MachairWind Offshore Windfarm

Appendix J – Ornithology Design-Based Analyses Results

ScottishPower Renewables | MachairWind Offshore Windfarm

SEPTEMBER 2024

DOCUMENT ID: MCW-DWF-PMG-REP-IBR-000010
Revision 1

This page is intentionally blank

TABLE OF CONTENTS

LIST OF FIGURES

GLOSARY OF ACRONYMS

Term	Description
km	Kilometres
OAA	Option Area Agreement
WDA	Windfarm Development Area

GLOSSARY OF TERMS

Term	Description
Breeding season	Furness (2015) defines breeding season as the period from modal return to the colony through to modal departure from the colony at the end of breeding, for birds at UK colonies.
Non-breeding season	Furness (2015) defines non-breeding season as the remaining part of the year that is not a part of breeding season.
Option Agreement Area (OAA)	The seabed area awarded to ScottishPower Renewables in January 2022 through the Scotwind leasing round. Project-specific surveys have been based on either the OAA or Windfarm Development Area (WDA) boundary, with an appropriate buffer implemented in each case.
Windfarm Development Area (WDA)	The application boundary within which consent will be sought for the WDA Infrastructure. The WDA is subject to a Section 36 consent and Marine Licence(s) application which is being applied for separately from the Offshore Transmission Development Area and Onshore Transmission Development Area.

1 DESIGN-BASED ANALYSES

1.1 APPROACH TO DESIGN-BASED ANALYSES

1. The initial design-based analyses follow the approach set out in **Appendix I Offshore Ornithology Methods Statement** and should be read in conjunction with this. Raw data from digital aerial surveys will contain details of all objects (bird, marine mammal, vessels, etc.) as well as latitude and longitude coordinates for each object. All non-bird records will be removed prior to analysis. Analyses will be conducted for each survey separately. Bird locations will be assigned to the following areas:

   - Windfarm Development Area (WDA) boundary;
   - WDA boundary plus 2 kilometre (km) buffer; and
   - WDA boundary plus 4 km buffer.

2. Design-based density (birds/km^2) and abundance values were estimated for individual species in each of the surveys using the 'R' Project statistical program (R Development Core Team, 2012).

3. The population abundance for each species on each survey was calculated as the number of birds recorded multiplied by the total area divided by the area surveyed in that area. Densities were obtained as the counts divided by the area surveyed. This is a simple extrapolation, that assumes similar densities are present in un-surveyed areas. These calculations were completed for:

   - WDA boundary;
   - WDA boundary plus 2 km buffer; and
   - WDA boundary plus 4 km buffer.

4. To obtain measures of uncertainty around the estimated abundances and densities, a bootstrap resampling method was for analysing time-series data as follows:

   - All transect lines tracked during each individual survey were divided into 500 metre segments;
   - The observations for each species on each individual survey was resampled using a time-series bootstrap function (R library 'boot' function 'tsboot') with a blocking structure defined as ten segments. Thus, resampling was conducted at the level of groups of 10 segments, randomly selected on each of the 1,000 iterations conducted. A block size of 10 was selected as a precautionary length, with the assumption that beyond this number of segments there will be no detectable autocorrelation;
   - Each bootstrap iteration provided a re-estimated number of observations which was analysed to obtain population and densities as described above. From the bootstrap samples, the mean, the standard deviation and upper and lower 95% bootstrap confidence intervals (bootstrap confidence interval, 2.5th and 97.5th value in the ranked bootstraps) were extracted from the bootstrap samples to provide the required measures of uncertainty; and
   - Density and abundance estimates calculated for each species in each survey are presented below.

5. To calculate density and abundance for each species in each survey, this method assumed that the surveyed area was representative of the un-surveyed region, thus the design of survey is important (hence 'design-based').

2 DESIGN-BASED ANALYSIS RESULTS

2.1 INTRODUCTION

6. The above methods were applied to the 30 months of digital aerial surveys collected from the Option Agreement Area (OAA) and WDA and buffers (2 km and 4 km). Species were selected for analyses based on the number of observations and the number of surveys the species was recorded from. Where more than 20 birds were recorded data were analysed. The exception to this was common tern, as birds were only recorded from three surveys. A summary of these initial results are provided here as plots of abundances with each survey that was completed. Plots show the relative abundances within the OAA, WDA plus a 2 km buffer and the WDA plus a 4 km buffer.

2.2 KITTIWAKE

7. Kittiwakes *(Rissa Tridactyla)* occurred across all surveys, with peaks occurring at various times within the survey area (**Figure 2.1**). There was a particularly large peak in November 2021, although the relative size of this peak reduced towards the WDA boundary (i.e. as buffers were removed). Within the WDA, the peak in November 2021 was relatively similar to other peaks in July 2022 and February 2023. There was little consistency in seasonal or interannual variation in abundances. There was also variation in the relative abundance of birds in flight to birds on the water. During peak abundances there was a relatively higher proportion of birds in flight.

2.3 COMMON GULL

8. Common gulls *(Larus canus)* occurred in 11 of 30 surveys, with peaks occurring at various times within the survey area (**Figure 2.2**). There were peaks in November 2021 and December 2022. The November 2021 peak was absent from the WDA boundary itself. Only a relatively small number of birds occurred in the breeding season, and none were recorded in the WDA, during the breeding season. Most records were of birds in flight.

2.4 GREAT BLACK-BACKED GULL

9. Great black-backed gulls *(Larus marinus)* were only recorded in 16 of the 30 surveys completed. The abundances of great black-backed gulls were clearly seasonal, with obvious peaks in the non-breeding seasons (**Figure 2.3**). The majority of records were of birds sitting on the water, including within the WDA where 47% of the predicted abundances were birds in flight.

2.5 HERRING GULL

10. Herring gulls (*Larus argentatus*) were only recorded in ten of the 30 surveys completed. The abundances of herring gulls were clearly seasonal, with obvious peaks in the non-breeding seasons, particularly November 2021 and December 2022 (**Figure 2.4**). Unlike great black-backed gull, the majority of records were of birds in flight, including within the WDA where 68% of the predicted abundances were birds in flight.

2.6 ARCTIC TERN

11. As would be expected from a highly migratory species, records of Arctic tern *(Sterna paradisaea)* were restricted to the breeding season, so occurred in 13 of 30 surveys (**Figure 2.5**). There was clear interannual variation, with a much larger peak abundance in the 2022 breeding season than in 2021 or 2023, which were similar. The majority of birds observed were in flight.

2.7 GREAT SKUA

12. Great skuas *(Stercorarius skua)* occurred in only 12 of 30 surveys with a clear breeding season pattern of abundance (**Figure 2.6**). There was clear interannual variation with the peak abundance occurring in May 2022. The breeding seasons of 2021 and 2023 were relatively similar. The majority of birds were recorded in flight.

2.8 GUILLEMOT

13. Guillemots *(Uria Aalge)* were recorded in all surveys, often in relatively large numbers (**Figure 2.7**). There were clear seasonal patterns with abundances typically higher in the breeding season than the non-breeding season. There were also interannual differences in abundances, generally being lower in the 2021 breeding season than the 2022 or 2023 breeding season. The majority of birds recorded in all months, seasons, years and locations were on the water.

2.9 RAZORBILL

14. Razorbills *(Alca torda)* were recorded on all surveys (**Figure 2.8**). Abundance was relatively low during the first breeding season in 2021, up until October 2021. After that point there was little indication of seasonal or inter-annual patterns, though abundance varied greatly. The majority of birds were recorded on the water with very small numbers in flight.

2.10 PUFFIN

15. Puffin *(Fratercula Arctica)* showed highly seasonal and inter-annual variations across the survey area (**Figure 2.9**). There was a relatively large, clear, peak in abundance in the 2022 breeding season, particularly July of that year. Peak abundance in the 2021 and 2023 breeding season were much smaller and relatively similar. While non-breeding season abundances were much lower than the breeding season, there were only four surveys with no puffins recorded: November 2021, January 2022, March 2022 and December 2022.

2.11 GREAT NORTHERN DIVER

16. There was obvious seasonal variation in great norther diver *(Gavia immer)* abundance across the survey area (**Figure 2.10**). Great northern divers were recorded from 17 surveys and were mostly absent in the middle of the breeding season. Since great northern divers do not breed in the United Kingdom, it is unsurprising that they did not occur in the breeding season. Some birds were recorded in May and June, which may be due to birds not of breeding age remaining in the non-breeding range for longer than birds of breeding age. It was also clear that abundances decreased as the area analysed moved towards the OAA. This is likely due to the typically coastal distribution of this species and the wider survey area covering areas of coastal waters closer to Islay than the WDA.

2.12 STORM PETREL

17. As a highly migratory species it was unsurprising that storm petrels *(Hydrobates pelagicus)* were only recorded during the breeding season (**Figure 2.11**). Storm petrels were only recorded from 8 of 30 surveys. There was some interannual variation apparent from the surveys with relative abundance higher in 2022 than 2021 and higher in 2023 than 2021. While most birds occurred outside the WDA, there were still storm petrels recorded from within the WDA, with a peak of 123 birds in July 2023.

2.13 FULMAR

18. Fulmars *(Fulmarus glacialis*) occurred in all but two surveys (**Figure 2.12**). There was no strong seasonal pattern and relatively little clear interannual variation. Peak abundances were in both the breeding and non-breeding season across the survey duration. In general, most birds were recorded as in flight.

2.14 MANX SHEARWATER

19. As a migratory species, Manx shearwaters *(Puffinus puffinus)* had a clear seasonal pattern of abundance, with obvious peaks in the breeding seasons sampled (**Figure 2.13**). There was some interannual variation in abundance, with the peak abundance in the 2022 breeding season, and relatively similar abundances in the 2021 and 2023 breeding season.

2.15 GANNET

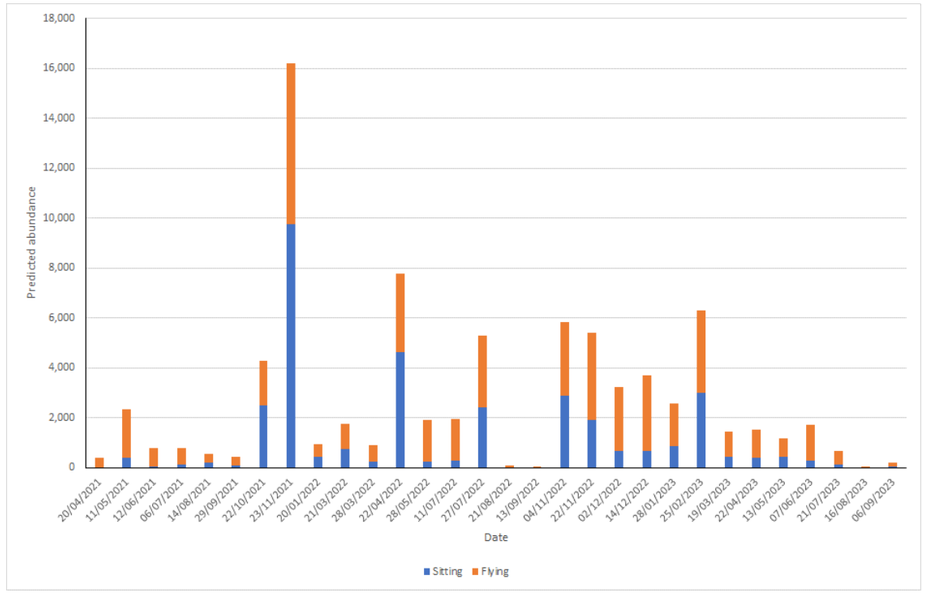
20. While gannets *(Morus Bassanus)* were recorded in all but one survey (December 2022) there was a seasonal pattern to their abundance. Numbers were lower through each non-breeding season than each breeding season sampled (**Figure 2.14**). There was some interannual variation in the breeding season abundance, with the peak occurring in the 2022 breeding season and the 2021 and 2023 breeding season were relatively similar. About half of birds recorded in the WDA were in flight.

2.16 OTHER SPECIES RECORDED

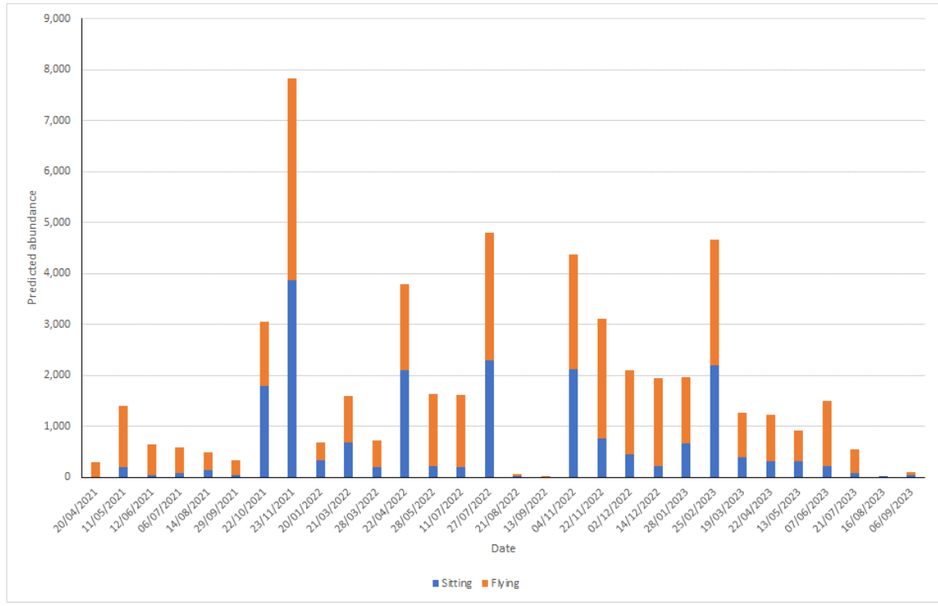
21. Several other species occurred in smaller numbers that have not been plotted. Common terns *(Sterna hirundo)* were recorded from three surveys in the breeding seasons of 2021 and 2022. Predicted abundance in the survey area peaked at 58 in August 2022, most of which occurred in the WDA (50 birds).

22. Arctic skuas *(Stercorarius parasiticus)* also occurred in three surveys (May 2022, August 2022 and June 2023), with a predicted peak abundance in May 2022 of 32 birds in the survey area, 19 of which were in the WDA. Black guillemot *(Cepphus grylle)* was recorded in one survey but not in the WDA. Sooty shearwaters were recorded in two surveys.

OAA



WDA plus 4 km

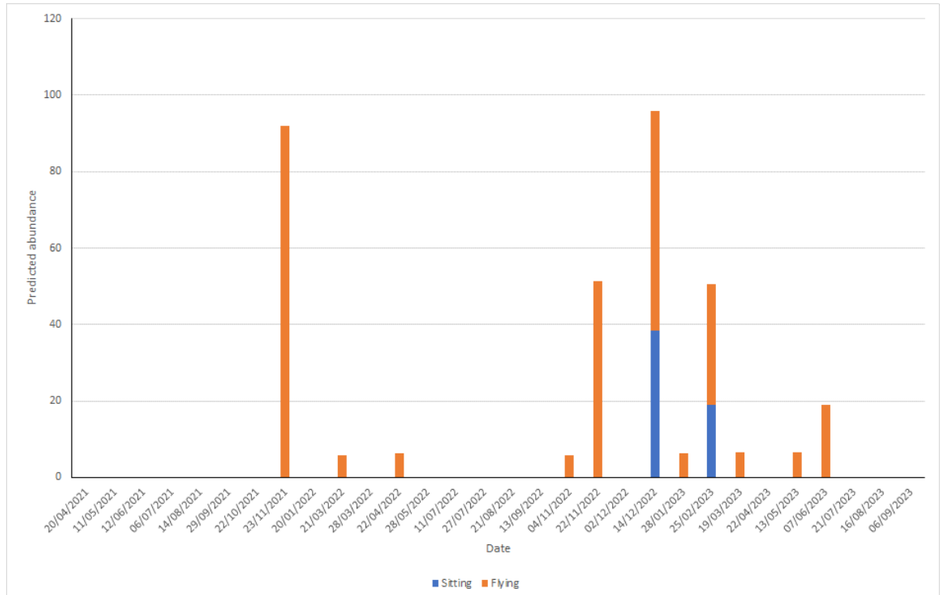


WDA plus 2 km buffer

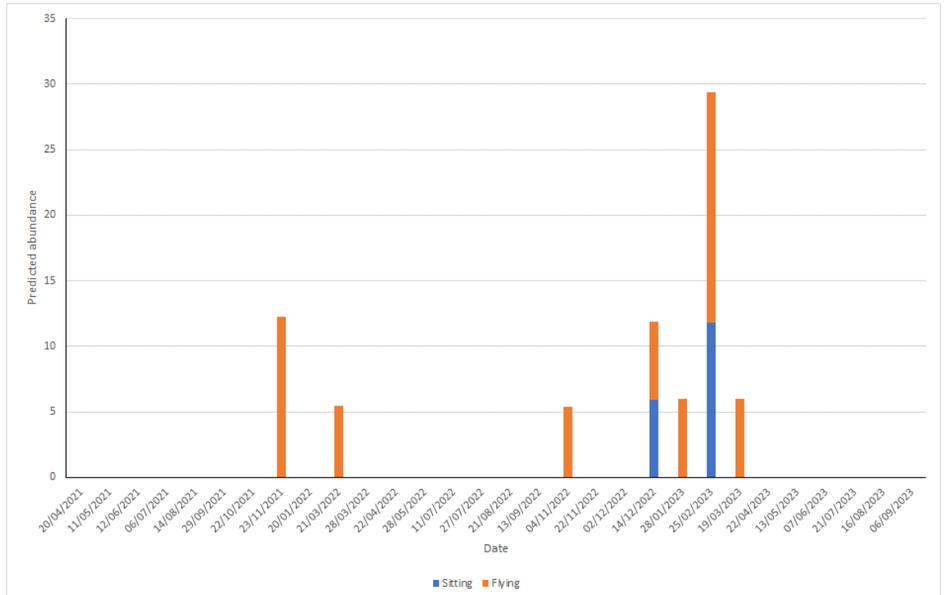
WDA only

Figure 2.1 Design-based estimated abundance of kittiwakes in flight (orange) and on the water (blue) for each survey within the OAA, WDA plus 4 km buffer, WDA plus 2 km buffer, and WDA only

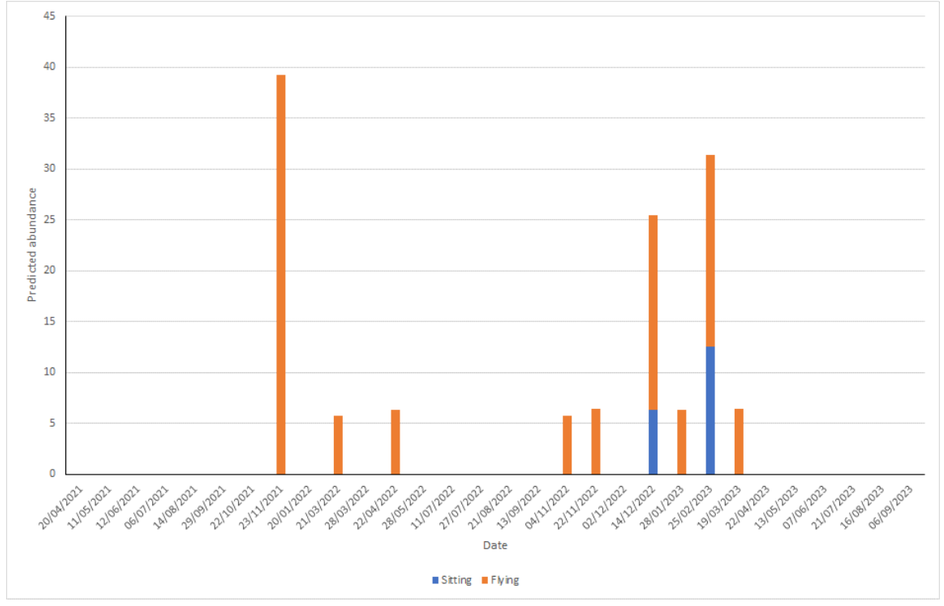
OAA



WDA plus 2 km buffer



WDA plus 4 km



WDA only

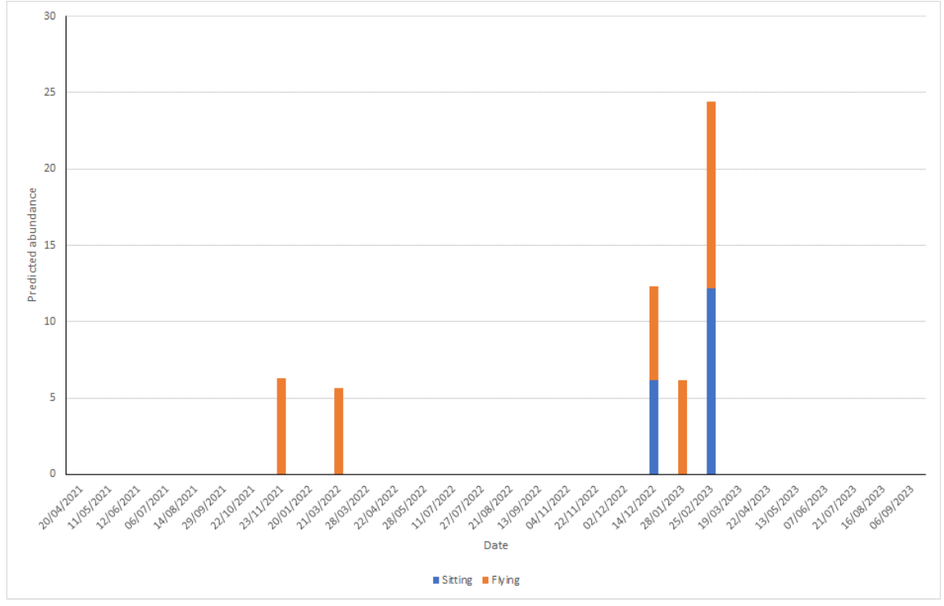
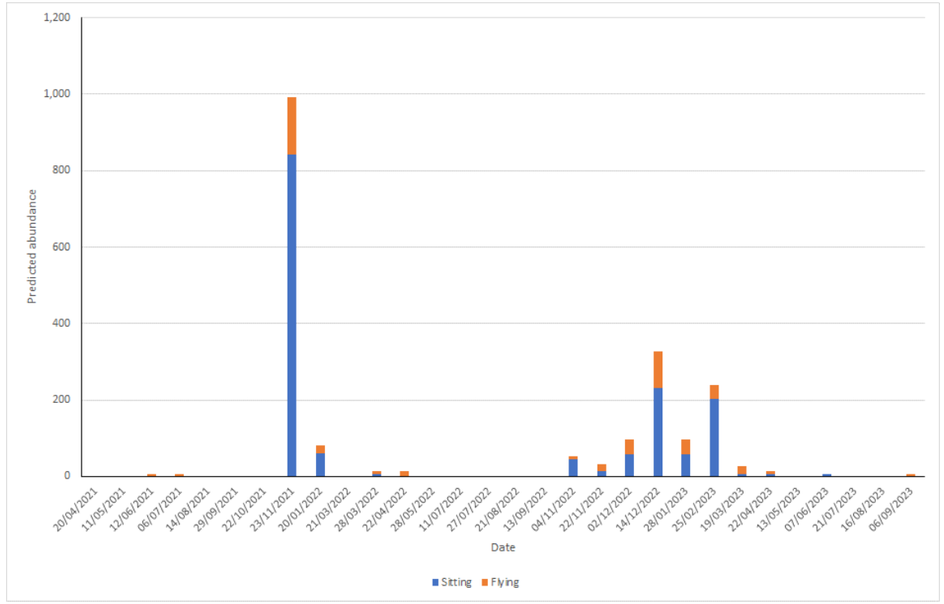
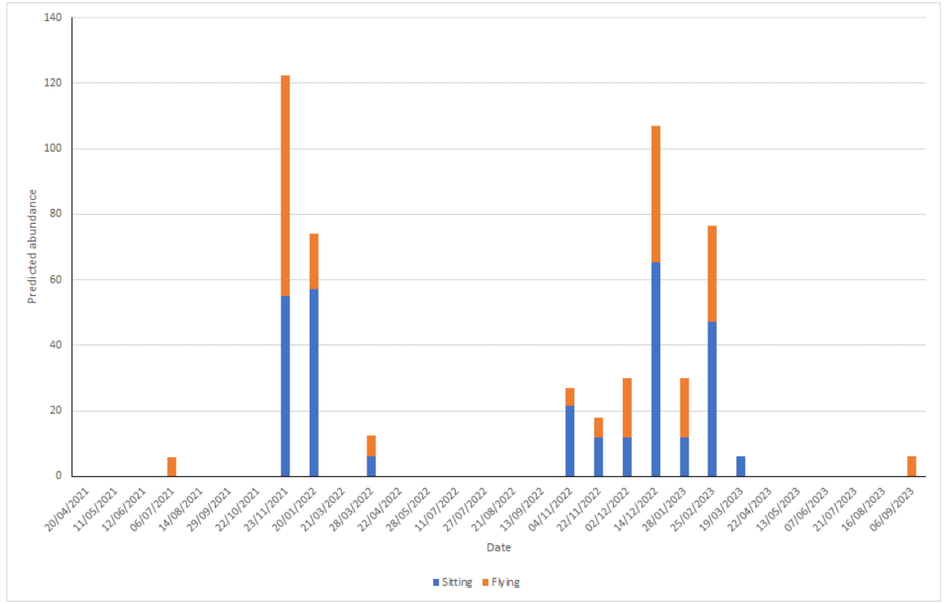


Figure 2.2 Design-based estimated abundance of common gulls in flight (orange) and on the water (blue) for each survey within the OAA, WDA plus 4 km buffer, WDA plus 2 km buffer, and WDA only.

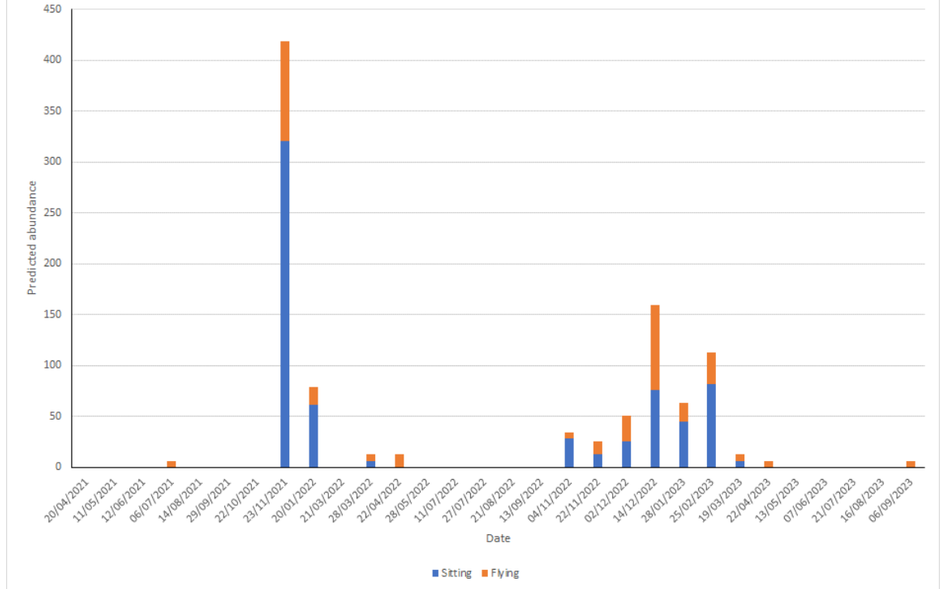
OAA



WDA plus 2 km buffer



WDA plus 4 km



WDA only

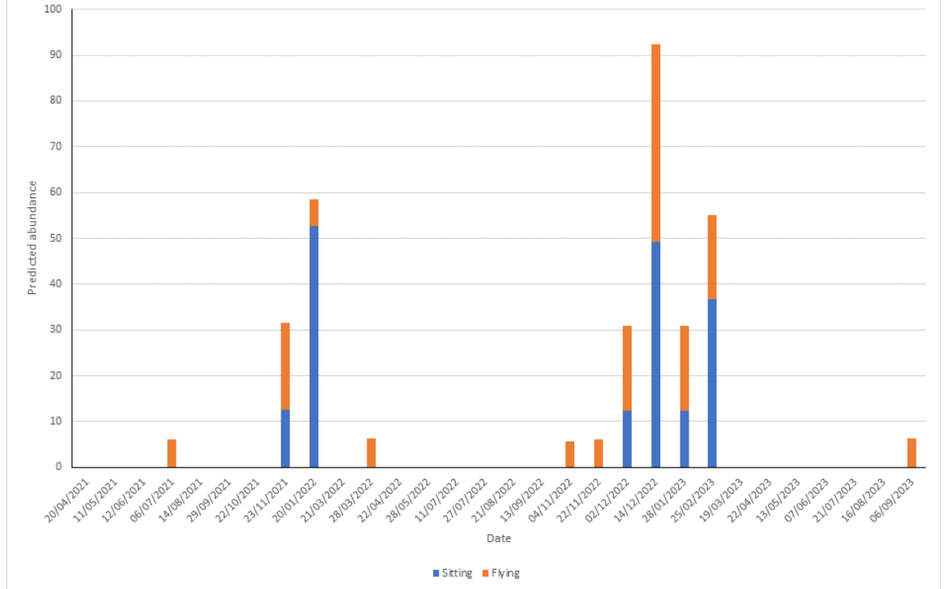
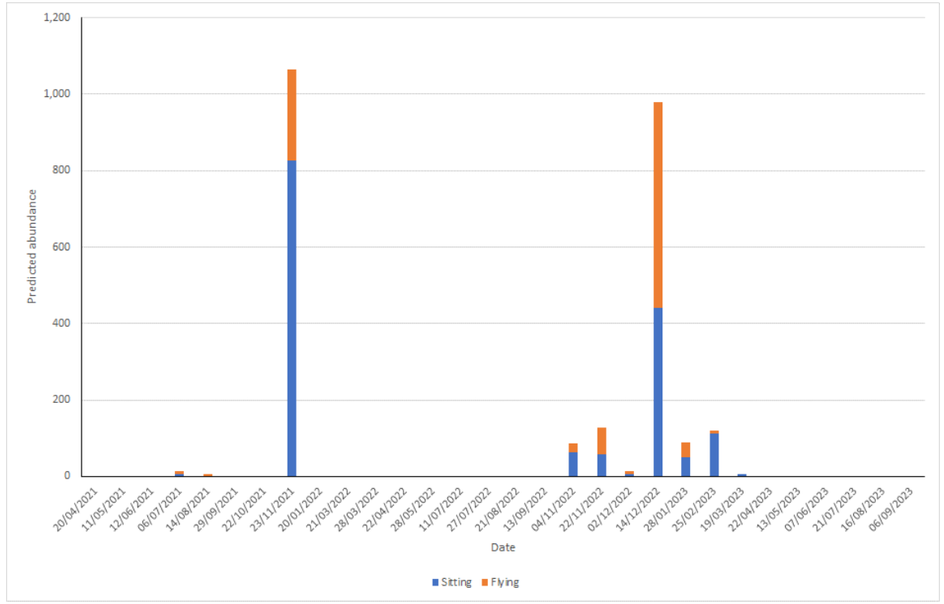
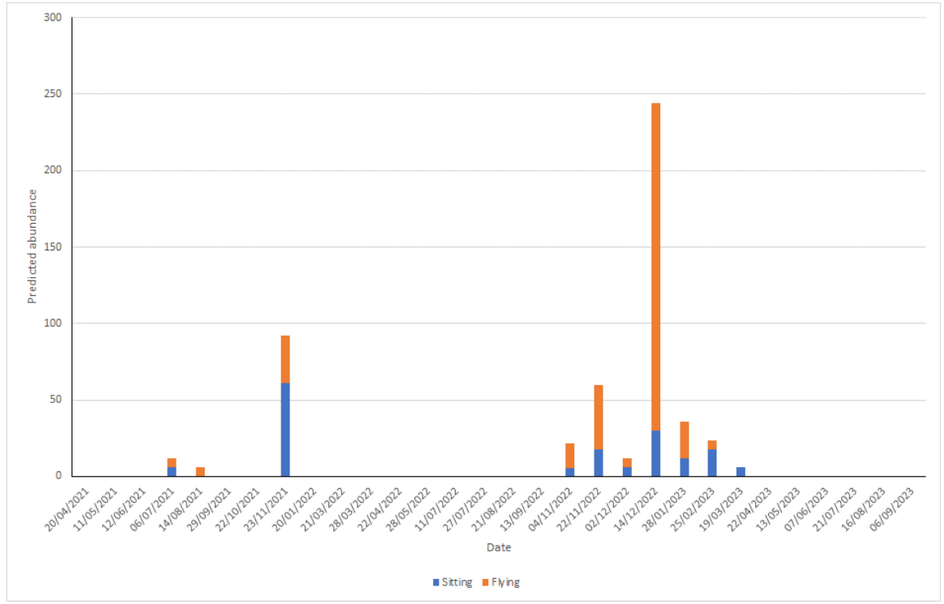


Figure 2.3 Design-based estimated abundance of great black-backed gulls in flight (orange) and on the water (blue) for each survey within the OAA, WDA plus 4 km buffer, WDA plus 2 km buffer, and WDA only.

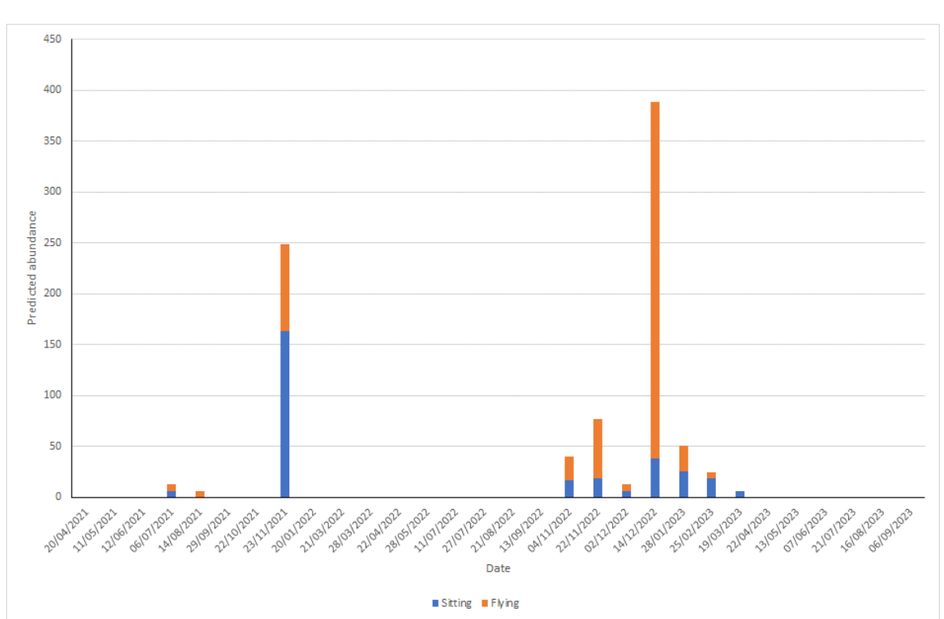
OAA



WDA plus 2 km buffer



WDA plus 4 km



WDA only

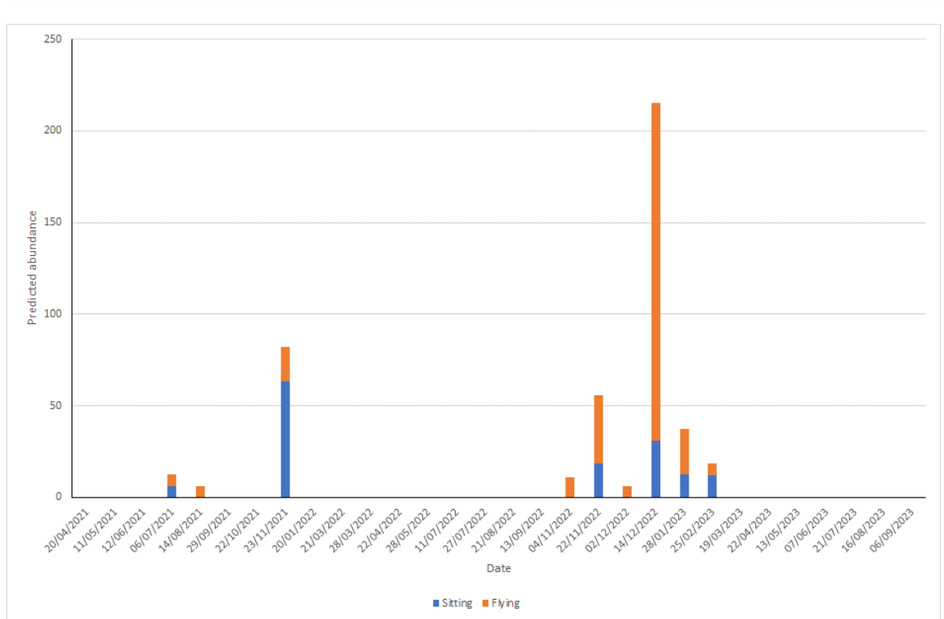
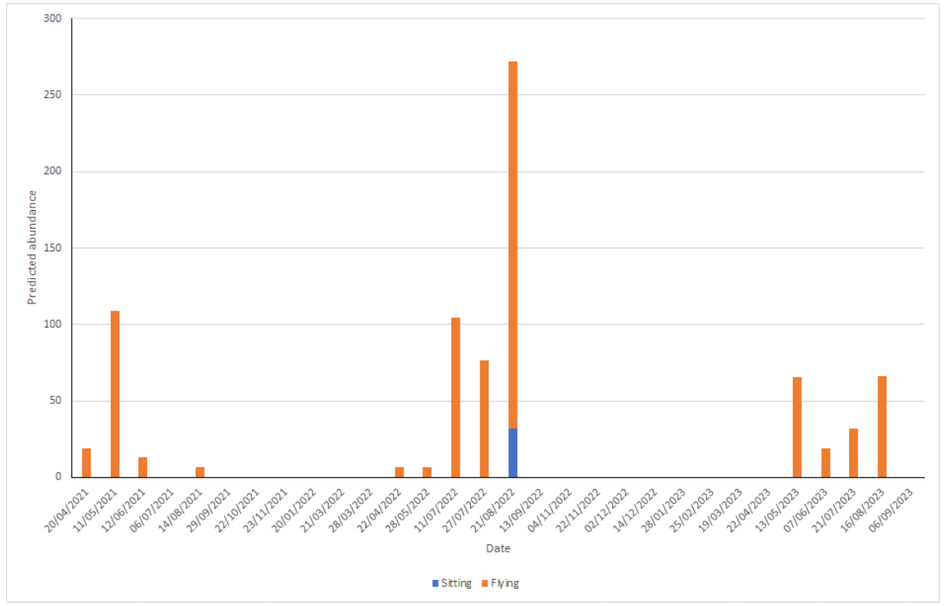
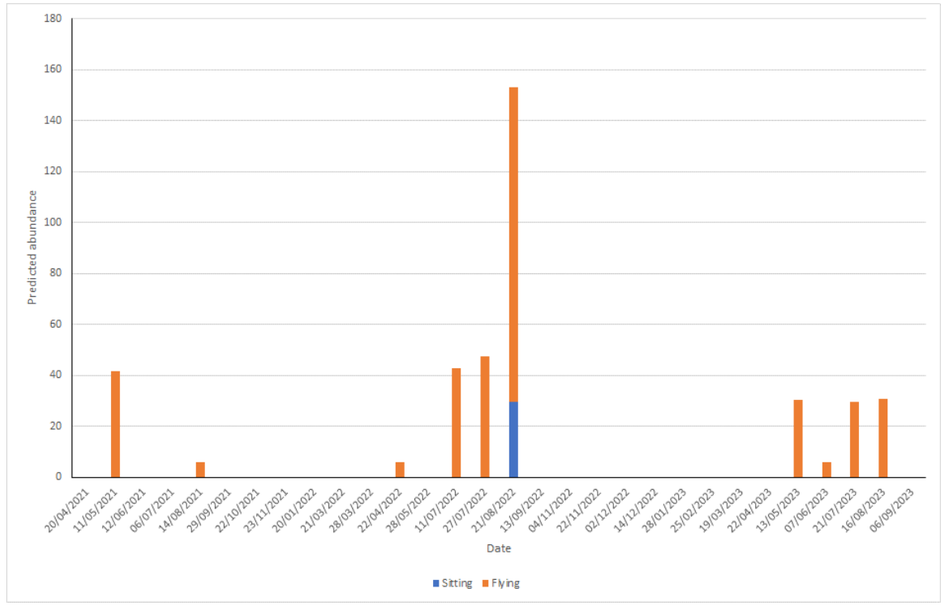


Figure 2.4 Design-based estimated abundance of herring gulls in flight (orange) and on the water (blue) for each survey within the OAA, WDA plus 4 km buffer, WDA plus 2 km buffer, and WDA only.

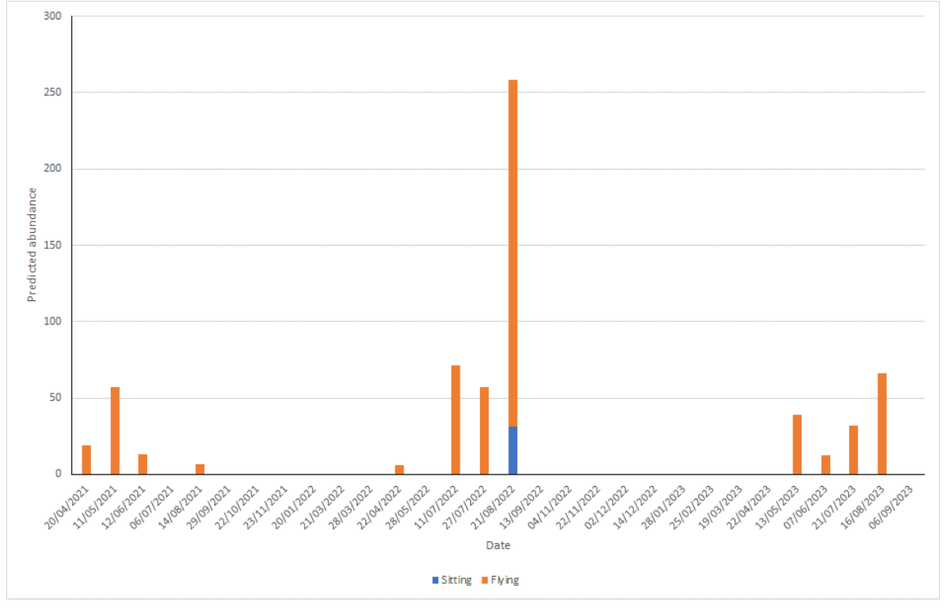
OAA



WDA plus 2 km buffer



WDA plus 4 km



WDA only

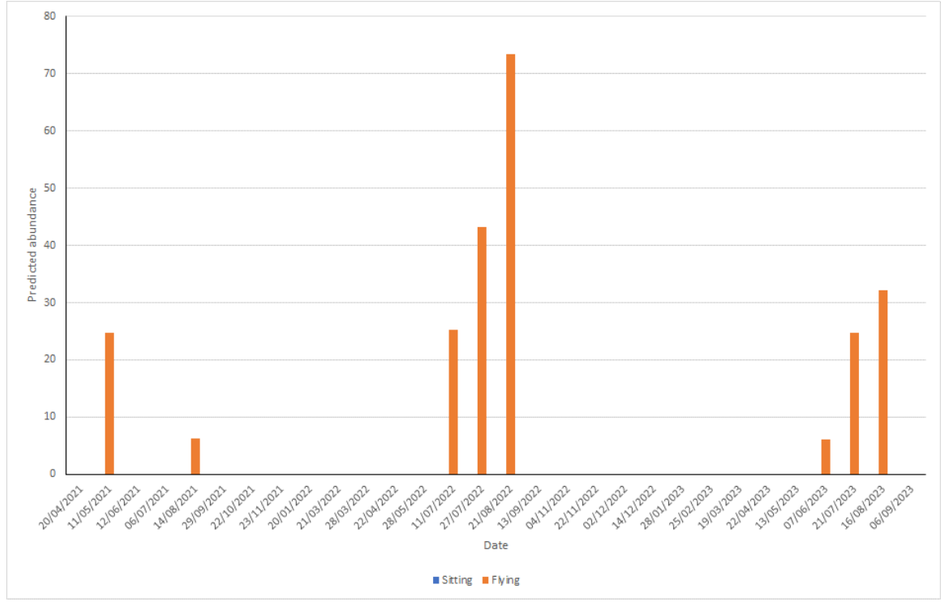
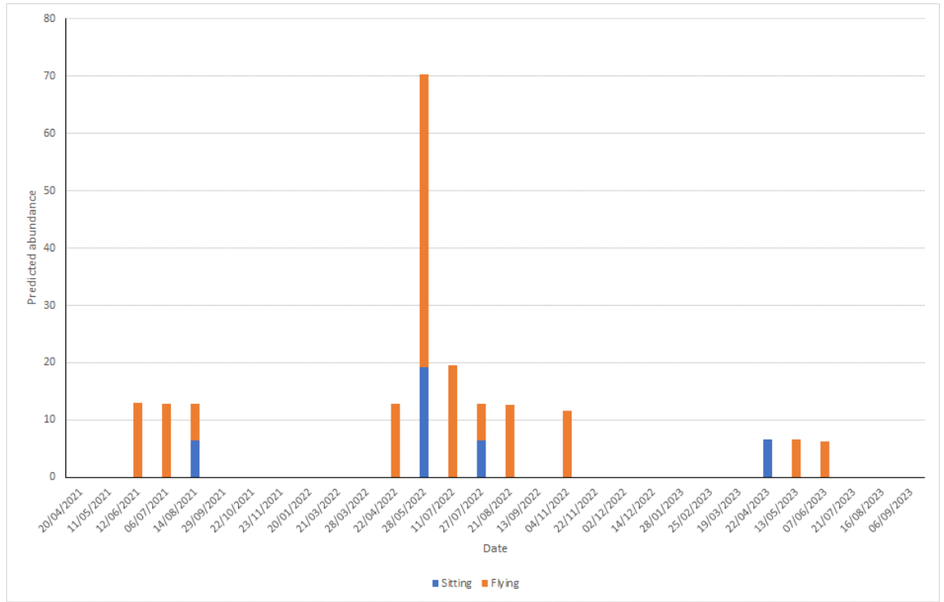
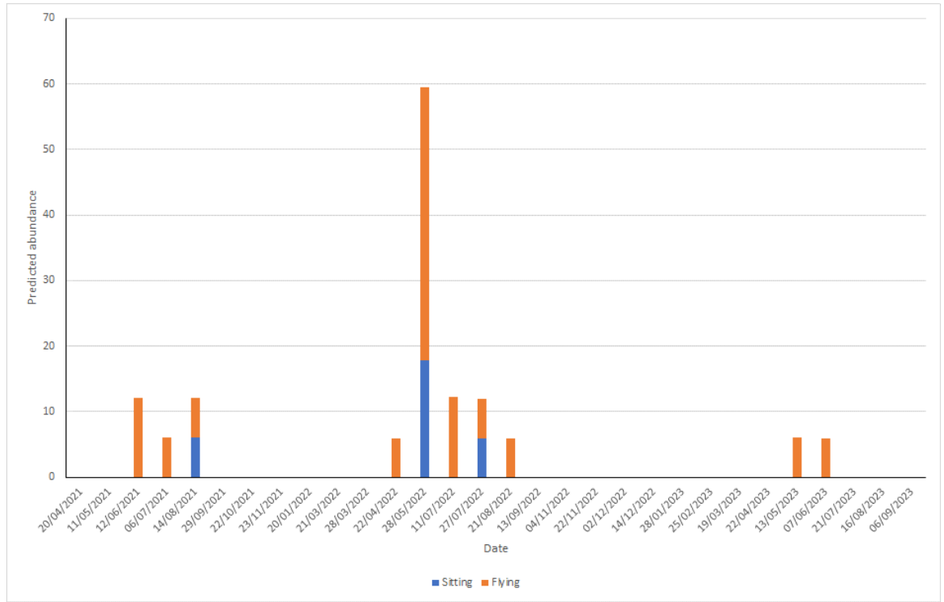


Figure 2.5 Design-based estimated abundance of Arctic terns in flight (orange) and on the water (blue) for each survey within the OAA, WDA plus 4 km buffer, WDA plus 2 km buffer, and WDA only.

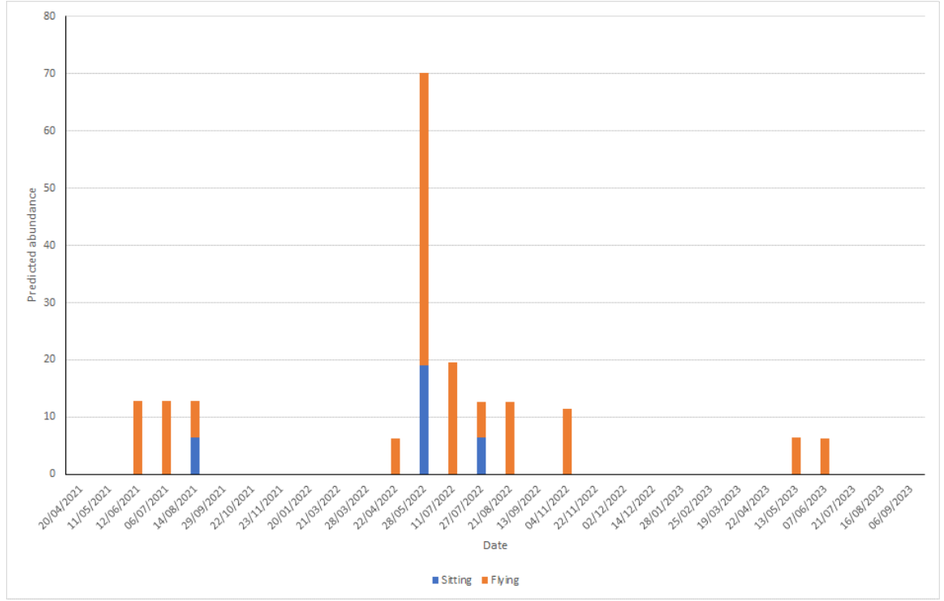
OAA



WDA plus 2 km buffer



WDA plus 4 km



WDA only

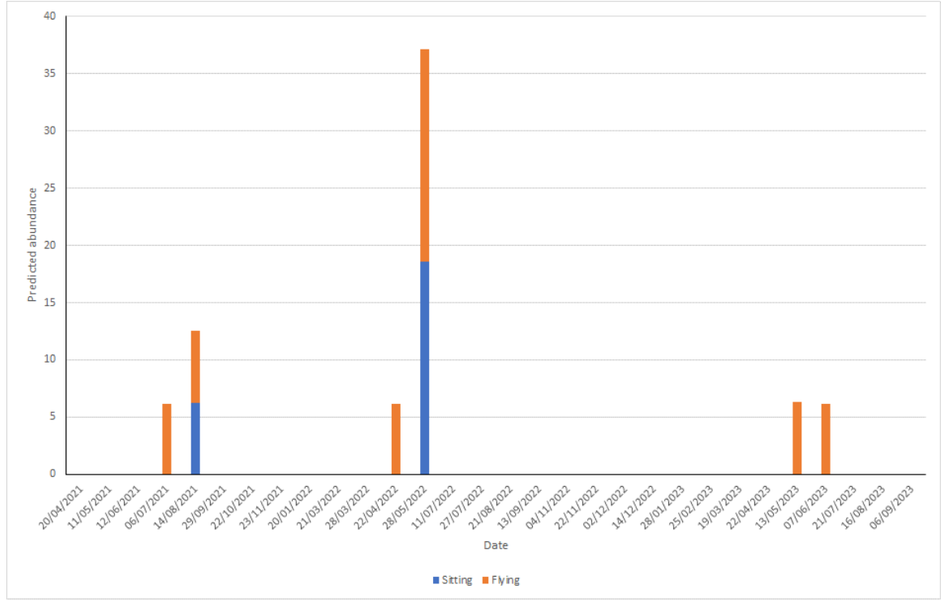
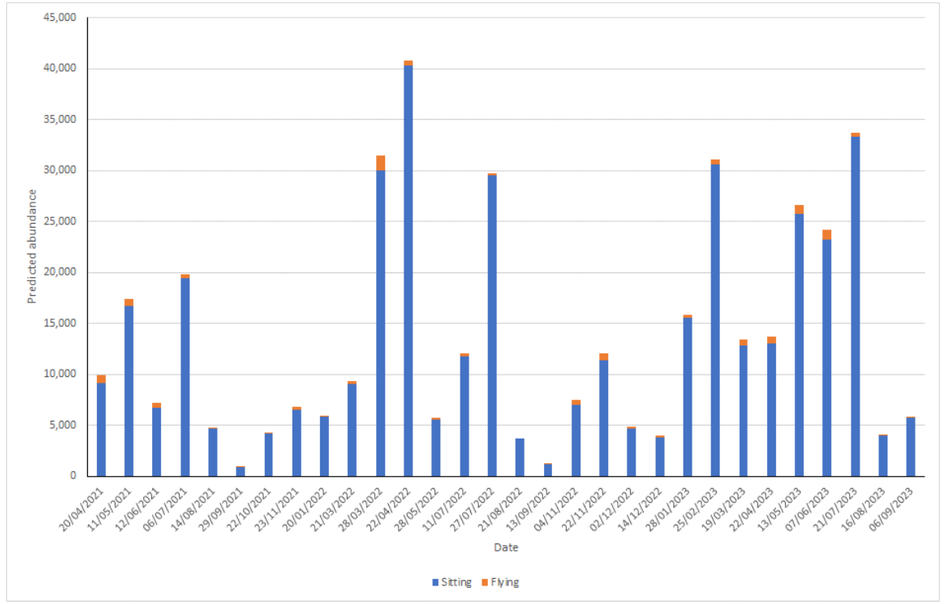
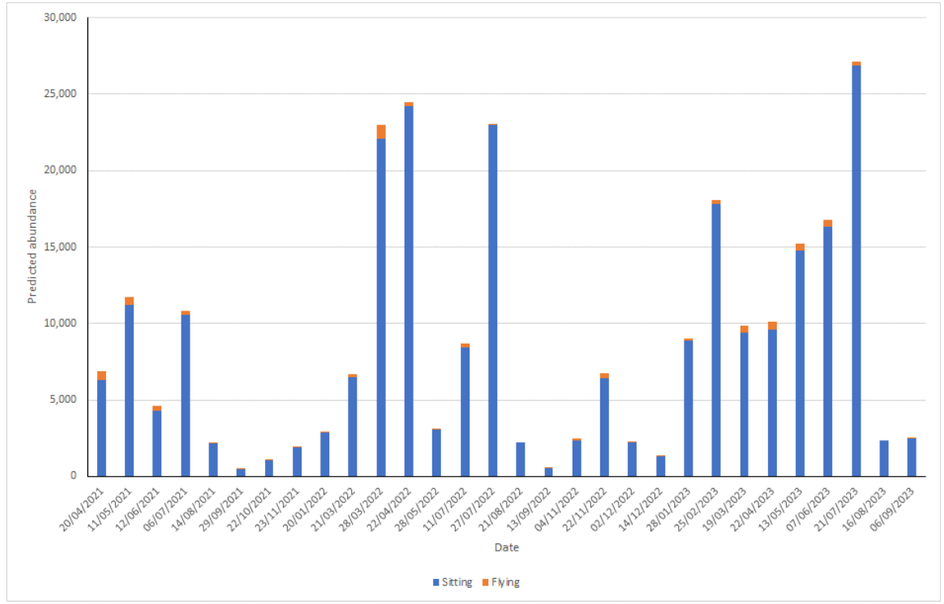


Figure 2.6 Design-based estimated abundance of great skua in flight (orange) and on the water (blue) for each survey within the OAA, WDA plus 4 km buffer, WDA plus 2 km buffer, and WDA only

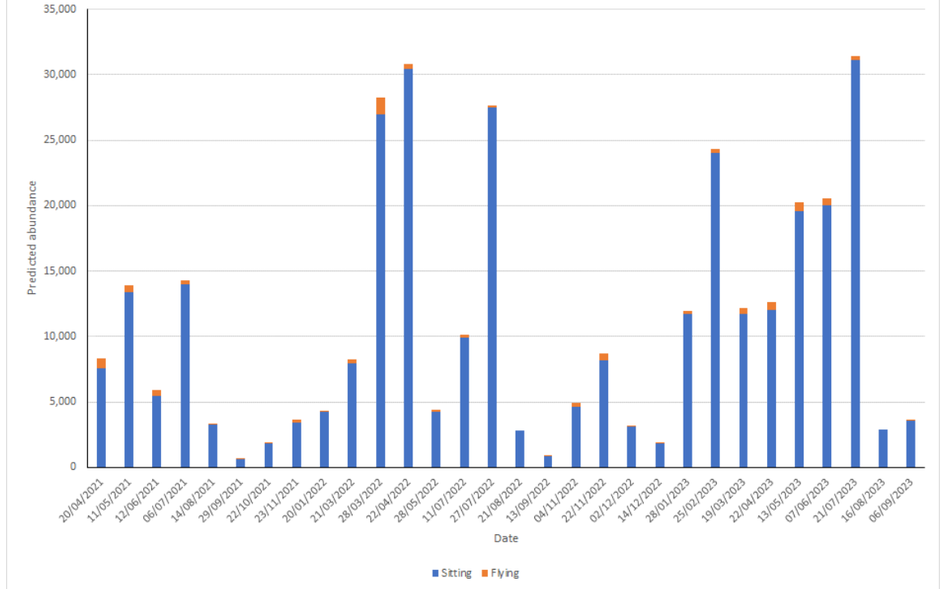
OAA



WDA plus 2 km buffer



WDA plus 4 km



WDA only

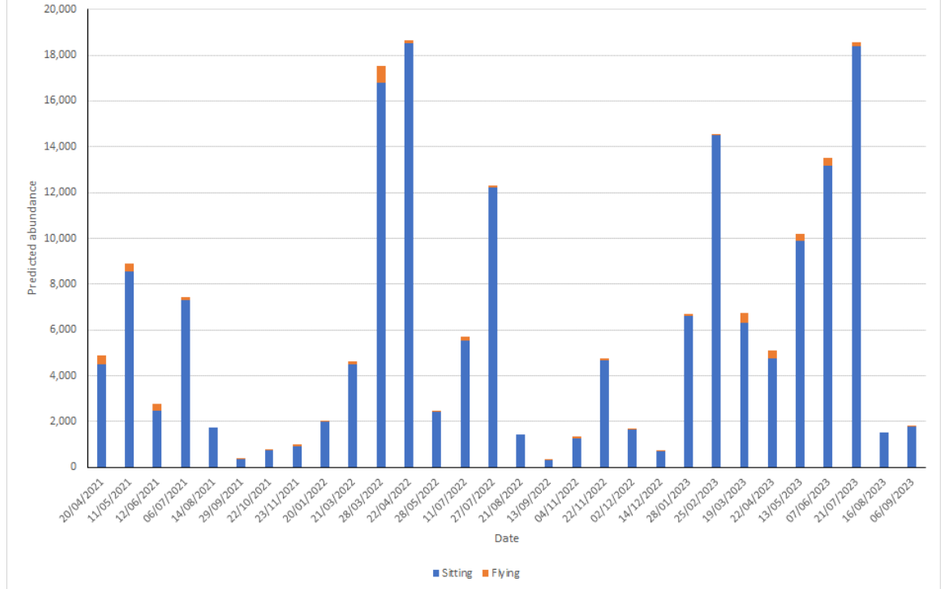
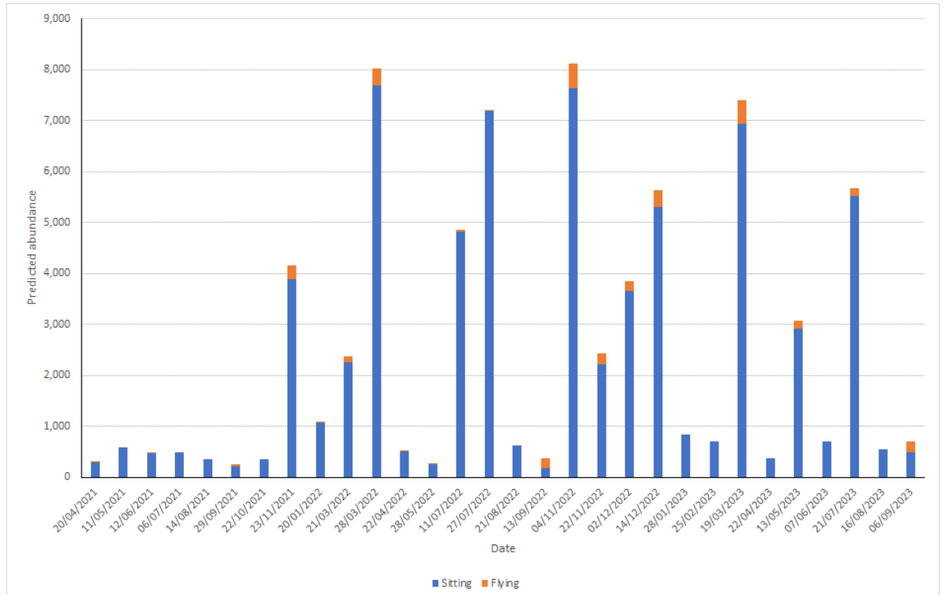
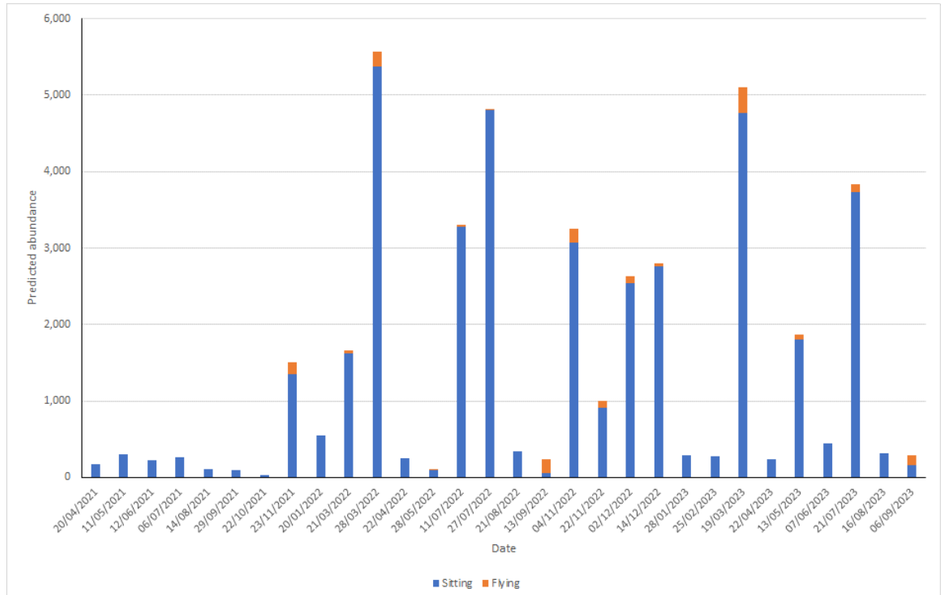


Figure 2.7 Design-based estimated abundance of guillemots in flight (orange) and on the water (blue) for each survey within the OAA, WDA plus 4 km buffer, WDA plus 2 km buffer, and WDA only

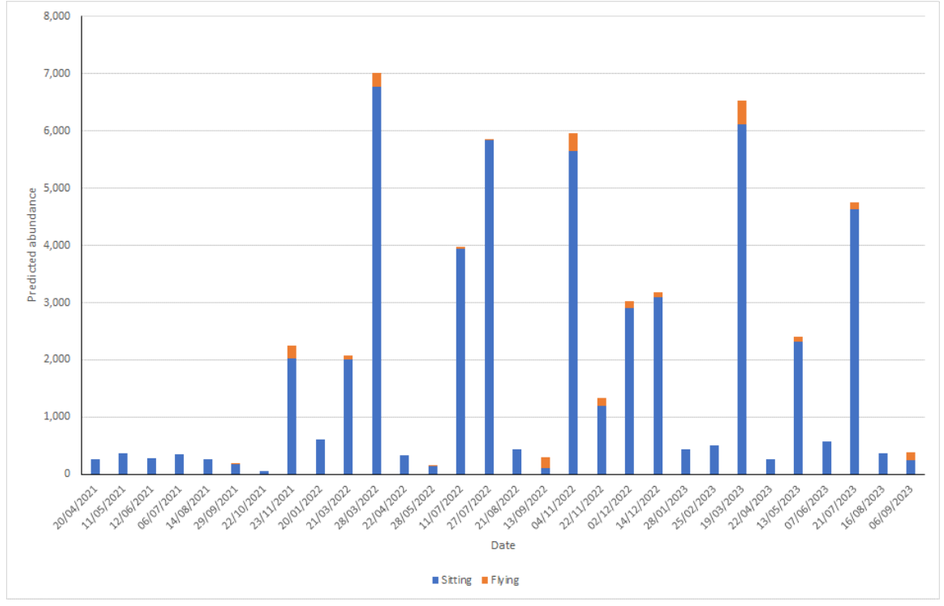
OAA



WDA plus 2 km buffer



WDA plus 4 km



WDA only

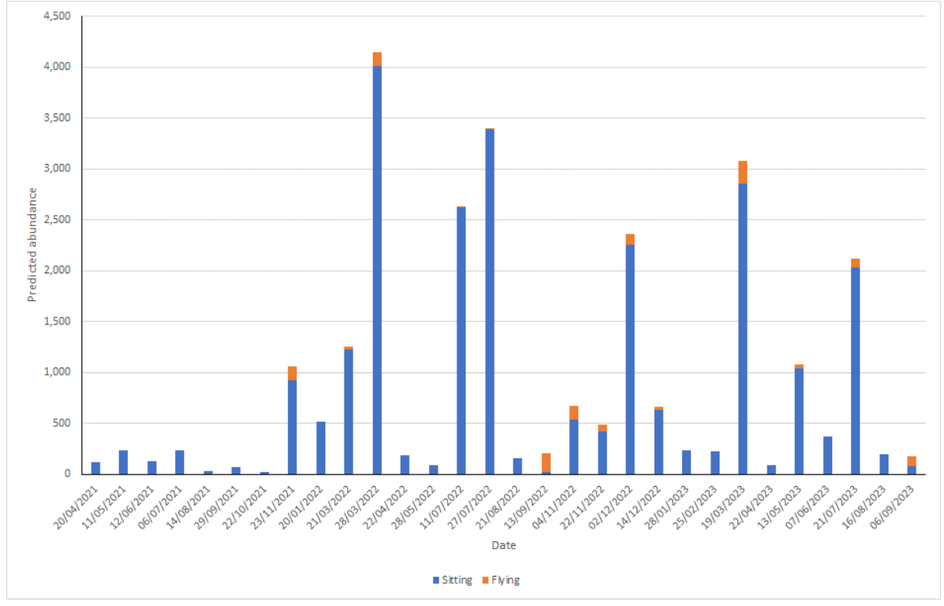
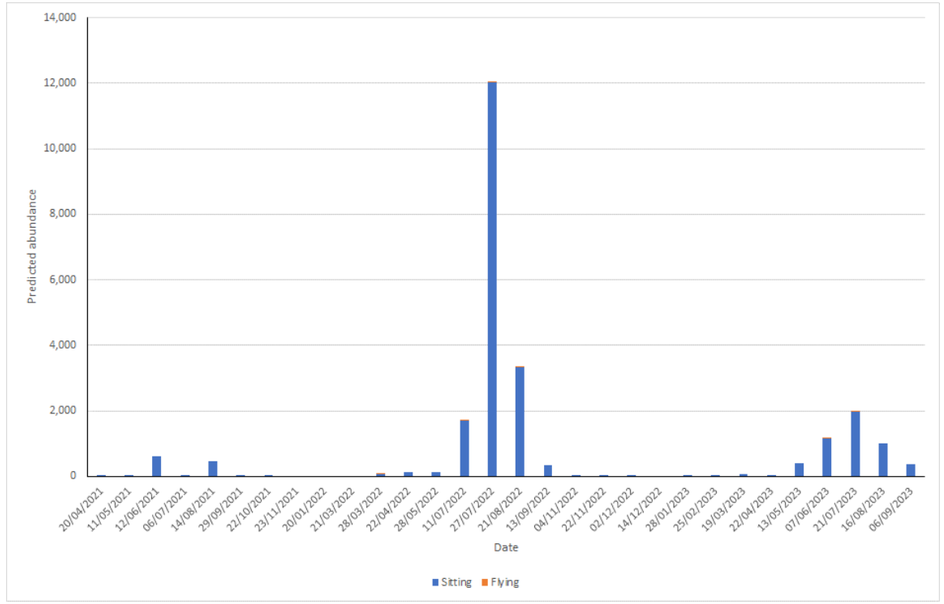
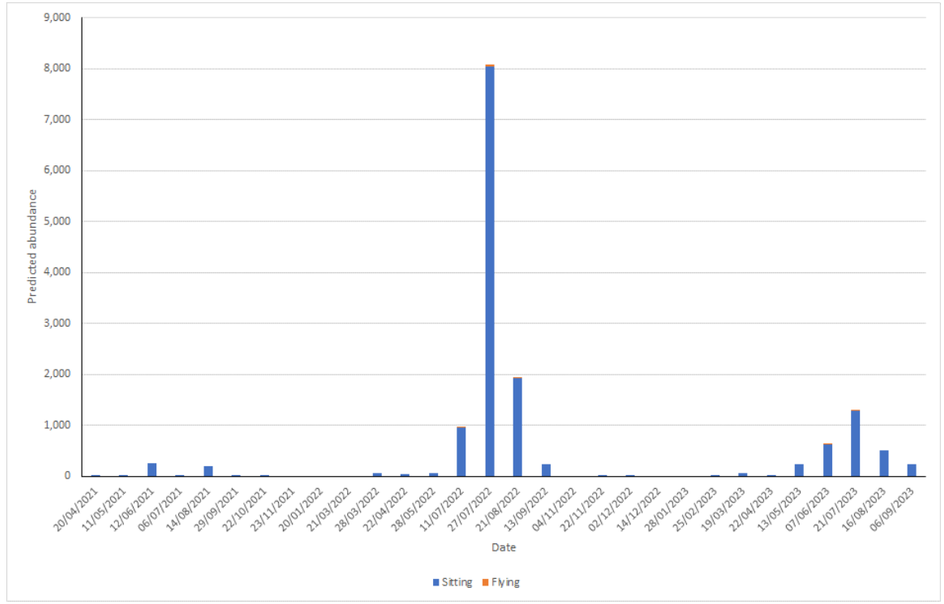


Figure 2.8 Design-based estimated abundance of razorbills in flight (orange) and on the water (blue) for each survey within the OAA, WDA plus 4 km buffer, WDA plus 2 km buffer, and WDA only

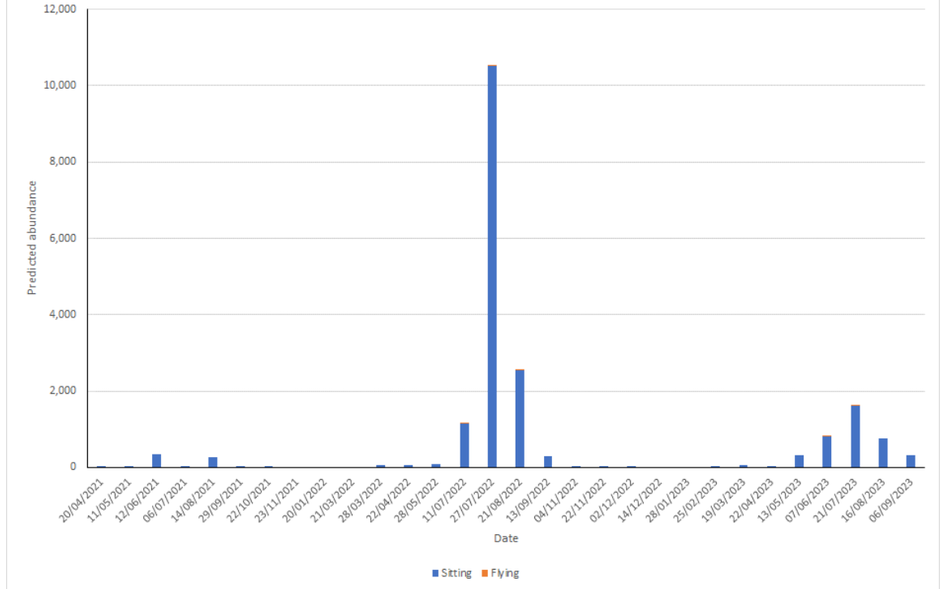
OAA



WDA plus 2 km buffer



WDA plus 4 km



WDA only

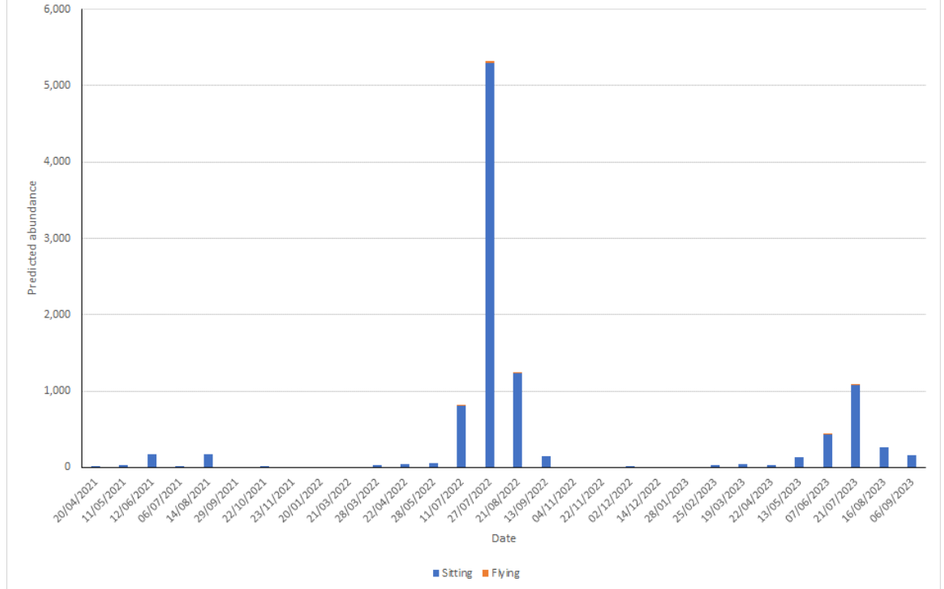
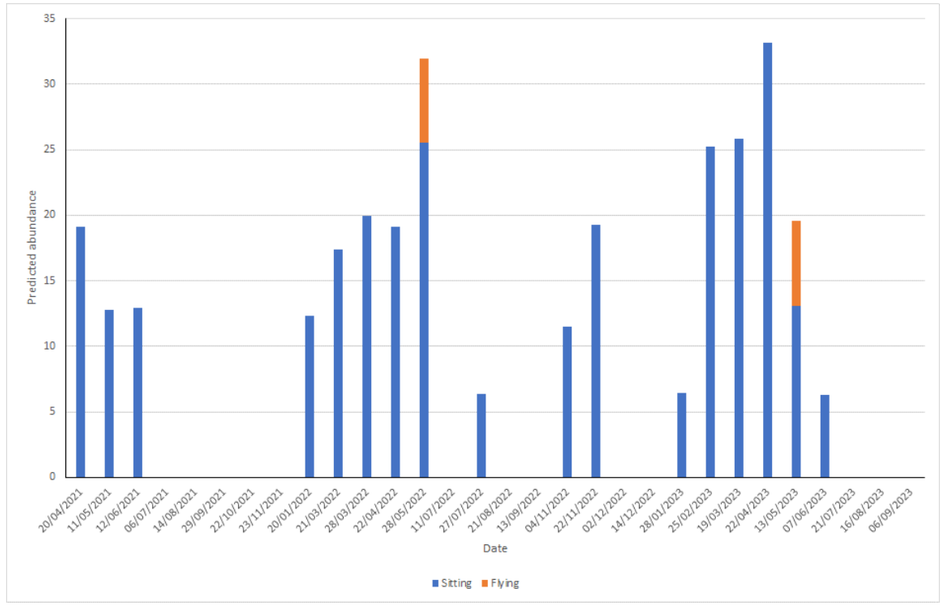
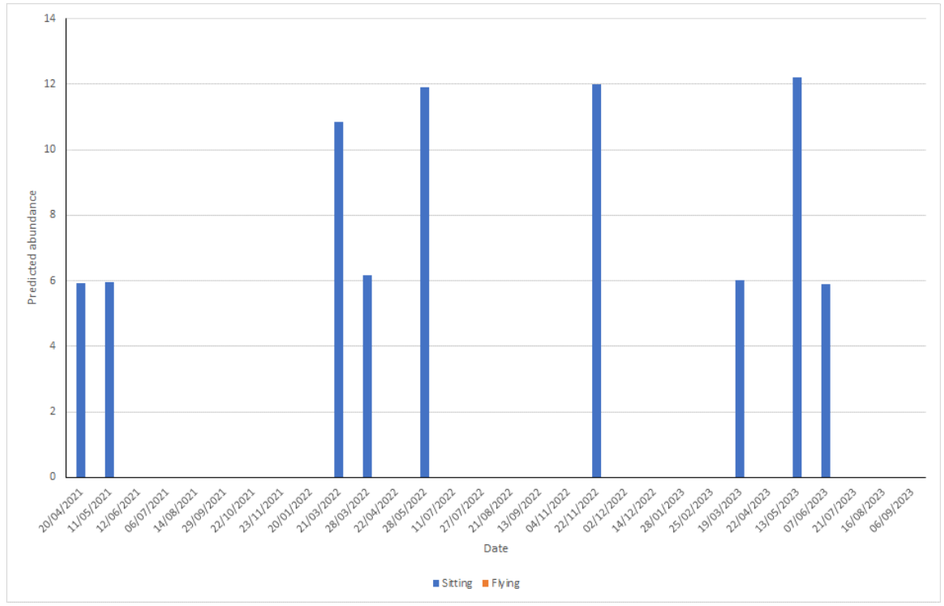


Figure 2.9 Design-based estimated abundance of puffins in flight (orange) and on the water (blue) for each survey within the OAA, WDA plus 4 km buffer, WDA plus 2 km buffer, and WDA only

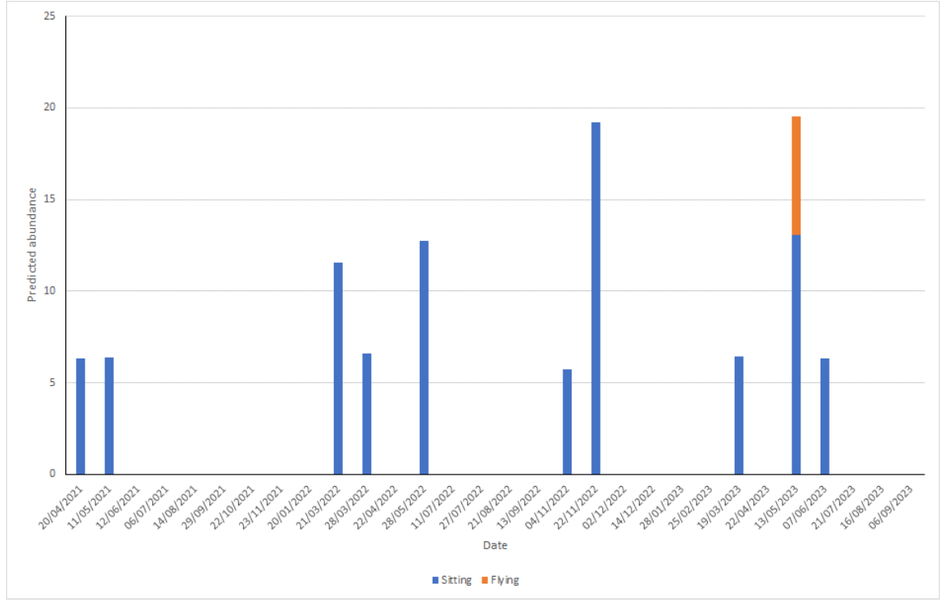
OAA



WDA plus 2 km buffer



WDA plus 4 km



WDA only

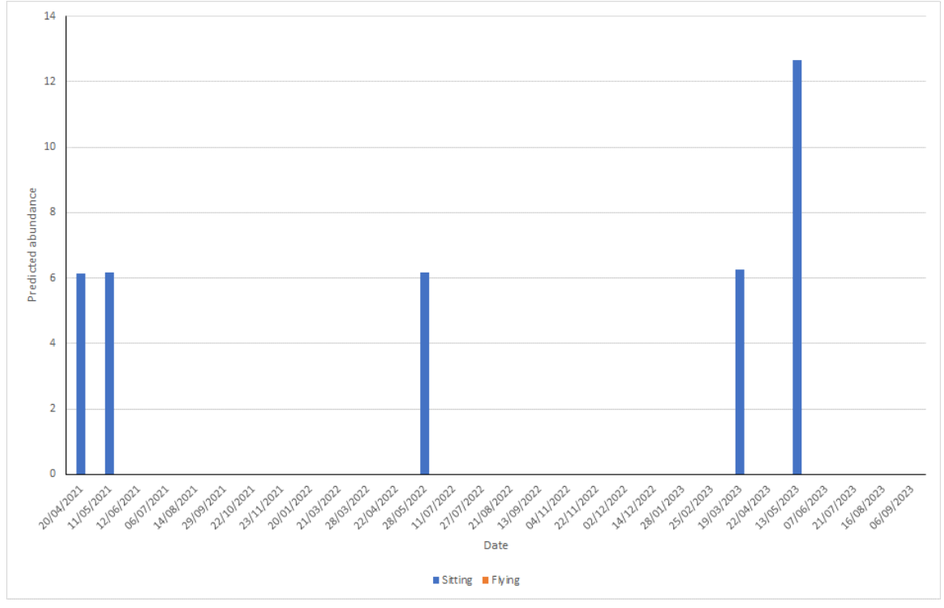
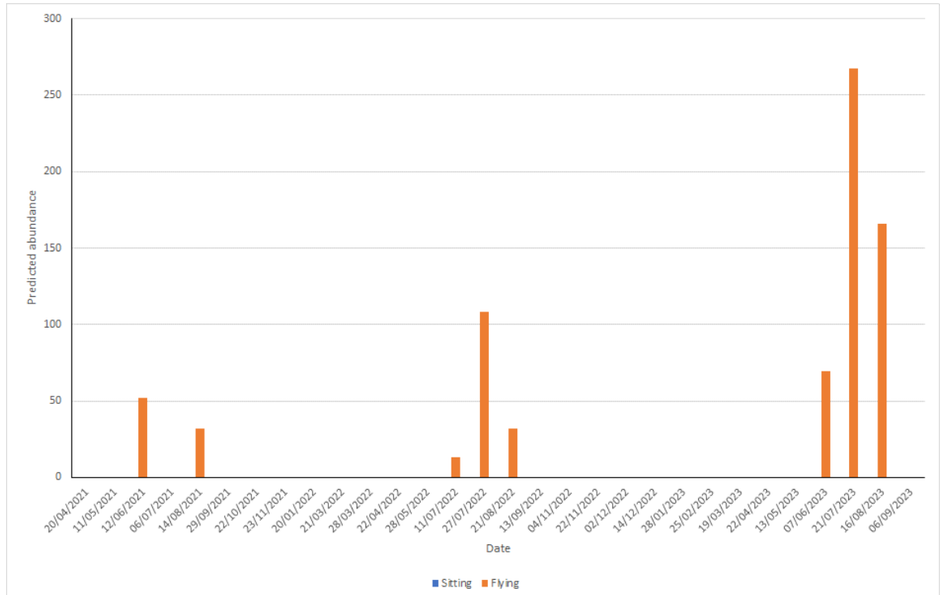
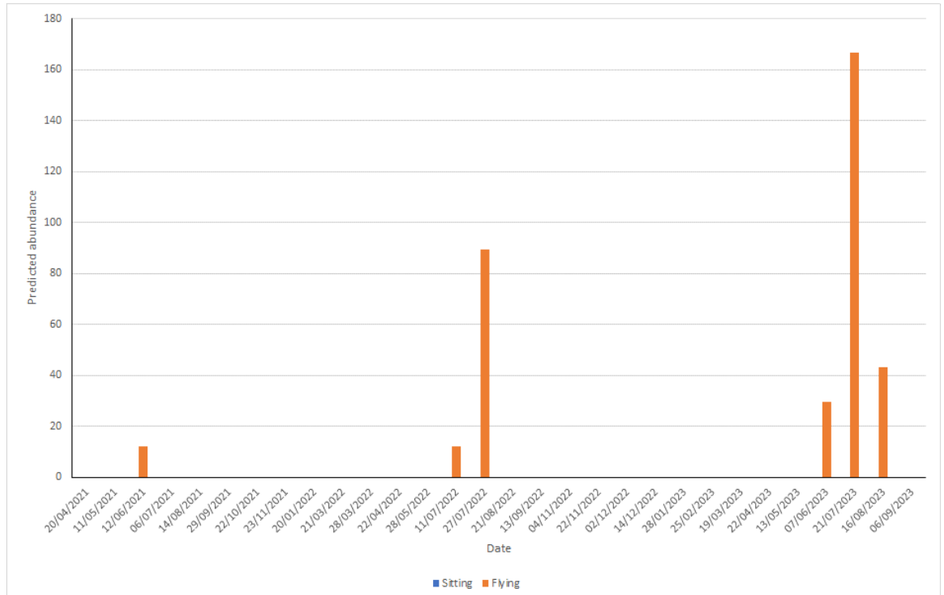


Figure 2.10 Design-based estimated abundance of great northern diver in flight (orange) and on the water (blue) for each survey within the OAA, WDA plus 4 km buffer, WDA plus 2 km buffer, and WDA only

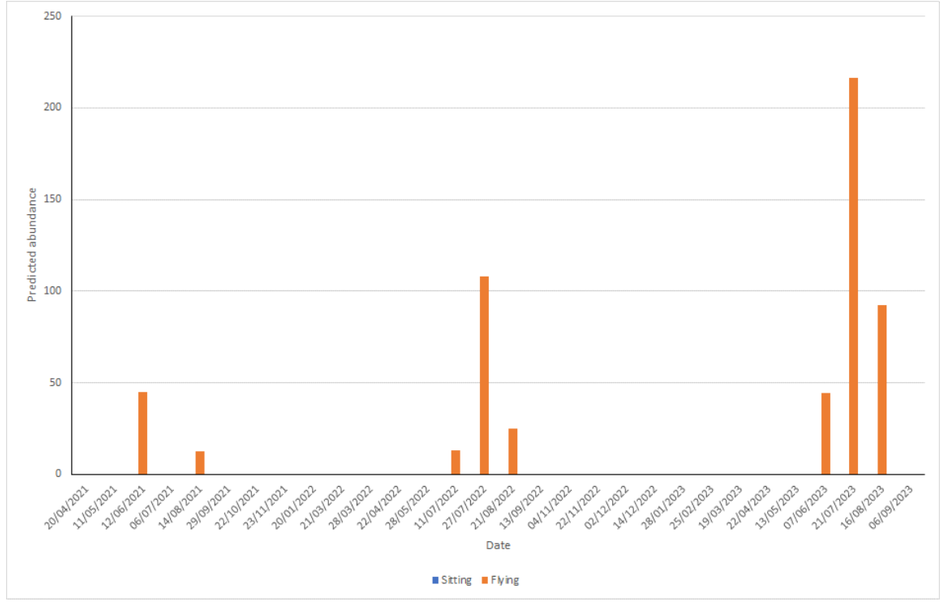
OAA



WDA plus 2 km buffer



WDA plus 4 km



WDA only

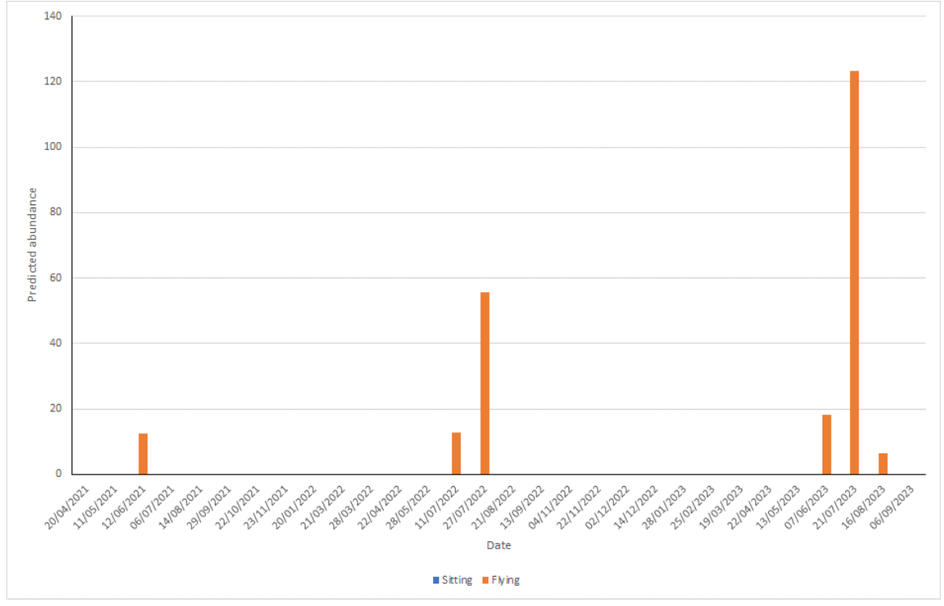


Figure 2.11 Design-based estimated abundance of storm petrel in flight (orange) and on the water (blue) for each survey within the OAA, WDA plus 4 km buffer, WDA plus 2 km buffer, and WDA only

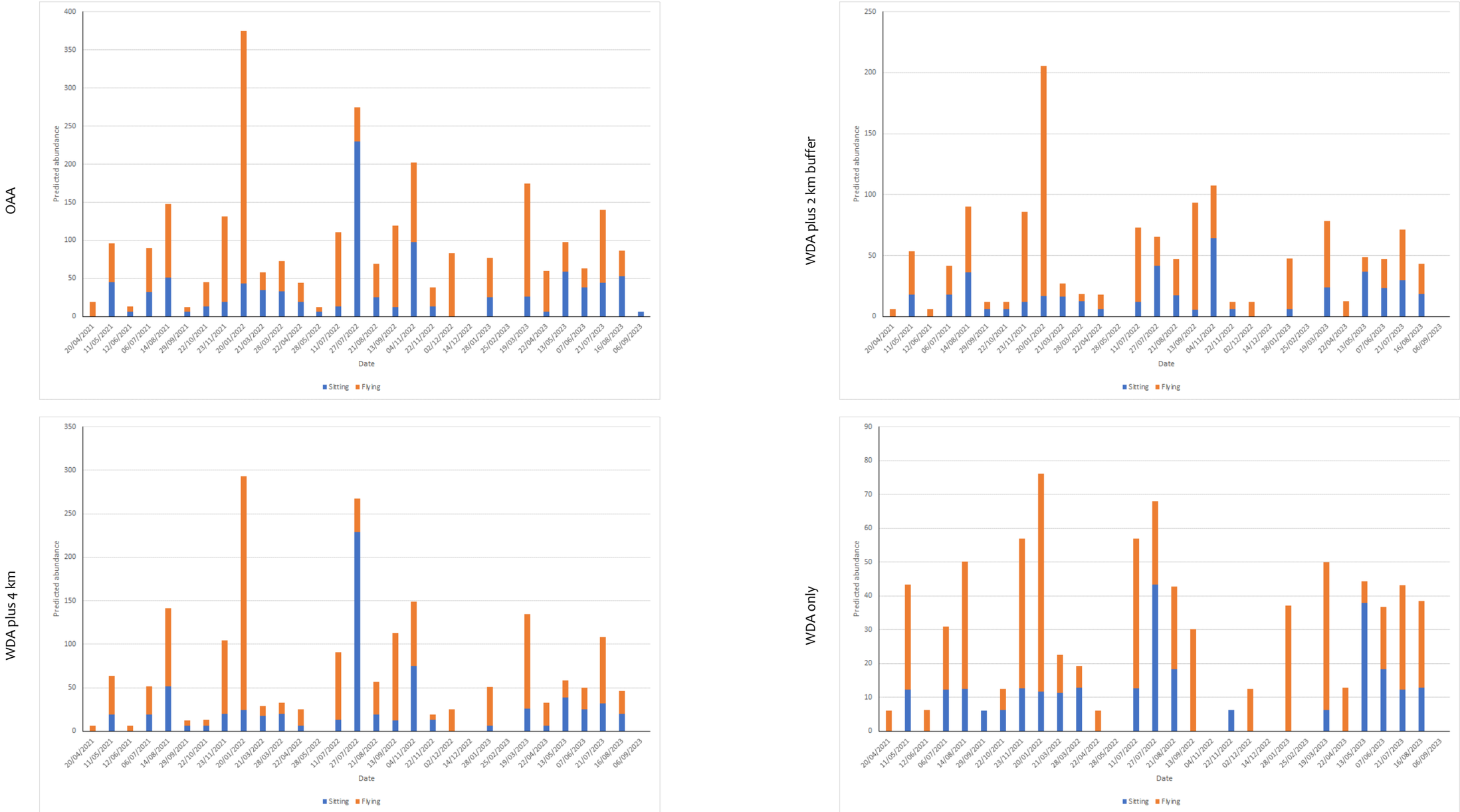
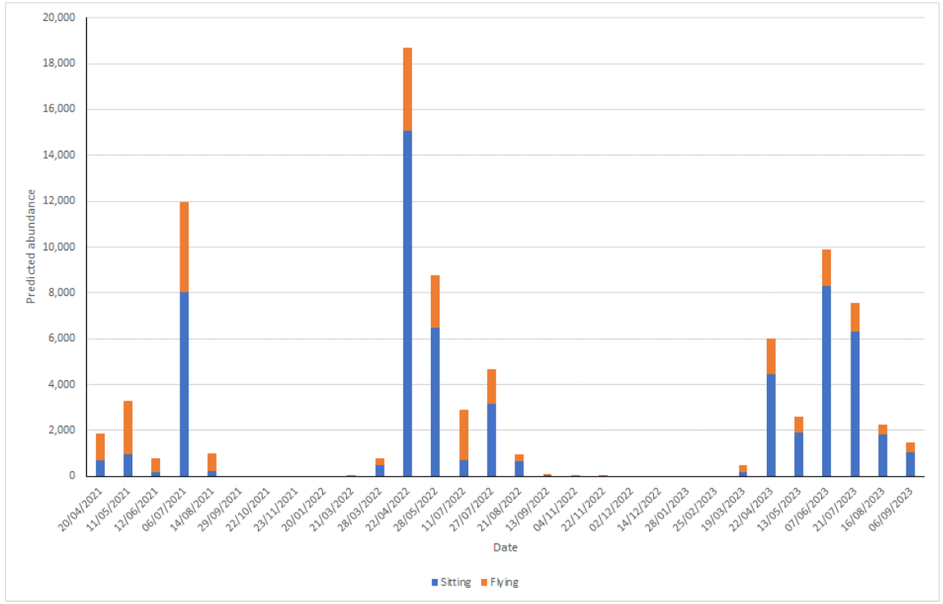
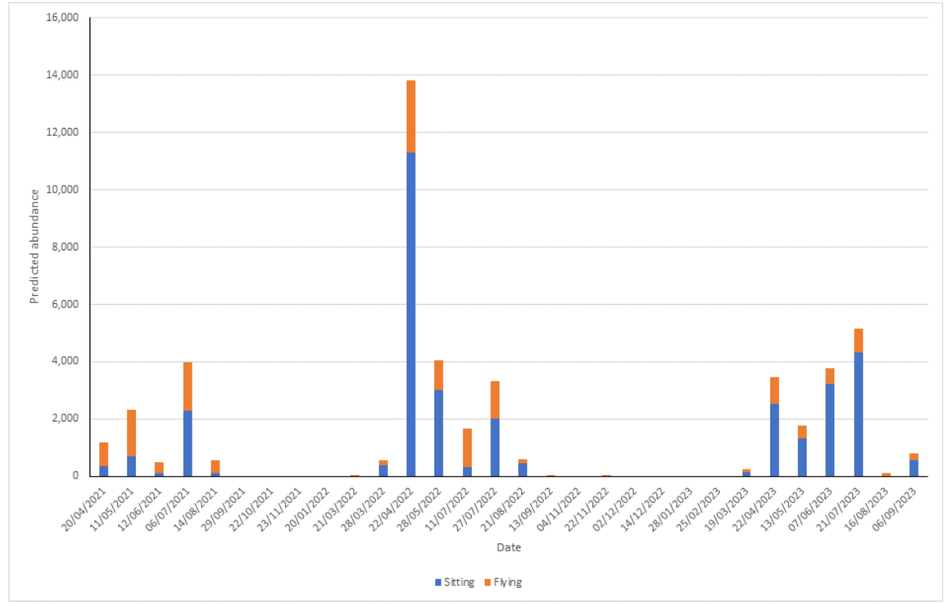


Figure 2.12 Design-based estimated abundance of fulmars in flight (orange) and on the water (blue) for each survey within the OAA, WDA plus 4 km buffer, WDA plus 2 km buffer, and WDA only

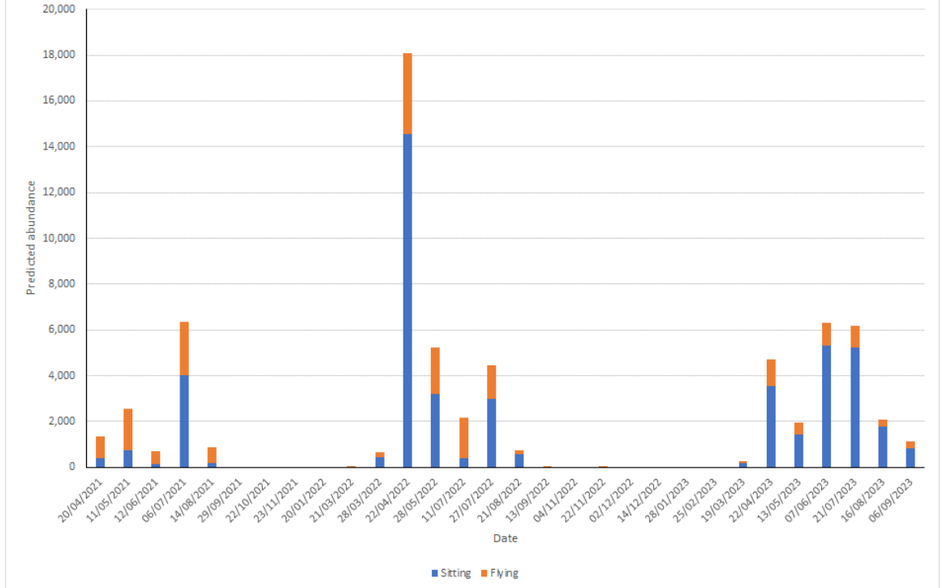
OAA



WDA plus 2 km buffer



WDA plus 4 km



WDA only

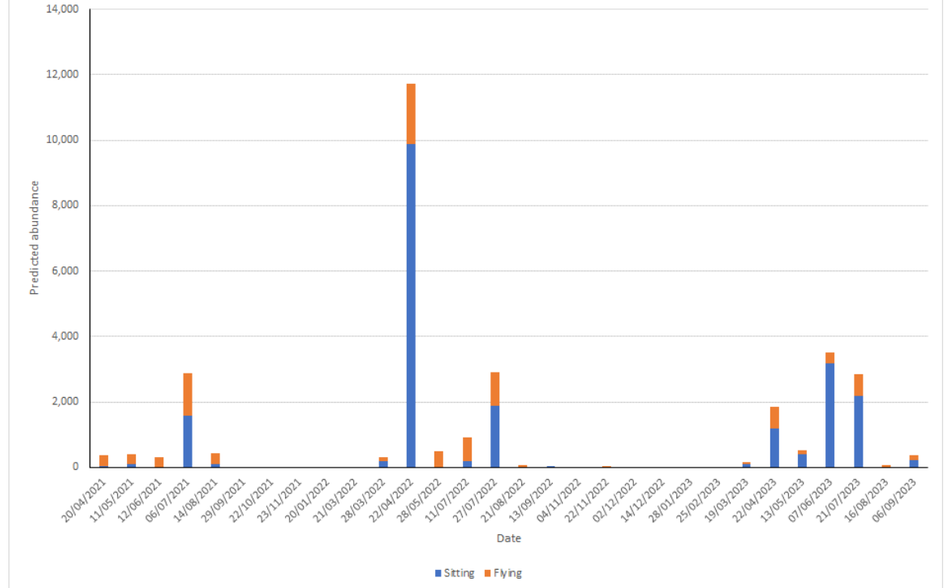
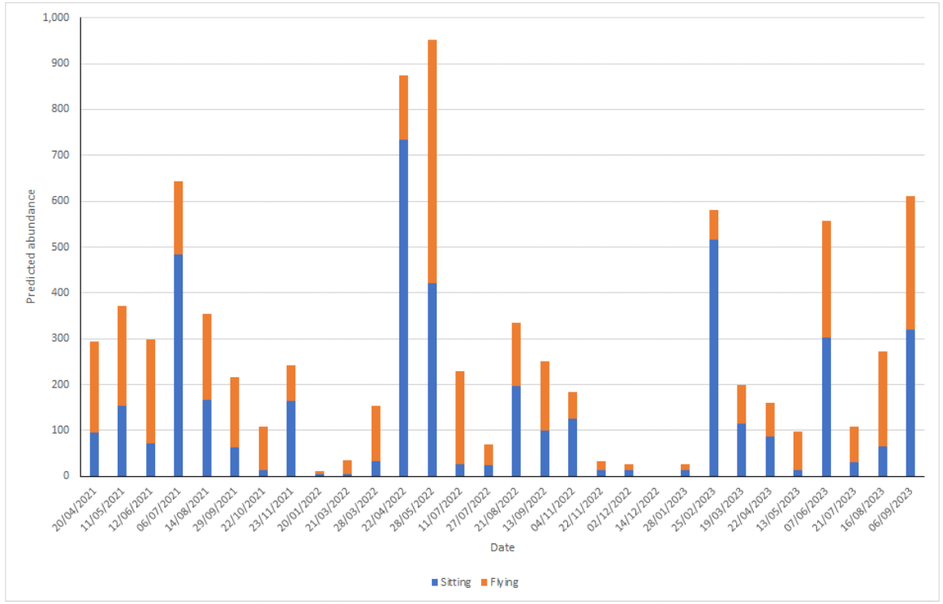
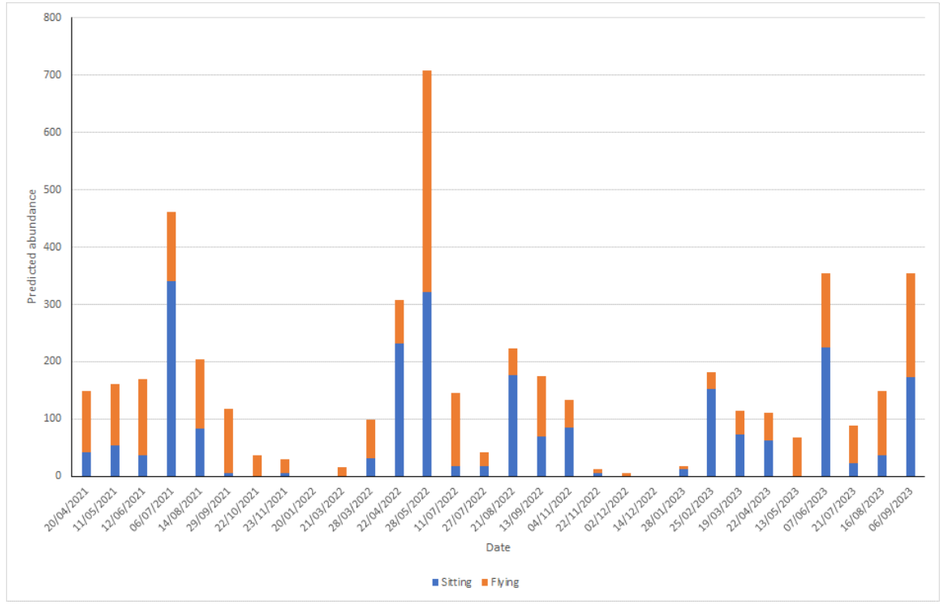


Figure 2.13 Design-based estimated abundance of Manx shearwater in flight (orange) and on the water (blue) for each survey within the OAA, WDA plus 4 km buffer, WDA plus 2 km buffer, and WDA only

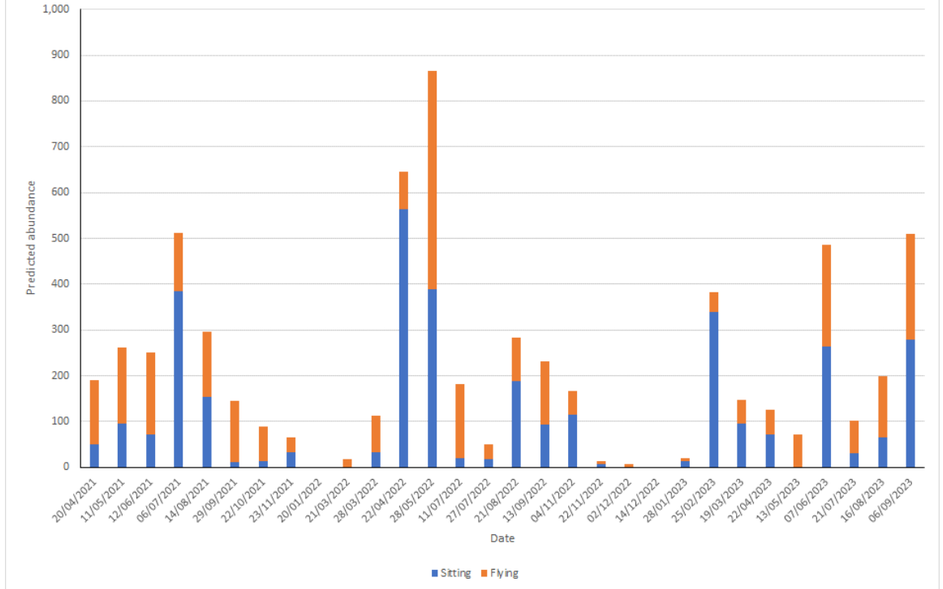
OAA



WDA plus 2 km buffer



WDA plus 4 km



WDA only

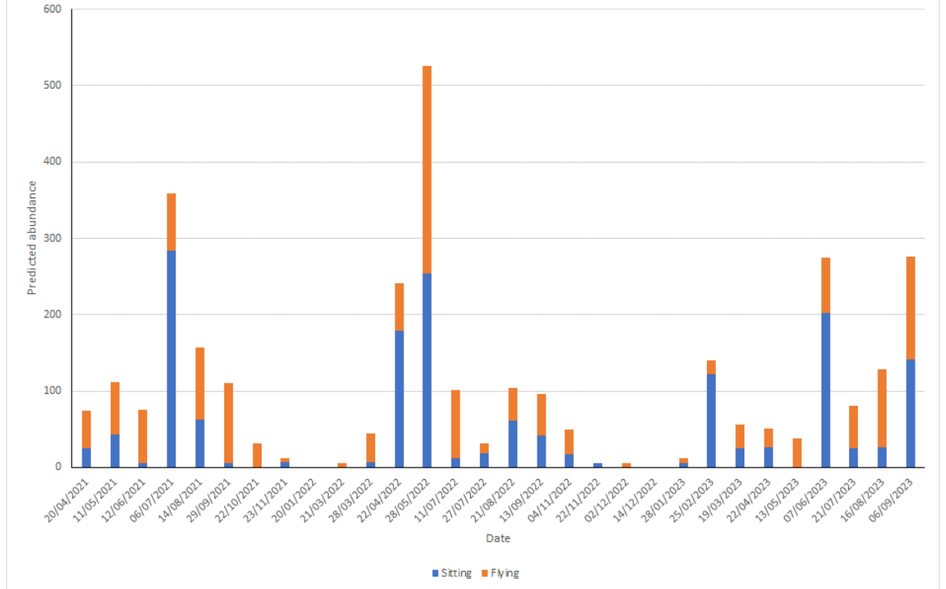


Figure 2.14 Design-based estimated abundance of gannets in flight (orange) and on the water (blue) for each survey within the OAA, WDA plus 4 km buffer, WDA plus 2 km buffer, and WDA only


ScottishPower
Renewables