Appendix 11-8:
Aerial Survey Data Comparison

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ORIEL WIND FARM PROJECT

Environmental Impact Assessment Report – Addendum
Appendix 11-8: Aerial Survey Data Comparison

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1 INTRODUCTION

1.1 Purpose of the report

The purpose of this technical report is to provide a comparison of seabird densities recorded during the Oriel Wind Farm Project's digital aerial surveys (DAS) (hereafter referred to as Oriel DAS) in 2020 with DAS undertaken in 2021 and 2022 for the Clogherhead Wind Farm Project (hereafter referred to as Clogherhead DAS). An area of the sea was covered by both DAS campaigns which provided an area of overlap from which to draw direct comparisons.

1.2 Project background

Oriel Windfarm Ltd ("the Applicant") is proposing to develop the Oriel Wind Farm Project (hereafter referred to as the Project). The offshore wind farm area is located in the Irish Sea, off the coast of County Louth (approximately 22 km east of Dundalk town centre and 18 km east of Blackrock). The closest wind turbine will be approximately 6 km from the closest shore on the Cooley Peninsula. The offshore cable corridor extends approximately 11 km southwest from the wind farm area to the landfall south of Dunany Point. The Project will comprise both onshore and offshore infrastructure including 25 offshore wind turbine generators (WTGs), associated foundations and inter-array cabling, offshore substation, one offshore cable within a defined offshore cable corridor, a landfall, onshore cable route and an onshore substation for connection to the electricity transmission network.

2 ASSESSMENT METHODOLOGY

2.1 Study area for comparison

DAS data was collected from the Oriel DAS Area in 2020, and from the Clogherhead DAS Area in 2021 and 2022 (Figure 2.1). The overlapping area between both DAS campaigns represents the Study Area, in which comparisons of the similarities and/or differences were made between the two DAS surveys.

The DAS conducted for the Project covered April to September 2020, whereas the Clogherhead DAS undertook year round surveys (April 2021 to March 2023). To allow comparison within the area of overlap, only the months which were surveyed by both campaigns have been used within this report (April to September, inclusive).

It should be noted that the data from Clogherhead Wind Farm Project for September 2021 was presented in a format that did not allow a direct comparison to be made and therefore has not been included within the analysis.

2.2 Species included in the comparison

To provide an indication of the densities between the three years (2020, 2021 and 2022), six species were used in the comparison exercise. The species used for comparison have DAS data available, were chosen due to having high abundances in the Study Area for both the Project and the Clogherhead surveys, and are qualifying species of Special Protection Areas (SPAs) close to the Study Area.

The six species chosen to compare were Atlantic puffin *Fratercula arctica*, black-legged kittiwake *Rissa tridactyla*, common guillemot *Uria aalge*, northern gannet *Morus bassanus*, Manx shearwater *Puffinus puffinus* and razorbill *Alca torda*. These six species also represent species that are commonly included within the impact assessments for offshore wind farm applications.

For species that had Oriel DAS data available but were recorded in low numbers e.g. great black-backed gull *Larus marinus*, it is noted that Clogherhead DAS also recorded this species in low numbers but in much lower numbers than those recorded by Oriel Project. Therefore, these species were not compared because less numbers were recorded at Clogherhead, which would result in less impacts, were they to be used in the assessment.

It should also be noted that common gull *Larus canus* and herring gull *Larus argentatus* were infrequently recorded during DAS campaigns, therefore boat-based data was used as part of the assessment presented

within the Environmental Impact Assessment Report. As a result, the data was not compatible for the purpose of comparison in this report.

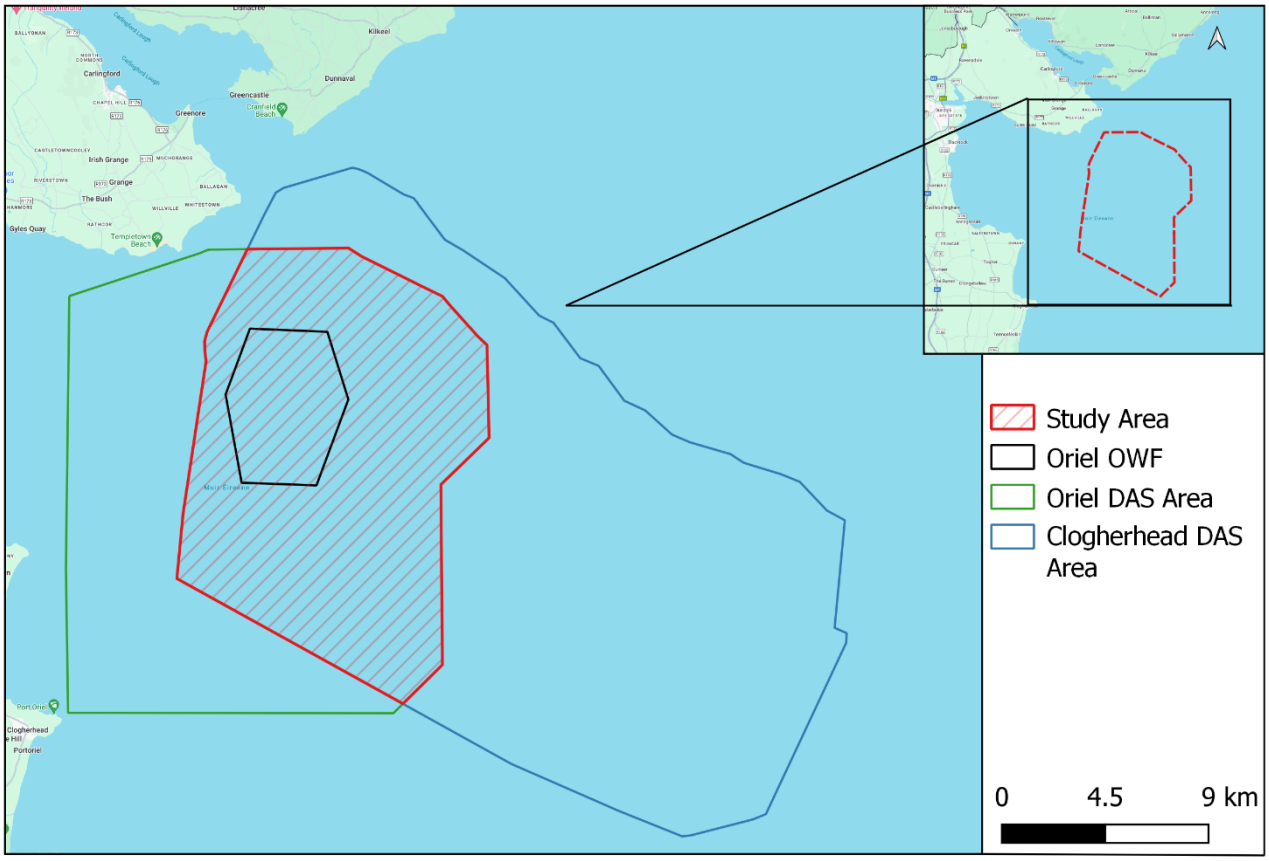

Figure 2.1: Study Area consisting of the overlapping area between the Oriel DAS Area and the Clogherhead DAS Area.

2.3 Density Modelling

Density modelling refers to the estimation and visualisation of the spatial distribution or density of organisms or ecological phenomena within a given area (Silverman, 1986[1]). One method for density modelling is Kernel Density Estimation (KDE) (Parzen, 1962[2]). KDE is a non-parametric technique that estimates the Probability Density Function of a variable based on observed data points.

In the context of ecology, KDE is applied to spatial data, such as the locations of individual organisms, to estimate the density of the population across a study area. The basic principle behind KDE is to assign a kernel, which is a smoothing function with a predefined shape (e.g., Gaussian), to each data point (Shekhar & Evans, 2003[3]). These kernels are then summed or integrated to generate a continuous density surface.

The estimation process involves the determination of the bandwidth or smoothing parameter, which controls the extent of smoothing around each data point. A larger bandwidth results in a smoother density surface but may over-smooth the data, whereas a smaller bandwidth can capture more detailed features but may introduce noise. Various bandwidth selection methods, such as cross-validation or plug-in estimators, are available to find an optimal bandwidth value for the data (Silverman, 1986[1]).

The radius used to generate the heatmaps was set to 8 km in all cases within the computer software R. This was chosen on the basis of experience of dealing with DAS data of a similar scale and as a suitable radius to

[1] Silverman, B.W. (1986). Density estimation for statistics and data analysis. London: Chapman and Hall.

[2] Parzen, E. (1962). On estimation of a probability density function and mode. *The Annals of Mathematical Statistics*, 33(3), 1065-1076.

[3] Shekhar, S., & Evans, M.R. (2003). Kernel density estimation in spatial ecology. In S. Shekhar & H. Xiong (Eds.), *Encyclopedia of GIS* (pp. 533-536). Springer US.

produce heatmaps that are effective in visualising general distribution trends. Outputs where then saved as shapefiles and visualised in QGIS.

2.3.1 Density Estimates

Point estimates and densities were produced using the raw bird data, the coverage calculated from the GPS log files, and the area of the boundary. The estimated bird populations for each boundary area were calculated using the following formula:

*Relative population estimate = (raw birds observed) / (coverage of digital aerial survey) * (total area of boundary).*

The density estimates still needed to be corrected, as these estimates were only based on the number of visible and identified birds. However, there are sources of bias that lead to an underestimate of these numbers. Namely, some of the birds were not identified to species level, but to broader groups (e.g., “common guillemot/razorbill” or “auk species”). These birds must be apportioned to relevant species to get the best estimate of the absolute number. In summary, to obtain absolute population estimates from the aerial survey data, the estimates need to be adjusted for unidentified birds (apportioning analysis).

As per the model-based approach, apportioning of unidentified species were applied to the point estimates.

2.3.2 Apportioning to known species

As described under section 2.3.1, there were unidentified taxon groups that could be apportioned to known species (e.g. auk species). The known species estimates (e.g. positively identified guillemot and razorbill) for each survey month were increased proportionally.

Each species will have a single proportional increase assigned to it for each survey month. These ratios can simply be summed to get the total proportional increase.

To exemplify this, consider a month with 1,200 “common guillemot/razorbills”, 200 of which are unknown, 900 identified common guillemots, and 100 identified razorbills. Applying the formula leads to a ratio of:

200 (unknown “common guillemot/razorbill”) / (900 common guillemot + 100 razorbill) = 0.20.

Thus, both razorbill and common guillemot need to be increased by 0.20 (or multiplied by 1.20), which leads to an absolute estimate of 900*1.20=1080 common guillemots and 100*1.2=120 razorbill. The 200 unknown birds have thus been proportionally attributed to razorbill and common guillemot (180 to common guillemot, and 20 to razorbill).

3 RESULTS

3.1 Atlantic puffin

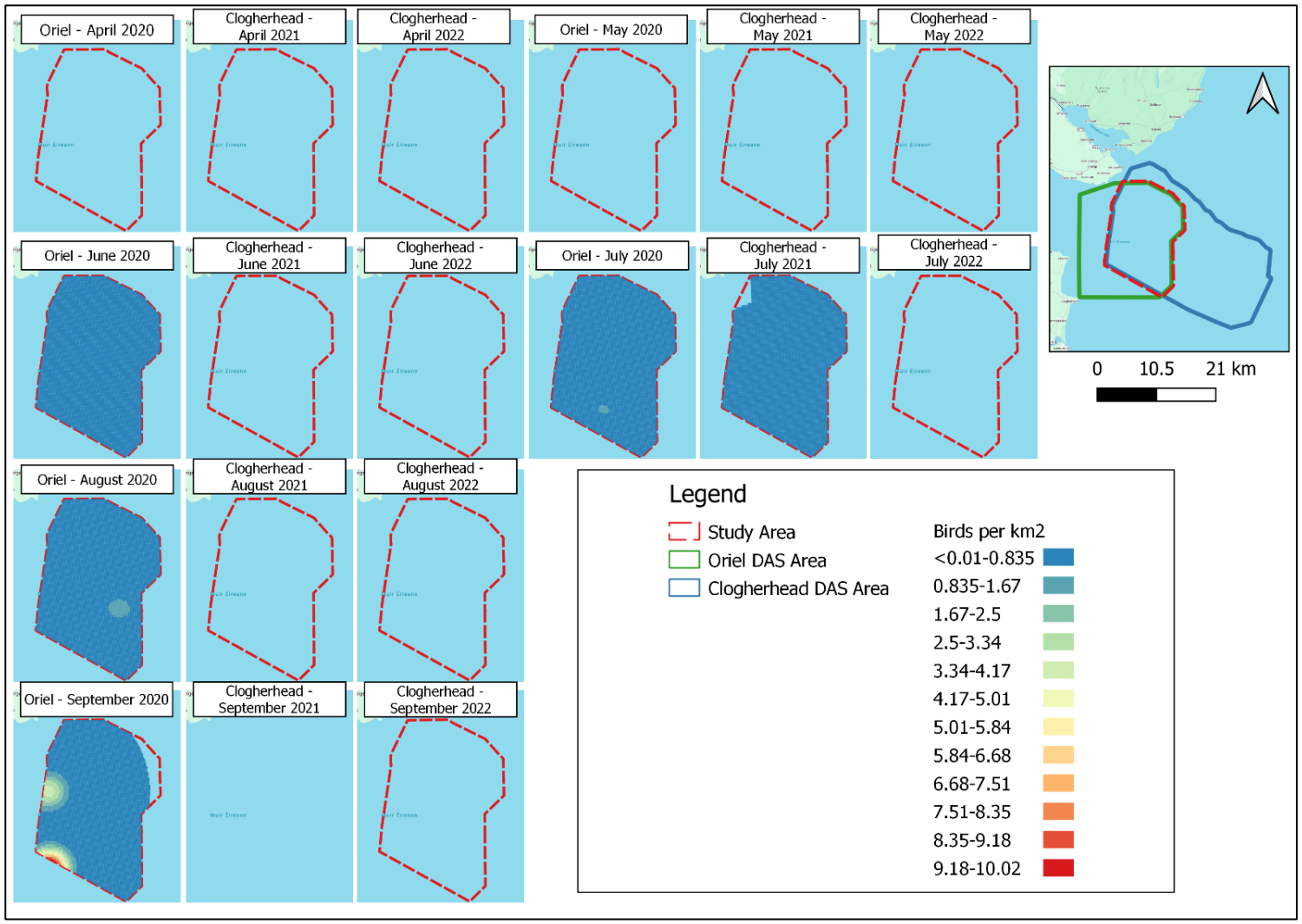

Figure 3.1: Atlantic puffin kernel density map across the Study Area.

Atlantic puffin were present in the Study Area during five of the 17 survey months, with birds present throughout the breeding season during the Oriel DAS but only present in July 2021 of the Clogherhead DAS.

The average density of Atlantic puffin present in the Study Area using Clogherhead DAS data was lower than the average density found using the Oriel DAS data in seven months (Table 3.1). Similarly, the maximum densities were lower for seven months when using the Clogherhead DAS data. The maximum density in the Study Area during the 17 survey months was of 10.02 birds per km^2 in September 2020.

There was no particular pattern of Atlantic puffin distribution with low densities throughout the Study Area.

Table 3.1: Average and maximum densities of Atlantic puffin in the Study Area from April to September 2020 – 2022.

	Birds per km^2	April	May	June	July	August	September
Oriel 2020	Average	0	0	0.06	0.10	0.13	0.31
	Maximum	0	0	0.49	0.88	1.12	10.02
Clogherhead 2021	Average	0	0	0	0.06	0	-
	Maximum	0	0	0	0.67	0	-
Clogherhead 2022	Average	0	0	0	0	0	0
	Maximum	0	0	0	0	0	0

**blue = lesser density than Oriel ; green = higher density than Oriel; orange = same density as Oriel*

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3.2 Black-legged kittiwake

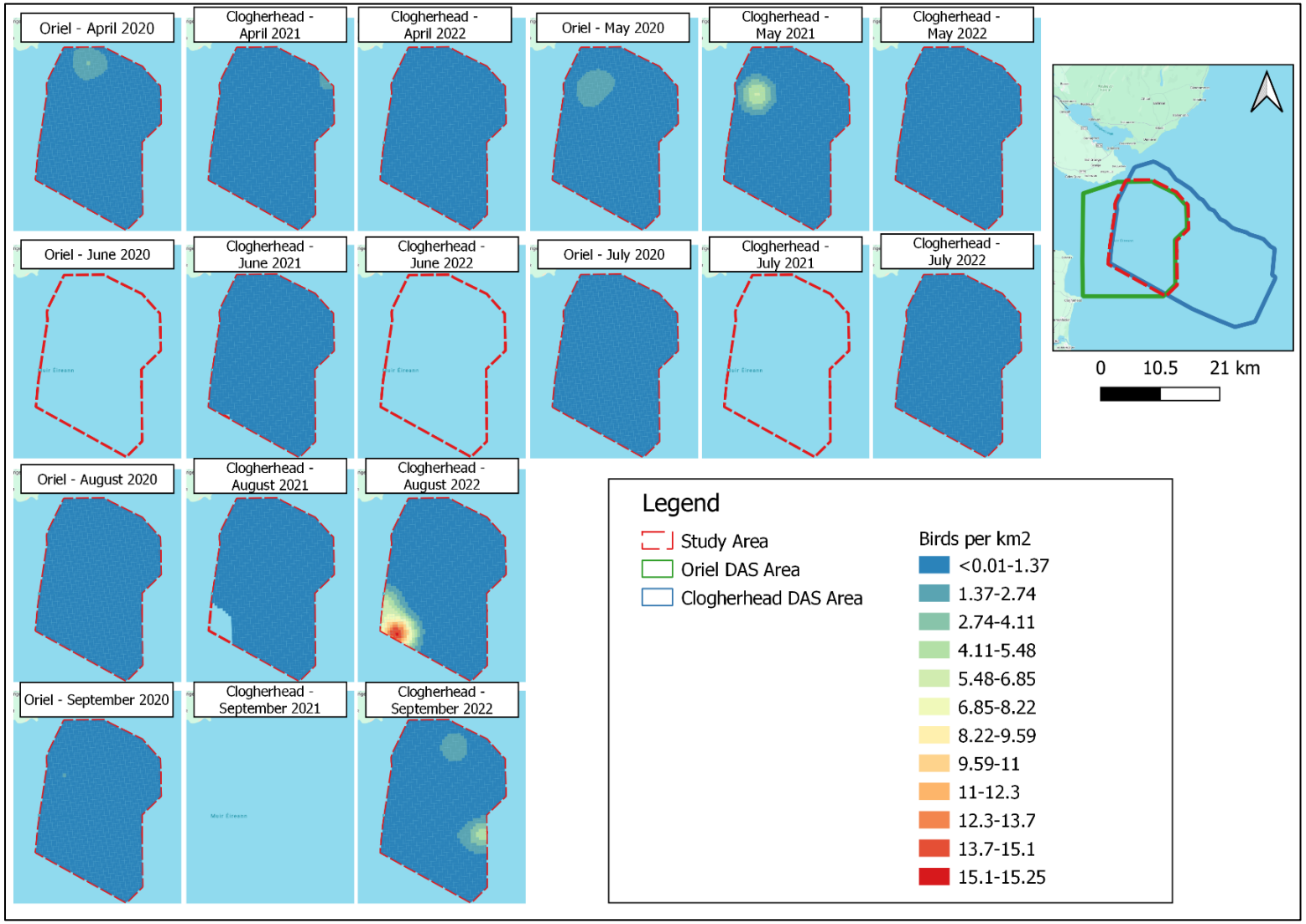

Figure 3.2: Black-legged kittiwake kernel density map across the Study Area.

Black-legged kittiwake were present in the Study Area during 14 of the 17 survey months, with birds present throughout the breeding season during both the Oriel DAS and Clogherhead DAS. Black-legged kittiwake were absent from the Study Area in June 2020 and 2022.

The average density of black-legged kittiwake present in the Study Area using Clogherhead DAS data was lower than the average density found using the Oriel DAS data in seven months and higher in three (Table 3.2). However, when comparing the maximum densities Oriel DAS data was higher than Clogherhead DAS data during five months and lower during five months. The maximum density in the Study Area during the 17 survey months was of 15.25 birds per km^2 in August 2020.

There was no particular pattern of black-legged kittiwake distribution with low densities throughout the Study Area.

Table 3.2: Average and maximum densities of black-legged kittiwake in the Study Area from April to September 2020 – 2022.

	Birds per km^2	April	May	June	July	August	September
Oriel 2020	Average	0.42	0.32	0	0.14	0.07	0.14
	Maximum	2.76	2.52	0	1.01	0.60	1.39
Clogherhead 2021	Average	0.10	0.30	0.07	0	0.04	-
	Maximum	2.03	5.54	0.88	0	0.51	-
Clogherhead 2022	Average	0.06	0.03	0	0.11	0.84	0.46
	Maximum	0.87	0.31	0	1.21	15.25	4.64

**blue = lesser density than Oriel ; green = higher density than Oriel; orange = same density as Oriel*

3.3 Common guillemot

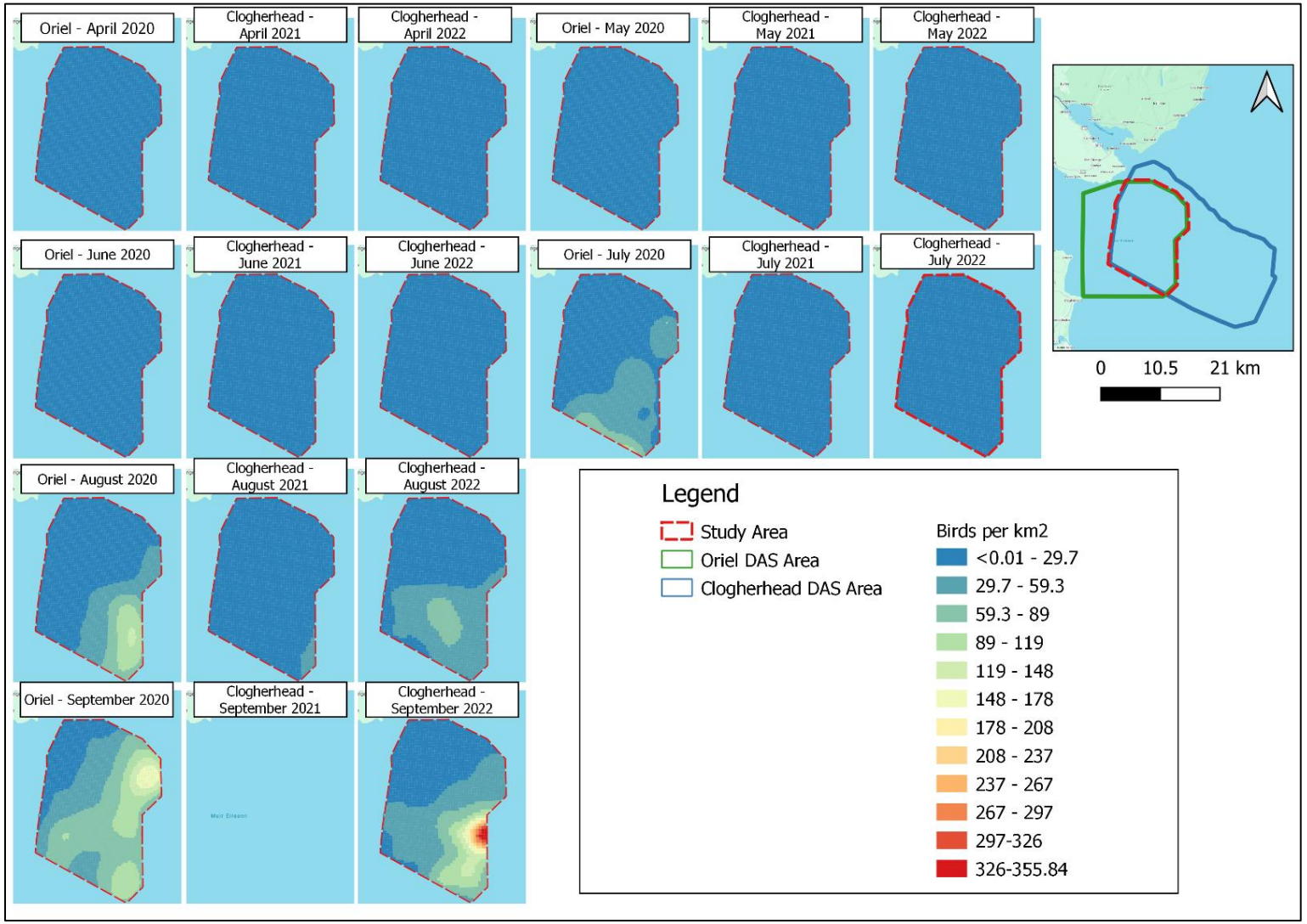

Figure 3.3: Common guillemot kernel density map across the Study Area.

Common guillemot were present in the Study Area during all of the 17 survey months, with birds present throughout the breeding season during both the Oriel DAS and Clogherhead DAS. The density of birds peaked towards the end of the breeding season when the young of that year move away from the breeding colony accompanied by their parents.

The average density of common guillemot present in the Study Area using Clogherhead DAS data was lower than the average density found using the Oriel DAS data in nine months and higher in two (Table 3.3). Similarly, when comparing the maximum densities Oriel DAS data was higher than Clogherhead DAS data during eight months and lower during three months. The maximum density in the Study Area during the 17 survey months was of 355.84 birds per km^2 in September 2022.

Common guillemot density peaked to the south and south east of the study area consistently throughout the three years of surveys.

Table 3.3: Average and maximum densities of common guillemot in the Study Area from April to September 2020 – 2022.

	Birds per km^2	April	May	June	July	August	September
Oriel 2020	Average	2.42	3.89	1.63	23.19	29.83	64.78
	Maximum	8.28	25.52	4.63	103.07	122.68	175.39
Clogherhead 2021	Average	1.61	1.03	2.77	7.53	13.17	-
	Maximum	8.09	3.28	6.00	25.03	47.79	-
Clogherhead 2022	Average	0.27	1.20	1.92	9.40	26.84	47.90
	Maximum	1.02	7.28	6.16	18.99	76.96	355.84

**blue = lesser density than Oriel; green = higher density than Oriel; orange = same density as Oriel*

3.4 Manx Shearwater

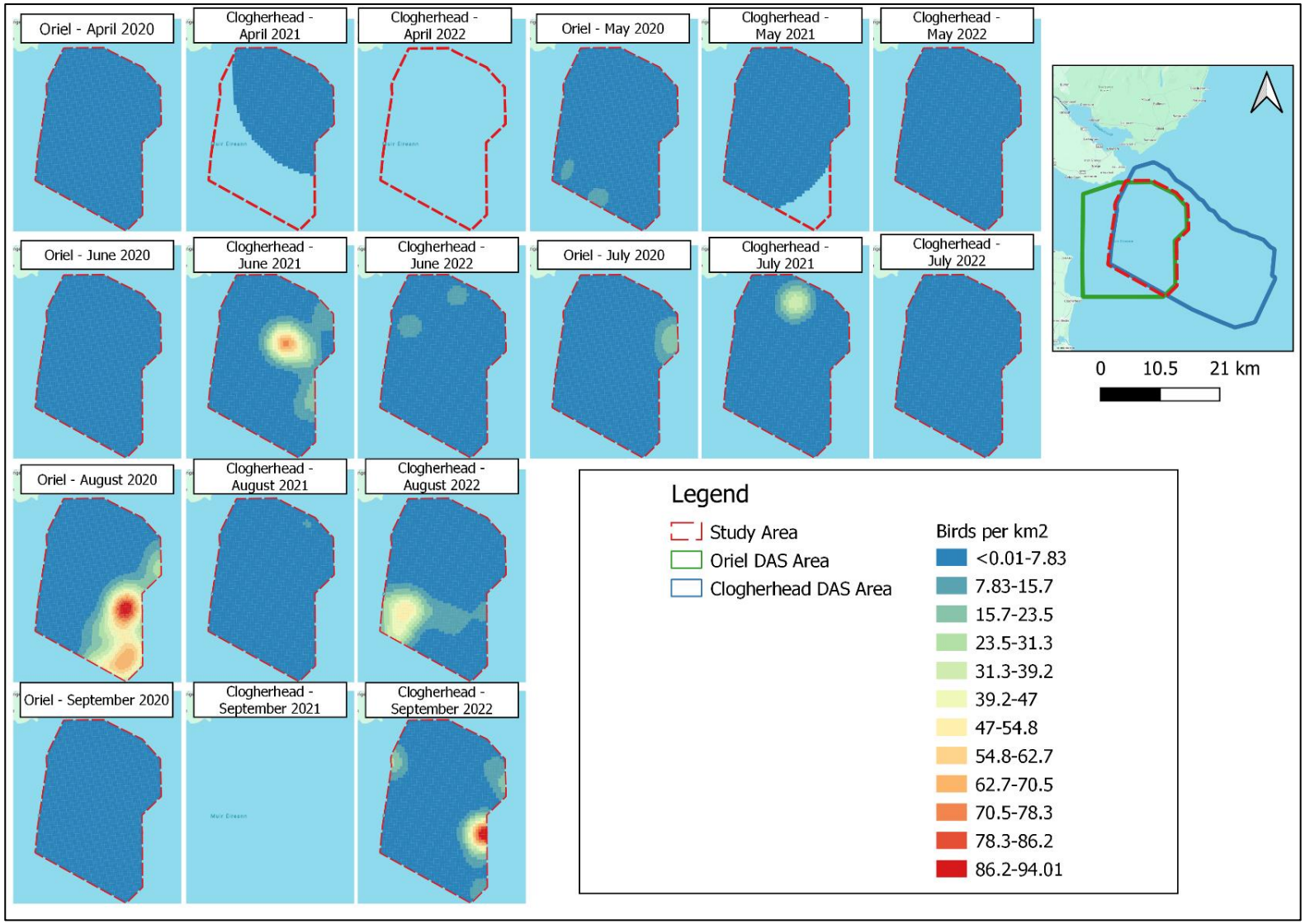

Figure 3.4: Manx shearwater kernel density map across the Study Area.

Manx shearwater were present in the Study Area during 16 of the 17 survey months, with birds present throughout the breeding season during both the Oriel DAS and Clogherhead DAS.

The average density of Manx shearwater present in the Study Area using Clogherhead DAS data was lower than the average density found using the Oriel DAS data in seven months and higher in four (Table 3.4). When considering the maximum densities, the Clogherhead DAS data were lower for six months and higher in five. The maximum density in the Study Area during the 17 survey months was of 93.40 birds per km^2 in August 2020.

There was no particular pattern of Manx shearwater distribution with maximum densities recorded throughout the Study Area.

Table 3.4: Average and maximum densities of Manx shearwater in the Study Area from April to September 2020 – 2022.

	Birds per km^2	April	May	June	July	August	September
Oriel 2020	Average	0.06	1.66	0.64	1.39	14.57	0.75
	Maximum	0.69	10.42	6.36	21.78	93.40	4.32
Clogherhead 2021	Average	0.04	0.07	6.99	2.81	1.13	-
	Maximum	2.42	1.23	71.94	36.95	8.11	-
Clogherhead 2022	Average	0	0.07	1.85	0.38	7.35	5.40
	Maximum	0	0.55	12.45	2.84	54.28	94.01

**blue = lesser density than Oriel ; green = higher density than Oriel; orange = same density as Oriel*

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3.5 Northern gannet

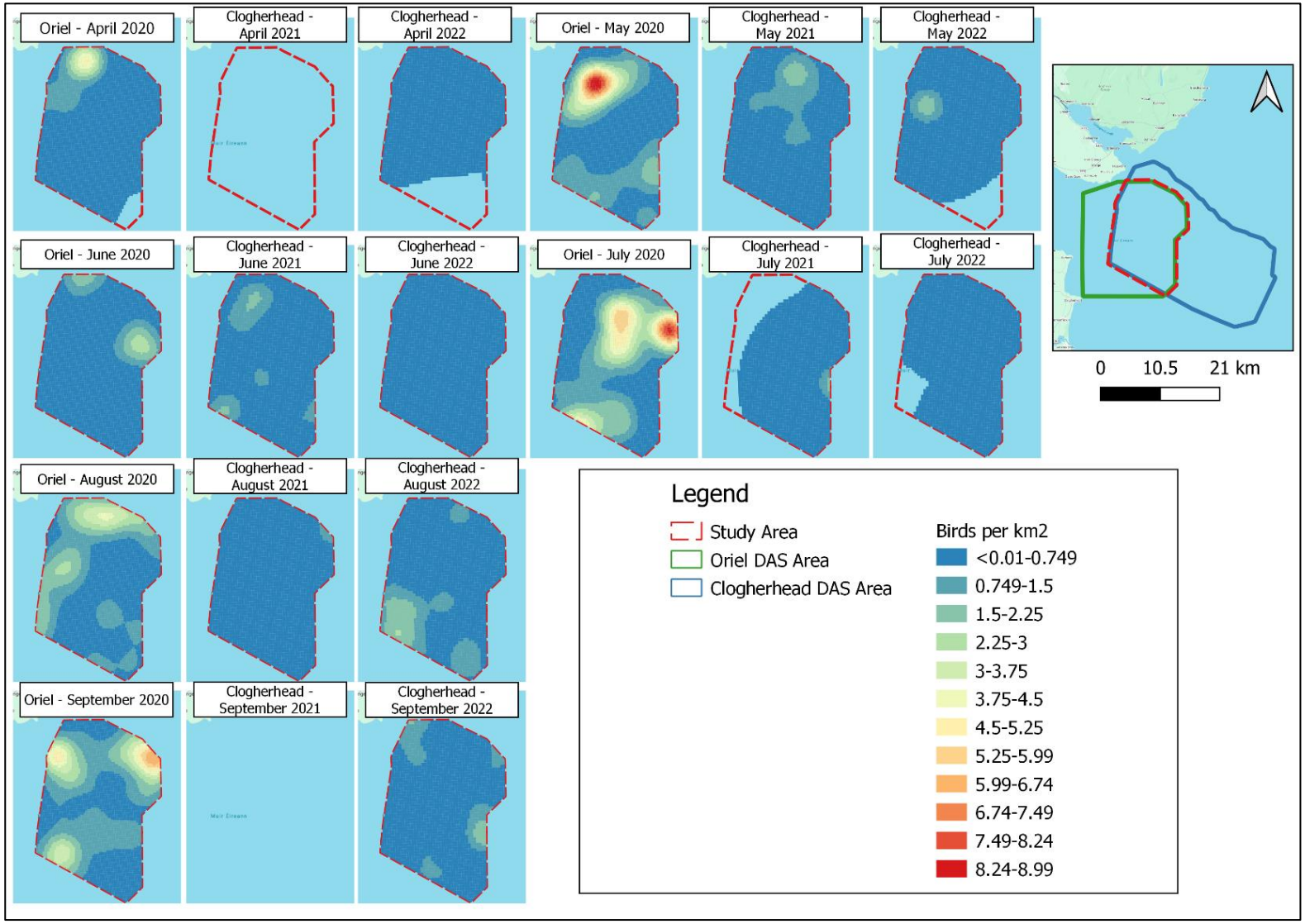

Figure 3.5: Northern gannet kernel density map across the Study Area.

Northern gannet were present in the Study Area during 16 of the 17 survey months, with birds present throughout the breeding season during both the Oriel DAS and Clogherhead DAS.

The average density of northern gannet present in the Study Area using Clogherhead DAS data was lower than the average density found using the Oriel DAS data in 10 months (Table 3.5). Similarly, when comparing the maximum densities Oriel DAS data was higher than Clogherhead DAS data during 10 months. The maximum density in the Study Area during the 17 survey months was of 8.39 birds per km^2 in July 2020.

There is no clear pattern for northern gannet distribution within the Study Area, however there might be a slight preference to the north of the Study Area.

Table 3.5: Average and maximum densities of northern gannet in the Study Area from April to September 2020 – 2022.

	Birds per km2	April	May	June	July	August	September
Oriel 2020	Average	0.34	1.22	0.38	1.61	1.02	1.36
	Maximum	4.62	8.99	2.64	8.39	3.93	6.66
Clogherhead 2021	Average	0	0.38	0.38	0.04	0.10	-
	Maximum	0	2.13	1.68	1.75	1.18	-
Clogherhead 2022	Average	0.05	0.12	0.04	0.02	0.51	0.43
	Maximum	0.55	1.99	0.47	0.26	2.72	2.26

**blue = lesser density than Oriel ; green = higher density than Oriel; orange = same density as Oriel*

3.6 Razorbill

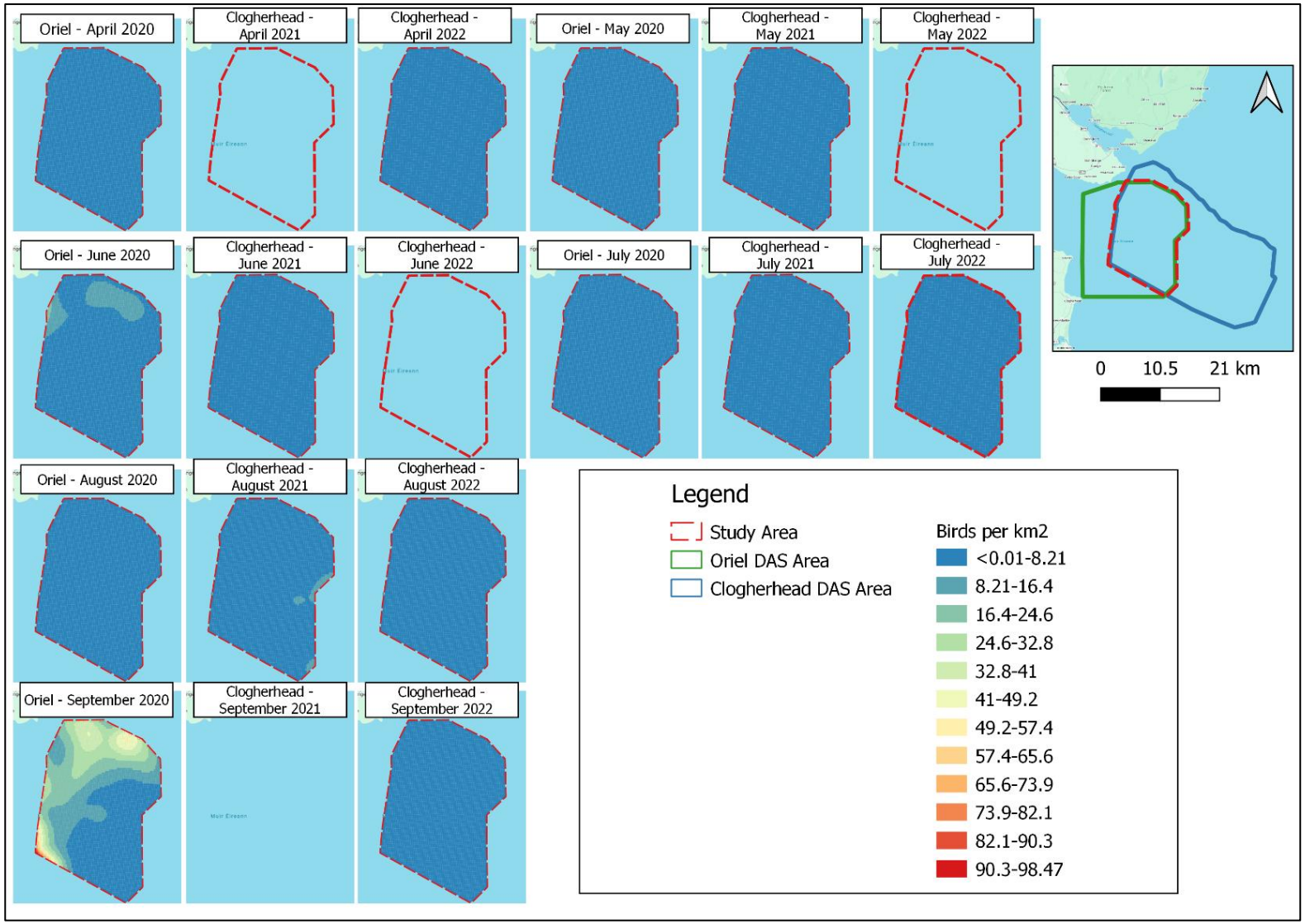

Figure 3.6: Razorbill kernel density map across the Study Area.

Razorbill were present in the Study Area during 14 of the 17 survey months, with birds present throughout the breeding season during both the Oriel DAS and Clogherhead DAS. There was a noticeable absence during May and June 2022 during the Clogherhead DAS.

The average density of razorbill present in the Study Area using Clogherhead DAS data was lower than the average density found using the Oriel DAS data in 10 months (Table 3.6). Similarly, when comparing the maximum densities Oriel DAS data was higher than Clogherhead DAS data during nine months. The maximum density in the Study Area during the 17 survey months was of 98.47 birds per km^2 in September 2020.

There is no clear pattern for razorbill distribution within the Study Area.

Table 3.6: Average and maximum densities of razorbill in the Study Area from April to September 2020 – 2022.

	Birds per km2	April	May	June	July	August	September
Oriel 2020	Average	0.34	0.73	3.99	0.39	0.81	14.23
	Maximum	3.93	5.51	21.00	3.75	5.68	98.47
Clogherhead 2021	Average	0	0.13	0.22	0.29	1.10	-
	Maximum	0	2.28	2.42	2.43	17.35	-
Clogherhead 2022	Average	0.22	0	0	0.07	0.59	0.48
	Maximum	2.34	0	0	0.49	6.78	6.89

**blue = lesser density than Oriel ; green = higher density than Oriel; orange = same density as Oriel*

4 CONCLUSION

When comparing the Oriel DAS and Clogherhead DAS data within the Study Area there is a clear pattern that Oriel DAS recorded a greater density of birds, when looking at both the average and maximum density per month (Table 4.1).

Table 4.1: Number of months in which the Oriel DAS data recorded a higher density than the Clogherhead DAS data (months when no birds recorded in all survey years not included).

Species	Maximum Density	Average Density
Atlantic puffin	7 out of 7	7 out of 7
Black-legged kittiwake	6 out of 11	7 out of 11
Common guillemot	8 out of 11	9 out of 11
Manx shearwater	6 out of 11	7 out of 11
Northern gannet	11 out of 11	10 out of 11
Razorbill	9 out of 11	10 out of 11

The Study Area covers the entirety of the proposed Project and therefore the breeding season assessment presented within the Environmental Impact Assessment Report presents an assessment on a greater number of birds. If the Clogherhead DAS data were to be used, a lesser impact on offshore ornithology receptors would be presented.