaying LiDAR points and corresponding photo records was developed by NIRAS' Informatics Department to facilitate the interpretation of results and identification of bird species. For each LiDAR record (i.e. potential bird), the viewer shows up to two photos, one taken immediately before and/or one taken immediately after the LiDAR record. Examples of the outputs and information displayed in the viewer are given in Figure 3.1 and Figure 3.2.

In both the "before" and "after" Viewer screens the following information is displayed:

- Bird Metadata (from the LiDAR record), including number of points (red[1] and green points combined), coordinates, elevation, size, time, date, timestamp and average point angle; and
- Image Metadata, including coordinates, elevation, timestamp and time difference (between the LiDAR record and the image).

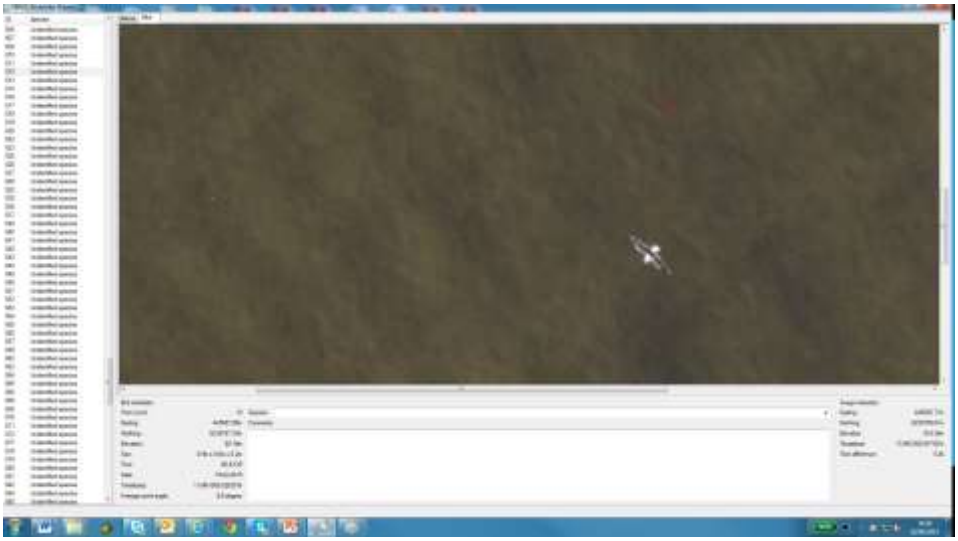
Once into the Viewer images can be examined by an expert ornithologist for species ID. The viewer has an integrated function that allows for species names and any comments be inserted by the ornithologist and all data can be exported into CVS for further work in other formats if required (i.e. Excel, GIS).

Figure 3.2: "Before" photo



[1] The red dots show the actual scanned points overlaid on the images, the green dot visualizes a projection of the average coordinates of the cluster onto the image, taken height into account.

Figure 3.3: "After" photo



4 Results

4.1 Introduction

LiDAR clusters corresponding with objects recorded at heights lower than 1.5 m were filtered out to avoid analysis of sea clutter ('false positives'), resulting in a total of 162 clusters being taken forward for further analysis.

After implementation of the analysis and processing methodology outlined in section 3.3, up to two images were successfully assigned to each of the 162 LiDAR clusters based on location and time. These were integrated with the LiDAR data and made accessible for ornithological analysis in the Viewer.

4.2 Classification of records

For a limited number of LiDAR records (11), birds were not found in the associated images. This is considered to be most likely a result of scanner noise[2]. As such, these records were also excluded from the analysis.

The remaining 151 LiDAR clusters (those representing birds flying at sea) were analysed in detail by an ornithologist together with their accompanying photos.

The resolution of the camera used for image acquisition, enabled "definite" ID of the 151 detected birds to species level to be possible for two species, Gannet (20 birds), Arctic Skua (1 bird) and Great Skua (1 bird). All remaining images (129) were reviewed and "probable" IDs to species or species group level assigned where possible.

Thirty-four birds were identified as probable Kittiwake across HOW03. However, it was also considered likely that the majority of birds identified as grey backed gull

[2] Note that these clusters normally consisted of few LiDAR points (typically below 4). Error points where LiDAR reflections were seen but no birds are most likely suspended matter in the air.

species from the images (91 birds) were also Kittiwake on the basis of flight profile, size and what was discernible on wing colouration; adults of the species have distinctive two toned grey coloured wings. This concurs with baseline characterisation surveys at HOW03 (DONG Energy 2017). The analysis of the images indicated that the majority of birds recorded in the HOW03 data were grey backed gull species. The remaining bird records were classified as tern spp. (3) and probable Herring Gull (1).

37% of the 151 detected birds were identified independently by a second expert ornithologist for which there was less than 2% disagreement with the first identification of the birds.

A summary of the results of the photo analysis is given in Table 4.1 below. Full results are provided in Appendix 1. Examples of the outputs of the Viewer used for photo analysis are given in Figure 4.1 and Figure 4.2.

Table 4.1: Summary of the results of the photo analysis for HOW03 data

Species/Species Group	No. recorded
Gannet	20
Great Skua	1
Tern species	3
Kittiwake	34
Grey backed gull species (probably Kittiwake)	91
Herring Gull	1
Arctic Skua	1
TOTAL	151

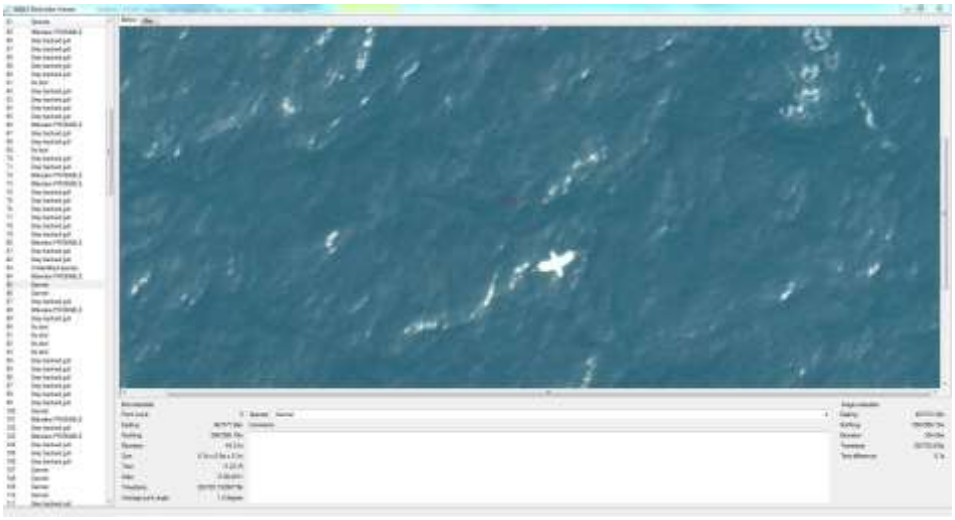


Figure 4.1: LiDAR Cluster and associated "before" picture showing bird classified as Gannet flying at 1.31 m (44.31 m elevation above ETRS89)

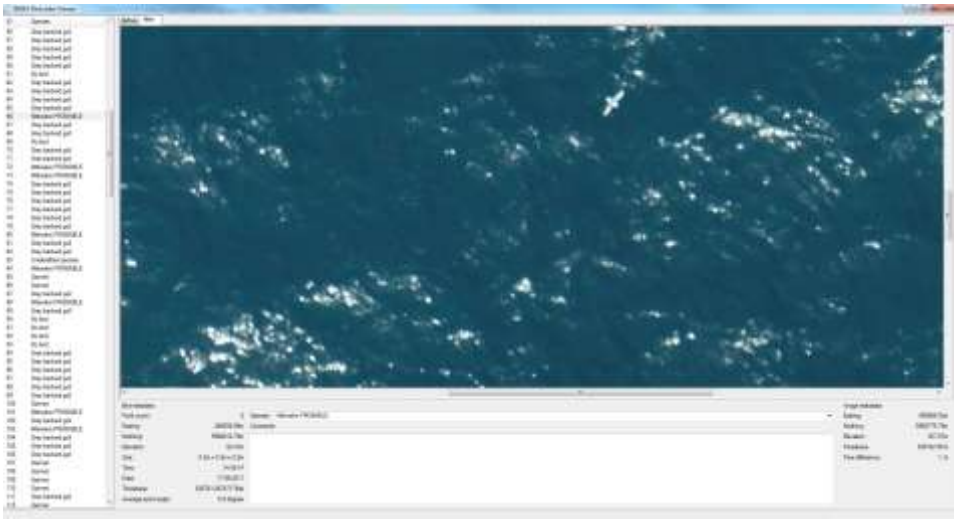


Figure 4.2: LiDAR Cluster and associated "before" picture showing bird classified as probable kittiwake flying at 9.46 m (52.46 m elevation above ETRS89)

4.3 Flight Height Data Results

Previous analyses have suggested that a minimum sample size of 100 estimates of flight height is required in order to generate a robust flight height distribution using digital aerial survey data (Johnston & Cook, 2016). This is available for the Project area only for grey backed gull species inclusive of (probable) Kittiwake and 'all birds'. For all other birds identified to species or species group level e.g. Gannet and tern species, less than 100 individuals of each species are available for the project area.

The flight height distribution for grey backed gull species inclusive of (probable) Kittiwake and 'all birds' are shown for the project area in Figure 4.6 and Figure 4.3. For Gannet and (probable) Kittiwake where less than a hundred individuals

are recorded at a project site, the flight height distributions at HOW03 are shown in Figure 4.4 and Figure 4.5. Flight height ("Elevation") values by individual LiDAR record can be found in Appendix 1.

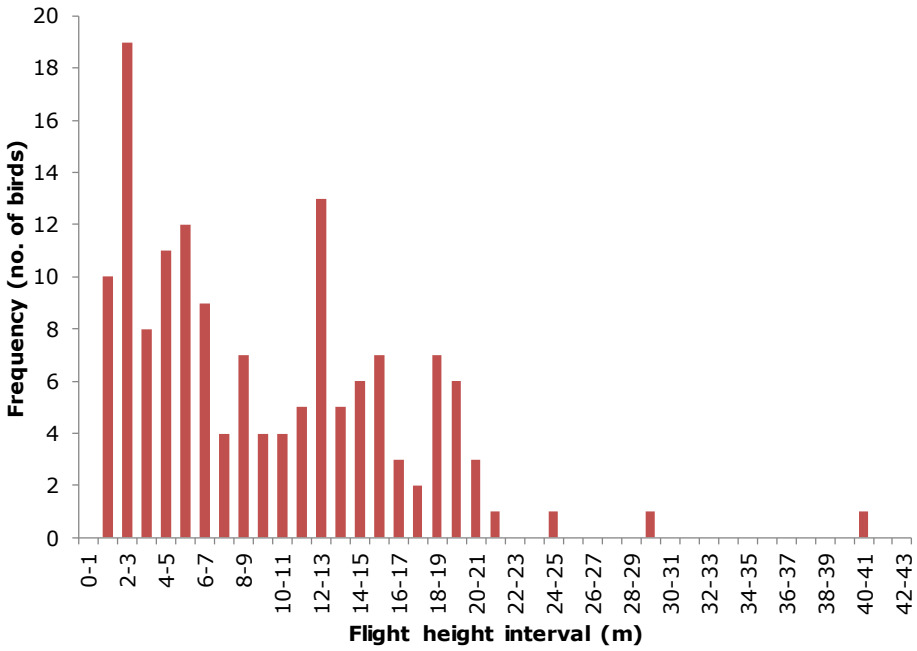


Figure 4.3: All birds Flight Height Distribution recorded at HOW03 (based on all bird IDs and associated elevation data recorded by LiDAR). One bird at 114 m has been omitted.

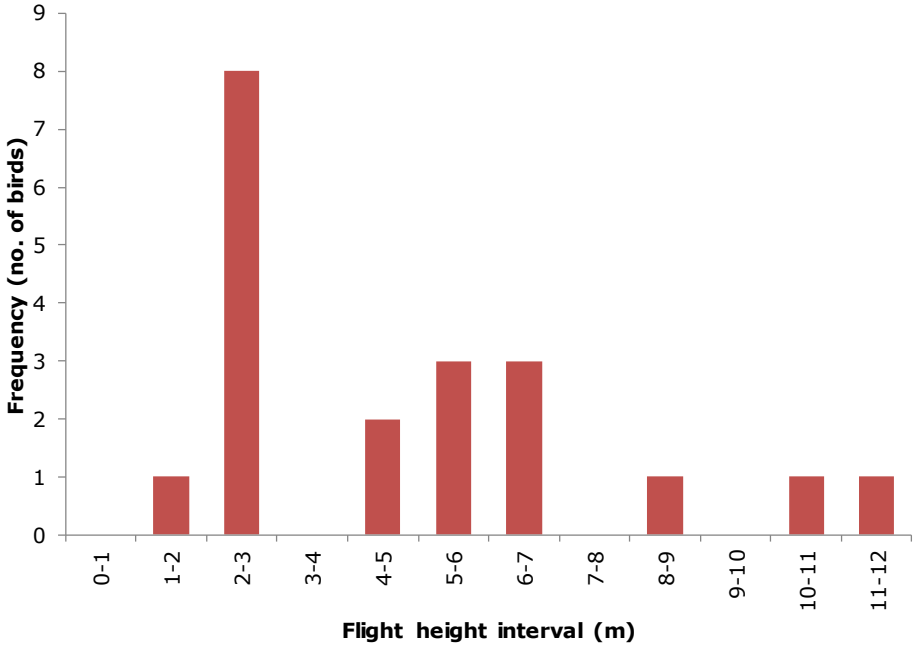


Figure 4.4: Gannet Flight Height Distribution recorded at HOW03 (based on definite Gannet IDs and associated elevation data recorded by LiDAR).

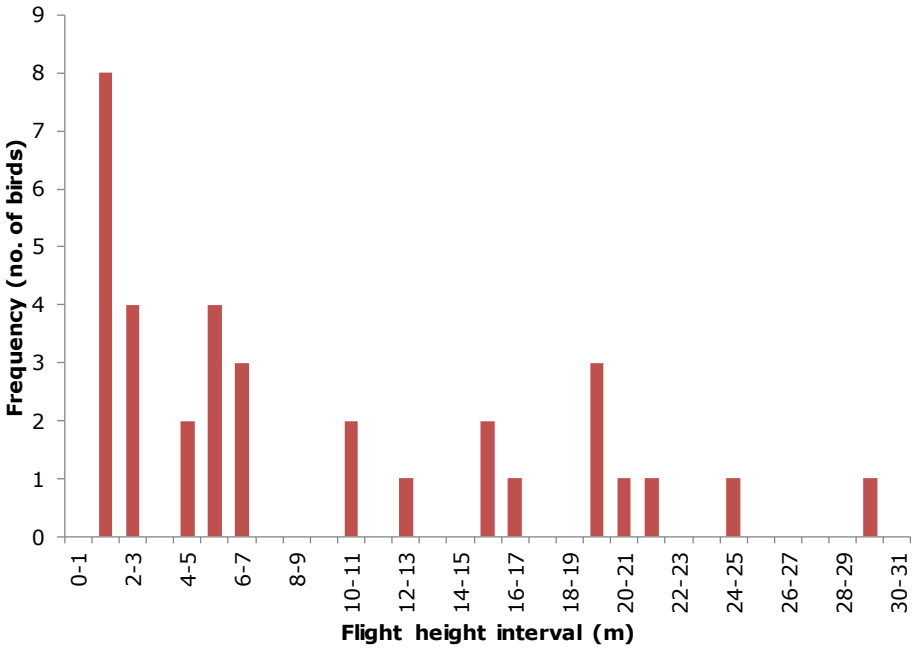


Figure 4.5: Kittiwake Flight Height Distribution recorded at HOW03 (based on probable Kittiwake IDs and associated elevation data recorded by LiDAR).

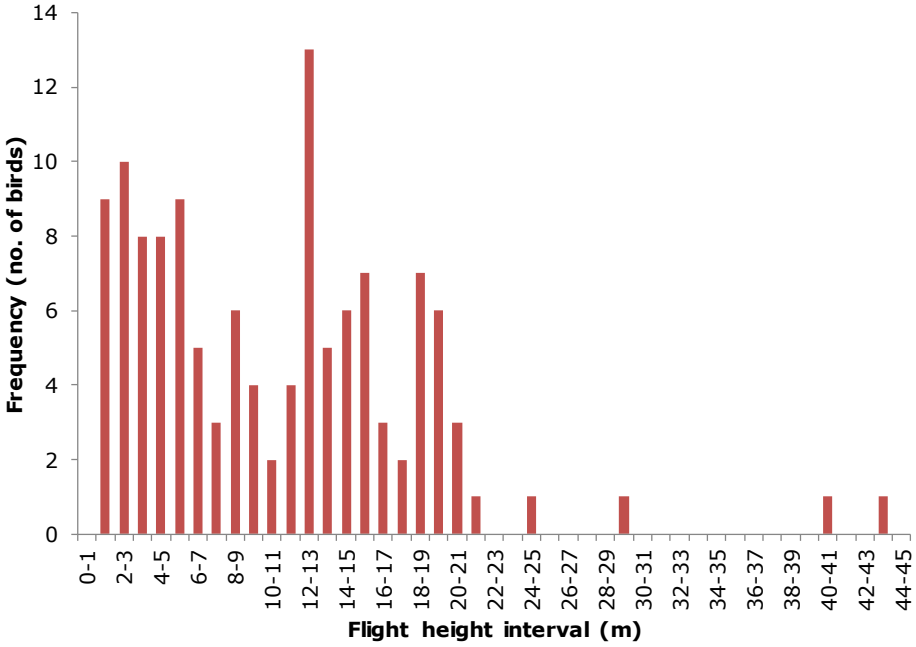


Figure 4.6: Grey backed gull species including probable Kittiwake, Flight Height Distribution recorded at HOW03 (based on all bird IDs and associated elevation data recorded by LiDAR). One bird at 113 m has been omitted.

An alternative representation of flight height distribution for the same species or species group is shown in Figure 4.7 and Figure 4.10 as the relative frequency of observations of birds inflight at 1 m intervals upwards from sea level. The grey shaded area indicates altitudes for which LiDAR data were not considered in the analysis due too many "false positives" originating from sea swell.

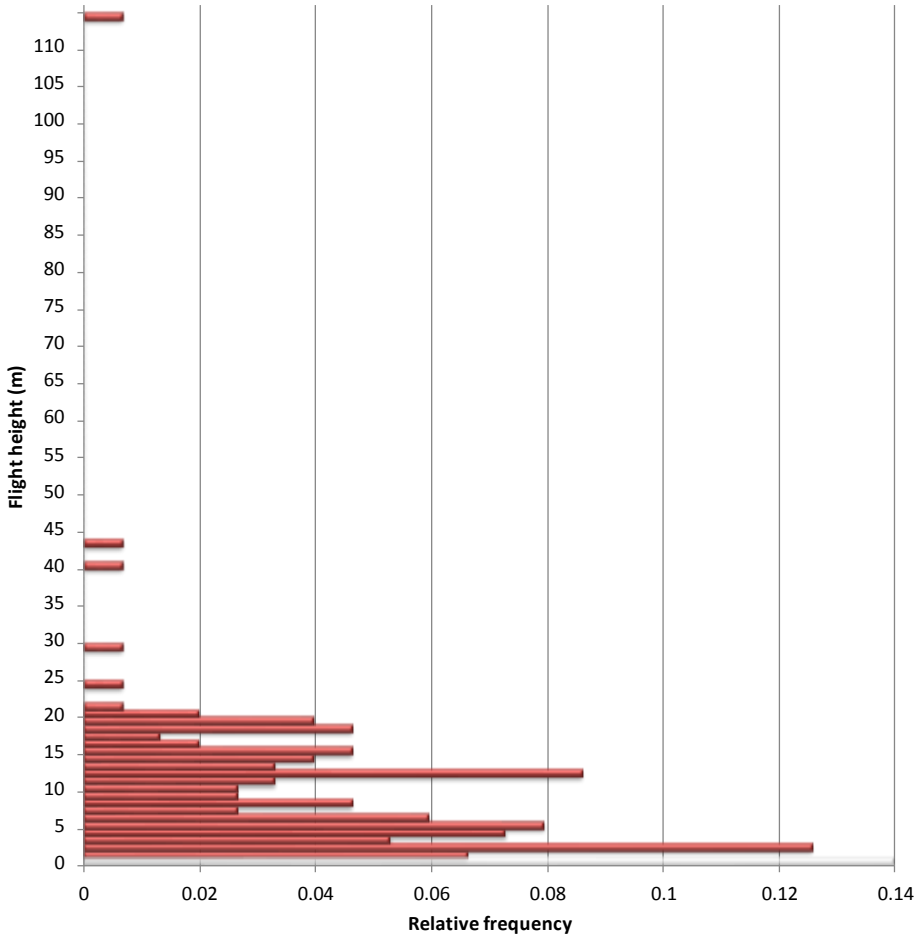


Figure 4.7: All birds Flight Height Distribution at HOW03. Data show the relative frequency of observations of birds at 1 m intervals from 0 – 116 m. The grey shaded area indicates altitudes below 1 m for which LiDAR data (below 1.5 m) were screened out to minimise on sea clutter impacting the analysis.

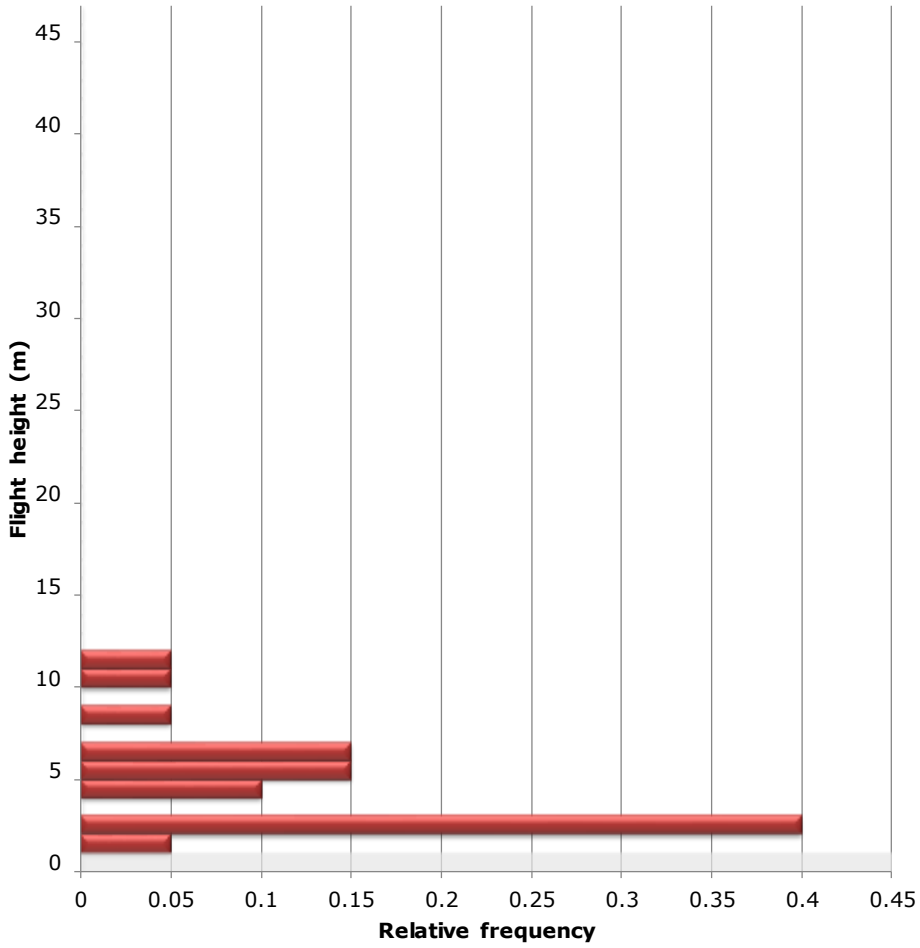


Figure 4.8: Gannet Flight Height Distribution at HOW03. Data show the relative frequency of observations of birds at 1 m intervals from 0 – 47 m. The grey shaded area indicates altitudes below 1 m for which LiDAR data (below 1.5 m) were screened out to minimise on sea clutter impacting the analysis.

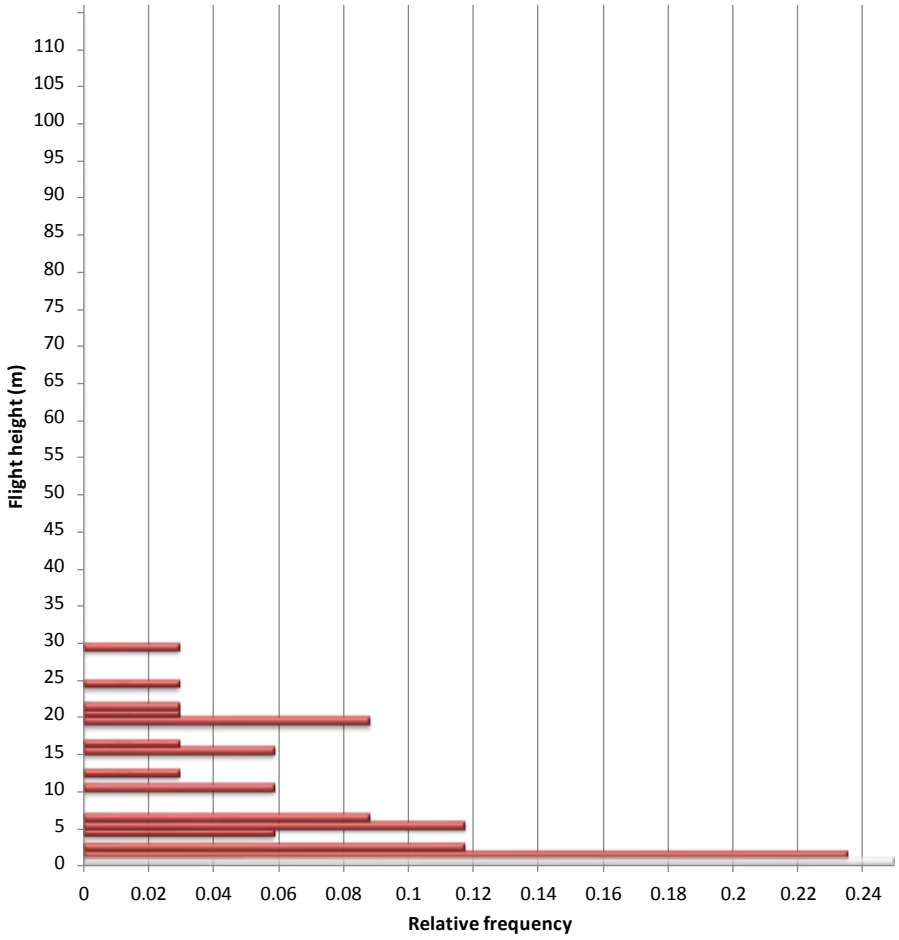


Figure 4.9: Kittiwake Flight Height Distribution at HOW03. Data show the relative frequency of observations of birds at 1 m intervals from 0 – 116 m. The grey shaded area indicates altitudes below 1 m for which LiDAR data (below 1.5 m) were screened out to minimise on sea clutter.

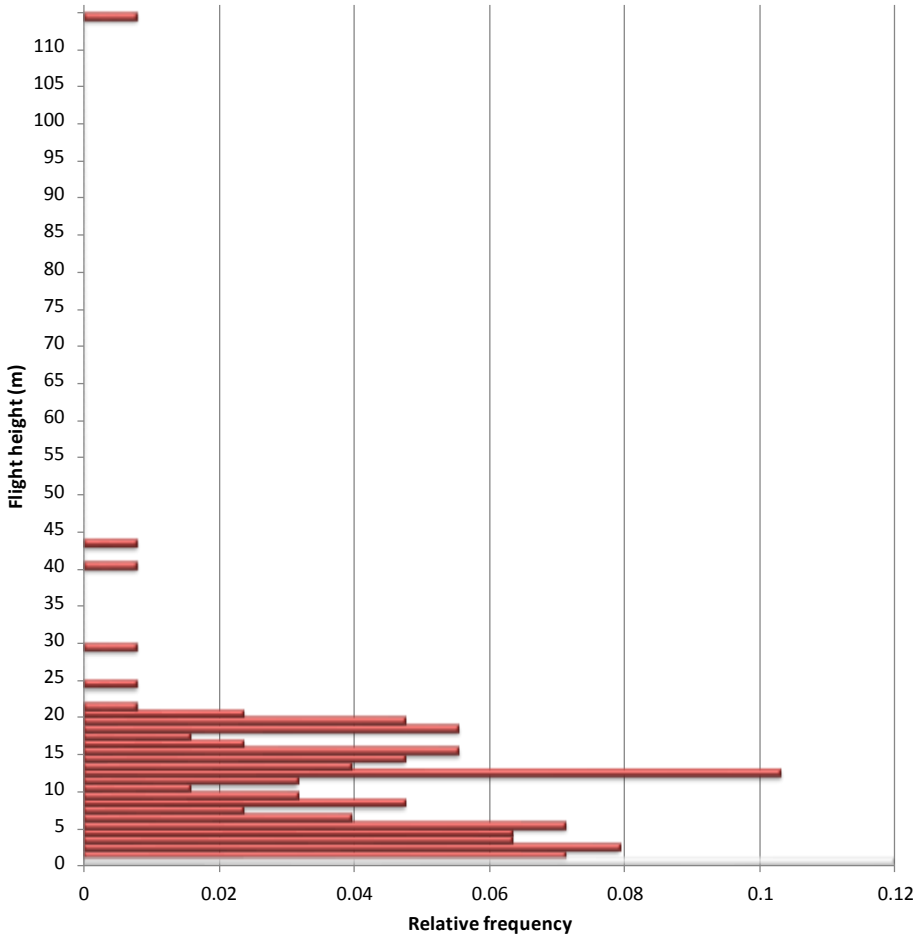


Figure 4.10: Grey backed gull species including probable Kittiwake, Flight Height Distribution (0 - 116 m) at HOW03. Data show the relative frequency of observations of birds at 1 m intervals from 0 – 116 m. The grey shaded area indicates altitudes below 1 m for which LiDAR data (below 1.5 m) were screened out to minimise on sea clutter.

4.4 Potential collision risk

A wind turbine hub-height of 123.87 m (above HAT) will be used at Hornsea Three (DONG 2017). This provides for a lower tip height clearance of 34.97 m LAT reducing the potential collision risk impacts on birds. The lower tip height equates to an "air gap" between MSL and lower tip height of 33.17m.

No greater than 2.0% (3) of the 151 seabirds recorded flying at or above 1.5 metres above sea level during a combined LiDAR and digital aerial survey in August 2017 at HOW03 project area, were at potential collision height for HOW03. Moreover, the majority of birds recorded were grey backed gull species (91 birds, 60%), these are largely considered to be Kittiwake. In combination with those birds identified as probable Kittiwake (34 birds), only 2.4% (3) of grey backed gulls flying were at potential collision risk. This is markedly lower than the proportion of Kittiwakes baseline characterisation surveys at HOW03 have identified as being at collision risk, and which has given rise to it being the key species of greatest interest to the HOW03 EIA and HRA. Though a comparable scenario is found for another key species, Gannet, with no birds at potential collision height, as recorded from 20 individuals at the project site, is less robust as the sample size is below 100 individuals.

5 Representativeness of study findings

The findings of this study found a markedly lower proportion of birds at potential collision height than the baseline characterisation surveys at HOW03 (HiDef pers comm.) and studies using a variety of recording platforms (e.g. boat-based observers, digital video aerial surveys) elsewhere in the UK e.g. Johnston *et al.* (2014). There are many reasons why these two estimated distributions may vary, including different observation processes and data collection processes, analytical differences, site-specific differences, survey times in different seasons or times of day, behavioural patterns affected by the presence of boats or planes.

In contrast to other approaches, Cook *et al.* (2018) validated that LiDAR is capable of measuring seabird flight heights with a high degree of precision, typically within 1 m. Cook *et al.* (2018) highlight that the uncertainty associated with measurements of seabird flight height from LiDAR is far lower than the uncertainty associated with measurements made using other technologies. Furthermore, flight heights are estimated relative to the sea surface, helping to overcome difficulties associated with negative flight heights that may be recorded when using digital aerial surveys, GPS tags or laser rangefinders (Cook *et al.* 2018).

A key limitation of LiDAR estimates of seabird flight height is that sea-swell may interfere with the detection of birds in flight, resulting in a high false positive rate. In this study a lower threshold of 1.5 m above sea level was used. As a consequence, the flight height distributions derived from this technique will be biased against birds flying below 1.5 m above sea level. Such an overestimate in the proportion on birds at greater altitudes is likely to lead to a precautionary assessment of collision risk though considered unlikely to be overly so (Cook *et al.* 2018).

6 Conclusion

This study has used data obtained from a combined LiDAR and digital aerial survey undertaken during two days in August 2017. It has been possible to extract a large number of bird detections from the survey results and to confidently and accurately determine the horizontal and vertical location of those birds. Furthermore, it has been possible with reasonable confidence to identify the species involved in the large majority of cases. This report has also demonstrated that, from the resulting data, it is possible to construct a flight height distribution for a species group that could be used to inform collision risk modelling using the Extended version of the Band (2012) collision risk model (so-called 'Option 4').

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APPENDIX 1 – LiDAR Data and Photo Analysis Results

timestamp	length	Width	Easting	Northing	Elevation	Average sea level height	Point count	Bird flight height	Day	Species
216868.635	0.194062273	0.014510986	472228.1809	5965061.404	58.76713334	54.55548206	3	4.21165	1	Grey backed gull
216868.725	0.210566554	0.005700144	472235.1413	5965065.652	59.37616666	54.55548206	3	4.82068	1	Grey backed gull
216868.846	0.655504532	0.002950959	472217.259	5965071.11	57.31682	54.55548206	5	2.76134	1	Grey backed gull
216891.232	0.220414011	0.983258046	472227.4681	5966149.749	75.369	54.55548206	5	20.81352	1	Grey backed gull
216895.721	0.21645553	0.001286316	472389.0645	5966365.431	67.4625	54.55548206	3	12.90702	1	Grey backed gull
216901.584	0.242830634	0.010803371	472409.7576	5966652.242	62.33473333	54.65241535	3	7.68232	1	Grey backed gull
216914.66	0.2124479	0.004590381	472517.6676	5967275.791	63.9189	54.57540615	3	9.34349	1	Grey backed gull
216914.852	0.218394082	0.000176553	472411.1376	5967283.352	61.52283333	54.57540615	3	6.94743	1	Grey backed gull
216922.179	0.230249383	0.005313409	472380.0958	5967631.002	66.94393333	54.40168489	3	12.54225	1	Grey backed gull
217055.157	0.213554953	0.013224671	472848.3113	5974087.061	62.2096	54.38770027	3	7.8219	1	Grey backed gull
217051.79	0.261532908	0.016276518	472820.2643	5973913.555	72.64256667	54.40214391	3	18.24042	1	Grey backed gull
230506.74	0.509030674	0.026414834	471942.9212	5960875.723	59.365325	53.83927097	4	5.52605	1	Gannet
230573.91	0.261199061	0.019354009	472265.3677	5964408.252	56.68996667	53.78028818	3	2.90968	1	Grey backed gull
230904.623	0.432581395	0.015803189	473631.1462	5983237.662	56.52949998	53.61425484	4	2.91525	1	Gannet
230585.054	0.214430827	0.020194778	472254.147	5965035.126	62.42216667	53.65019633	3	8.77197	1	Grey backed gull
230585.114	0.244078582	0.014799164	472261.2535	5965038.005	58.84816667	53.65019633	3	5.19797	1	Grey backed gull

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230597.683	0.474392616	0.008399526	472131.0204	5965738.2	66.73839998	53.65019633	4	13.0882	1	Grey backed gull
230604.798	0.240133738	0.004775241	472178.9398	5966133.426	64.90426666	53.65019633	3	11.25407	1	Grey backed gull
230610.089	0.37012573	0.51305674	472358.7991	5966429.099	68.96227499	53.65019633	4	15.31208	1	Grey backed gull
230783.35	0.311729045	0.021835502	472989.5028	5976334.273	56.58563335	53.65003356	3	2.9356	1	Gannet
218372.163	0.245158217	0.334841374	468919.0016	5954995.83	59.0057	54.54075433	4	4.46495	1	Grey backed gull
218358.277	0.325625762	0.258982797	468887.3192	5955498.735	57.29916	54.54042967	5	2.75873	1	Grey backed gull
218091.954	0.229388974	0.382610864	469774.1001	5965402.652	67.814325	54.42629704	4	13.38803	1	Grey backed gull
218087.887	0.487735195	0.269674064	469583.471	5965592.006	74.043275	54.47617776	4	19.5671	1	Grey backed gull
218088.249	0.150197197	0.327240613	469552.0982	5965585.245	73.01183333	54.47617776	3	18.53566	1	Grey backed gull
218085.846	0.430523425	1.104510605	469708.864	5965640.871	60.913075	54.3972091	8	6.51587	1	Gannet
218086.293	0.213592203	0.04255328	469712.6191	5965623.586	65.31986667	54.36228225	3	10.95758	1	Gannet
217608.318	0.748238123	0.996052685	471164.1369	5984559.242	60.477725	54.35594193	8	6.12178	1	Gannet
217574.701	1.023309144	0.776164	471330.4727	5985739.917	94.77342	54.36703267	10	40.40639	1	Herring Gull
219078.481	0.193060115	0.455158915	466708.3857	5959565.002	75.8489	54.52746149	4	21.32144	1	Kittiwake PROBABLE
219192.147	0.21722176	0.006260235	467101.3462	5965251.957	56.05836667	54.50255223	3	1.55581	1	Grey backed gull
219192.285	0.509377199	0.000693941	467244.6944	5965258.718	67.110825	54.40113738	4	12.70969	1	Grey backed gull
219203.352	0.247417606	0.000634883	467095.6523	5965799.965	58.91906667	54.36118454	3	4.55788	1	Grey backed gull
219203.168	0.206837965	0.436488947	467091.3151	5965790.927	64.13746667	54.52768721	3	9.60978	1	Grey backed gull

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219203.011	0.47051358	0.003934794	467092.6097	5965783.719	60.496075	54.52768721	4	5.96839	1	Grey backed gull
219202.976	0.614607538	0.467184767	467103.5888	5965782.185	59.619975	54.52768721	4	5.09229	1	Grey backed gull
219202.901	0.426505549	0.01368688	467098.7008	5965778.431	60.47075	54.52768721	4	5.94306	1	Kittiwake PROBABLE
219202.897	0.835586428	0.422248391	467076.8814	5965777.782	64.8316	54.52768721	7	10.30391	1	Kittiwake PROBABLE
219202.881	0.228359464	0.002842206	467093.3179	5965777.629	59.23003333	54.52768721	3	4.70235	1	Kittiwake PROBABLE
219202.76	0.2283675	0.003949558	467098.3803	5965771.86	60.27453333	54.52768721	3	5.74685	1	Kittiwake PROBABLE
219202.691	0.259271232	0.000391264	467067.1272	5965768.265	60.09786667	54.41415245	3	5.68371	1	Kittiwake PROBABLE
219202.626	0.420134572	0.523238966	467081.6335	5965765.482	59.98308	54.41415245	5	5.56893	1	Gannet
219202.62	0.25331812	0.004008617	467099.6402	5965765.349	59.3706	54.41415245	3	4.95645	1	Kittiwake PROBABLE
219202.595	0.95332349	0.535131936	467104.6297	5965764.001	60.77805	54.41415245	4	6.3639	1	Kittiwake PROBABLE
219202.265	0.689697552	1.419530328	467077.0512	5965748.255	62.42997778	54.41415245	9	8.01583	1	Gannet
219202.149	0.455407622	0.005691794	467089.0967	5965743.039	60.555625	54.43234714	4	6.12328	1	Kittiwake PROBABLE
219201.989	0.220497469	0.007345441	467081.5889	5965735.62	57.87663334	54.43234714	3	3.44429	1	Grey backed gull
219201.919	0.683786079	0.010756087	467082.9051	5965732.17	60.13928	54.43234714	5	5.70693	1	Gannet
219201.528	0.230320945	0.000605353	467083.0577	5965713.968	56.4182	54.41470321	3	2.0035	1	Kittiwake PROBABLE
219205.664	0.248092618	0.002716705	467264.8945	5965912.709	60.4858	54.38065989	3	6.10514	1	Kittiwake PROBABLE
219213.734	0.447542705	0.017990792	467127.6522	5966313.027	69.78735	54.39853983	4	15.38881	1	Kittiwake PROBABLE
219220.688	0.480316601	0.005529381	467181.6531	5966666.712	68.580375	54.42095645	4	14.15942	1	Grey backed gull

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219287.856	0.456997261	0.013878821	467613.4692	5969966.564	60.951825	54.33569607	4	6.61613	1	Arctic Skua
219604.3	0.234409737	0.544928317	468860.4334	5984806.894	59.05422	54.39461008	5	4.65961	1	Great Skua
220539.861	0.444485496	0.384042917	464293.9125	5962796.586	64.71148	54.45171898	5	10.25976	1	Tern species
220448.523	0.227927759	0.050689414	464482.8674	5966364.108	57.94616667	54.43525133	3	3.51092	1	Grey backed gull
220370.634	0.220005326	0.036146415	464927.7772	5969329.116	65.51103334	54.38957321	3	11.12146	1	Grey backed gull
220278.471	0.208584047	0.368146065	465012.3186	5972727.084	68.082625	54.43650971	4	13.64612	1	Grey backed gull
220277.708	0.465214564	0.0858168	465068.2778	5972742.8	58.678225	54.39623042	4	4.28199	1	Grey backed gull
220195.674	0.447871998	0.414140667	465355.1755	5975741.059	68.62011667	54.36391059	6	14.25621	1	Grey backed gull
220040.032	0.393532098	0.077438925	465831.3588	5982082.552	97.934075	54.39162696	4	43.54245	1	Grey backed gull
221393.816	0.215698259	0.015606242	452645.3795	5972533.27	75.28326667	54.66606483	3	20.6172	1	Kittiwake PROBABLE
221399.719	0.251264371	0.438825211	452799.6814	5972827.567	72.78625	54.58078636	4	18.20546	1	No bird
221441.368	0.148682898	0.562284881	453107.3163	5974923.693	74.1341	54.60070412	3	19.5334	1	Kittiwake PROBABLE
221454.015	0.047842287	0.398825648	452875.6874	5975523.898	70.865	54.61629469	3	16.24871	1	Grey backed gull
221489.839	0.215263829	0.450696333	453156.1684	5977236.117	73.471975	54.68797964	4	18.784	1	Grey backed gull
221498.402	0.607530234	0.035055301	453212.3747	5977649.304	74.11048	54.66212931	5	19.44835	1	Grey backed gull
221498.751	0.480841845	0.035231533	453311.5121	5977675.079	61.4884	54.66212931	4	6.82627	1	Gannet
221503.137	0.578744684	0.50490208	453258.284	5977898.25	73.65938	54.66710637	5	18.99227	1	Grey backed gull
221505.932	0.527385036	0.553248143	453079.3359	5978019.874	75.9454	54.66710637	4	21.27829	1	No bird

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221503.392	0.208794548	0.006804478	453235.5931	5977909.484	68.4439	54.63629909	3	13.8076	1	Grey backed gull
221504.521	0.425773038	0.501994266	453262.7983	5977967.003	70.1777	54.63132819	3	15.54637	1	Grey backed gull
221505.635	0.210724065	0.003451192	453376.8442	5978029.302	72.3585	54.63132819	3	17.72717	1	Grey backed gull
222192.536	0.212244157	0.044546844	450329.5618	5976775.11	78.59056667	54.56730058	3	24.02327	1	Kittiwake
222171.118	0.218858285	0.372361746	450656.0636	5977538.596	74.758775	54.62446767	4	20.13431	1	Grey backed gull
222162.434	0.14229739	0.384274307	450658.5323	5977874.784	70.0114	54.60146611	3	15.40993	1	Grey backed gull
222161.592	0.230006679	0.035834787	450434.1535	5977941.807	71.50576667	54.63839146	3	16.86738	1	Grey backed gull
222161.332	0.214935134	0.033442177	450463.7499	5977947.245	72.86243333	54.61625087	3	18.24618	1	Grey backed gull
222159.28	0.282936276	0.311874518	450420.8986	5978030.595	70.2875	54.59364988	3	15.69385	1	Grey backed gull
222157.483	0.139506148	0.461020414	450644.1532	5978074.109	74.6012	54.69133679	3	19.90986	1	Grey backed gull
222155.621	0.21496165	0.030105727	450553.8555	5978159.512	71.64863333	54.69642164	3	16.95221	1	No bird
222152.596	0.20646073	0.026672175	450590.9568	5978276.229	72.1343	54.63562869	3	17.49867	1	Grey backed gull
221966.327	0.209302519	0.037807915	451173.7961	5985462.447	73.24613333	54.67900466	3	18.56713	1	Grey backed gull
291921.712	0.188052821	0.522913867	472071.6015	5965282.426	55.59219999	41.5601382	3	14.03206	2	Grey backed gull
291937.4409	0.133612868	0.456130166	472176.8989	5966080.155	156.32205	41.5742547	4	114.7478	2	Grey backed gull
291943.7168	0.008516108	0.559690599	472245.9835	5966411.662	53.72063334	41.59720676	3	12.12343	2	Grey backed gull
291947.576	0.166412162	0.006551387	472412.0171	5966612.587	53.99533332	41.48695938	3	12.50837	2	Grey backed gull
291945.3764	0.081946399	0.504642778	472289.5281	5966497.396	59.45280001	41.41475451	3	18.03805	2	Grey backed gull

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291946.5081	0.183724222	0.583024858	472339.5533	5966556.837	51.5561	41.60351077	3	9.95259	2	Grey backed gull
291948.5595	0.210554835	0.004310974	472316.822	5966659.203	53.6218	41.53660713	3	12.08519	2	Grey backed gull
291986.2675	0.234866083	0.015302745	472523.7061	5968564.237	44.89003333	41.58859096	3	3.30144	2	Grey backed gull
291986.7484	0.230248287	0.013110861	472530.427	5968588.635	45.91823334	41.41442788	3	4.50381	2	Grey backed gull
292286.9944	0.665721143	0.979513143	473945.0461	5983764.78	43.21198	41.45307588	5	1.7589	2	Gannet
304415.6129	0.46420026	0.025096734	471296.659	5954674.432	43.5994	42.07544375	4	1.52396	2	No bird
304526.4956	0.233688233	0.02588731	471741.6837	5960892.094	43.90266666	42.31698125	3	1.58569	2	Kittiwake PROBABLE
304573.9247	0.464483932	0.049515832	471979.9626	5963635.766	50.654125	42.17770058	4	8.47642	2	Grey backed gull
304575.8968	0.500030075	0.048604251	472122.0056	5963736.421	43.758625	42.14615177	4	1.61247	2	Kittiwake PROBABLE
304575.833	0.18584786	0.628612288	472145.137	5963730.263	44.505	42.14615177	3	2.35885	2	Kittiwake PROBABLE
304575.8165	0.467780948	0.047297382	472127.7984	5963731.055	44.060025	42.14615177	4	1.91387	2	Kittiwake PROBABLE
304575.7364	0.246727197	0.023725328	472125.7526	5963726.567	43.75833333	42.18054519	3	1.57779	2	Kittiwake PROBABLE
304575.5357	0.221705966	0.024685312	472141.8633	5963713.084	44.06106667	42.18054519	3	1.88052	2	Kittiwake PROBABLE
304575.2919	0.421576084	0.483694984	472136.7671	5963699.554	44.1577	42.18054519	3	1.97715	2	Kittiwake PROBABLE
304575.4553	0.189443076	0.025604961	472155.8929	5963706.9	45.8187	42.19571247	3	3.62299	2	Grey backed gull
304623.1748	0.431284389	0.053726857	472386.182	5966465.097	44.770625	42.2415898	4	2.52904	2	Gannet
304630.7109	0.217582403	0.029106081	472411.7117	5966911.674	49.15143333	42.12335148	3	7.02808	2	Tern species
304630.7105	0.253776939	0.027089307	472436.9821	5966908.998	45.08406667	42.13982119	3	2.94425	2	Tern species

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304789.6009	0.217912716	0.01460951	473220.3695	5975780.902	61.79843334	42.16456066	3	19.63387	2	Kittiwake PROBABLE
293171.6195	0.240821014	0.044968821	469367.4214	5960450.404	57.47783333	41.69497496	3	15.78286	2	No bird
305874.7504	0.432802884	0.666985477	469699.1785	5964722.704	47.89272001	42.38162361	5	5.5111	2	Grey backed gull
305797.0007	0.27518225	0.371172057	469789.2812	5967542.722	45.62849998	42.30614937	3	3.32235	2	Grey backed gull
305796.4194	0.390303881	0.470935338	469782.2314	5967564.585	45.22103335	42.30614937	3	2.91488	2	Grey backed gull
305778.3167	0.221467644	0.027013899	469922.9872	5968210.521	50.59603335	42.44347466	3	8.15256	2	Grey backed gull
305761.8875	0.298496668	0.349090188	469938.8851	5968810.787	52.46528	42.19414668	5	10.27113	2	Kittiwake PROBABLE
305758.471	0.245121817	0.288597327	470126.8978	5968915.258	53.71674	42.29202972	5	11.42471	2	Grey backed gull
305755.3449	0.270577355	0.361106688	470090.7997	5969035.592	57.08305	42.3762294	4	14.70682	2	Grey backed gull
305751.4287	0.214874035	0.022530939	469900.2517	5969197.404	64.5713	42.17788152	3	22.39342	2	No bird
305731.4604	0.035857813	0.352930513	469952.3249	5969925.359	56.72576663	42.26107495	3	14.46469	2	Grey backed gull
305736.2721	0.302607916	0.356677927	470100.8229	5969734.211	48.44369999	42.33390706	4	6.10979	2	Grey backed gull
305736.3085	0.222080986	0.022569653	470025.6569	5969740.74	58.11409998	42.23426199	3	15.87984	2	Kittiwake PROBABLE
305735.8284	0.242440213	0.02603059	470084.7833	5969752.352	47.8043333	42.13450005	3	5.66983	2	Kittiwake PROBABLE
305736.8618	0.221440137	0.020332043	470168.3643	5969706.134	54.8101667	42.38324332	3	12.42692	2	Grey backed gull
305735.3786	0.245726981	0.026053817	470163.5486	5969760.932	51.81196669	42.23055937	3	9.58141	2	Grey backed gull
305729.3648	0.276633454	0.335509683	469928.8813	5970001.574	55.17275001	42.39618749	4	12.77656	2	Grey backed gull
305729.7349	0.229973392	0.020393984	470058.2436	5969976.6	47.38056667	42.24244723	3	5.13812	2	Grey backed gull

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305730.3338	0.384006163	0.401886913	470166.1409	5969944.927	54.39660002	42.26882662	5	12.12777	2	Grey backed gull
305729.2297	0.606250707	0.378597201	470114.2477	5969989.922	54.83945	42.25690784	6	12.58254	2	Grey backed gull
305727.0006	0.253621617	0.022763217	470149.0982	5970068.555	54.89679996	42.26962145	3	12.62718	2	Kittiwake PROBABLE
305706.3576	0.448040522	0.039580124	470208.2834	5970821.174	51.26472497	42.33306966	4	8.93166	2	Grey backed gull
305668.3069	0.22262147	0.022561909	470243.0627	5972218.052	49.86706669	42.54464436	3	7.32242	2	Grey backed gull
293647.3338	0.56088386	0.561245666	466869.7194	5963481.621	60.99035	41.82274761	6	19.1676	2	Kittiwake PROBABLE
293735.733	0.676809004	0.002884945	467377.2636	5967980.786	44.3143	41.76009674	5	2.5542	2	Gannet
293875.4074	0.848486325	0.956024174	467965.2251	5975038.957	45.98836667	41.7130736	6	4.27529	2	Gannet
293878.5997	0.44917532	0.00474996	468049.0253	5975199.273	54.0628	41.72148395	4	12.34132	2	Grey backed gull
293876.9969	0.222617814	0.001537181	468000.5002	5975118.946	43.67916667	41.69410906	3	1.98506	2	Kittiwake PROBABLE
293891.2361	0.468116473	0.009310504	468099.6917	5975838.698	44.320475	41.73190332	4	2.58857	2	Kittiwake PROBABLE
293935.661	0.241471558	0.007219648	468155.9475	5978050.328	52.95466667	41.51920749	3	11.43546	2	Grey backed gull
294742.8056	0.272514465	0.397566296	464913.1684	5968474.9	44.6737	41.73208097	4	2.94162	2	No bird
294742.3567	0.311073423	0.335852366	464960.9717	5968482.157	45.80844	41.73208097	5	4.07636	2	No bird
294741.9565	0.27368063	0.323620967	464934.1176	5968502.484	44.8864	41.73208097	4	3.15432	2	No bird
294741.8883	0.334677033	0.428070772	464960.1187	5968499.891	45.90803333	41.73208097	3	4.17595	2	No bird
294701.6877	0.158860349	0.403798318	464837.1957	5970023.037	45.32146666	41.7747819	3	3.54668	2	Grey backed gull
294701.5741	0.23770506	0.038505996	464835.213	5970027.617	44.19403333	41.7747819	3	2.41925	2	Grey backed gull

timestamp	length	Width	Easting	Northing	Elevation	Average sea level height	Point count	Bird flight height	Day	Species
294701.519	0.252842749	0.389487228	464837.0686	5970029.355	44.47965	41.7747819	4	2.70487	2	Grey backed gull
294696.3966	0.396037437	0.051921761	465070.9234	5970188.538	55.28915	41.75987164	4	13.52928	2	Grey backed gull
294666.9019	0.252773351	0.036391056	464927.9889	5971307.445	43.6054	41.59186641	3	2.01353	2	Kittiwake PROBABLE
294667.0181	1.029781975	0.457256934	464924.318	5971303.35	45.1909	41.59186641	5	3.59903	2	Grey backed gull
294667.0755	0.163055548	0.429586478	464918.5625	5971302.074	44.6679	41.59186641	3	3.07603	2	Grey backed gull
294646.56	1.261501766	0.722068488	464940.5948	5972052.257	53.48826667	41.70964574	9	11.77862	2	Gannet
294562.8594	0.444029811	0.439371597	465424.8467	5975168.215	58.3475	41.70370392	5	16.6438	2	Kittiwake PROBABLE
294556.72	0.217725134	0.319362889	465308.3773	5975422.796	56.444725	41.68567135	4	14.75905	2	Grey backed gull
294368.9825	0.413175432	0.075348238	465987.5141	5982601.673	71.19215	41.50361208	4	29.68854	2	Kittiwake PROBABLE
294368.4227	0.240964062	0.044040087	466077.0243	5982607.184	49.94446667	41.49720836	3	8.44726	2	Grey backed gull
295633.896	0.513314391	0.003706425	452829.3922	5972012.62	43.671925	42.08248758	4	1.58944	2	No bird
295636.5339	0.442444424	0.015532358	452682.9765	5972144.048	43.7094	42.03881427	4	1.67059	2	Kittiwake PROBABLE
295649.0379	0.214237486	0.002283758	452863.3197	5972755.673	57.77286667	41.96887882	3	15.80399	2	Grey backed gull
295653.0167	0.425183079	0.008770002	452846.7409	5972960.105	54.6974	42.03514394	4	12.66226	2	Grey backed gull
295664.7912	0.467306796	0.931272227	452692.0453	5973560.792	44.92421429	42.14944829	7	2.77477	2	Gannet
295785.544	0.305665652	0.937711675	453350.7791	5979466.261	46.28203333	42.0538244	6	4.22821	2	Gannet
296568.9256	0.930833219	0.606966598	449974.536	5972423.811	44.098775	42.08085909	8	2.01792	2	Gannet
296568.8654	0.979587841	0.614979552	449973.1446	5972426.423	44.1686875	42.08085909	8	2.08783	2	Gannet

timestamp	length	Width	Easting	Northing	Elevation	Average sea level height	Point count	Bird flight height	Day	Species
296568.8458	0.547431829	0.693055805	449975.1354	5972426.806	44.29458333	42.08085909	6	2.21372	2	Gannet
296566.761	0.21245015	0.043448981	450059.7873	5972496.812	50.1647	42.04695906	3	8.11774	2	Grey backed gull