Offshore Wind Evidence + Change Programme

ProcBe Annual Report No.2

Year 2

Strategic shearwater and storm petrel demography, distribution, and at-sea behaviour to improve understanding of impacts of offshore wind farms on SPA populations in UK waters

THE CROWN ESTATE


ProcBe
Procellariiform Behaviour and demographics

SUMMARY

This report forms the Year 2 Annual Report for the ProcBe Project. The ProcBe Project is a three-year project, which commenced in November 2023 and will complete in December 2026. This project forms part of the Offshore Wind Evidence and Change programme, led by The Crown Estate in partnership with the Department for Energy Security and Net Zero and Department for Environment, Food & Rural Affairs, which aims to expand offshore wind sustainably whilst supporting the marine environment.

Offshore wind farms (OWFs) have the potential to impact seabirds through collision, displacement and barrier effects. Interactions of shearwater and petrel species with OWFs have not previously been the focus of targeted research. In comparison with other species, relatively little is known about at-sea behaviour (e.g., flight height, flight speed, nocturnal activity) and demographic rates of shearwaters and petrels. This is mainly because these species are difficult to study and are not thought to have been the primary species interacting with recent developments in UK waters, which predominantly have focussed on the North Sea. However, this is set to change with the proposed developments in Round 4 and Round 5 in the Irish and Celtic Seas, especially floating wind. This project will focus primarily on Manx Shearwater (MSW; *Puffinus puffinus*), European Storm Petrel (ESP; *Hydrobates pelagicus)* and Leach's Storm Petrel *(LSP; Hydrobates leucorhous)*.

The aim of this project is to fill critical evidence gaps around how Manx Shearwaters and storm petrels interact with OWFs (impact pathways) and improve demographic rates and population modelling approaches to allow adequate assessment of potential impacts. This will be achieved by a combination of strategic tracking of birds, behavioural observations, and population modelling, as well as the use of novel technologies and techniques. The project will build on existing efforts to improve baseline data, provide critical evidence around impact pathways and reduce uncertainty in required impact assessment parameters.

The project is divided into four principal work packages (WPs), led by four different organisations. There is also a fifth work package (WP5) which focuses on the project management and dissemination of results. This report focuses on the four main delivery WPs, as Years 1 and 2 predominantly focus on data collection. Within each year of the project, however, are numerous Deliverables which will be available on the Marine Data Exchange[1].

WP1 focuses on MSW distribution and impact pathways and is being led by the OxNav Group based at the University of Oxford. WP2 focuses on ESP and LSP distribution and impact pathways and is being led by the RSPB. WP3 focuses on collecting data on MSW and storm petrel flight heights and is being led by JNCC. WP4 focuses on MSW and storm petrel demographic rates and population modelling and is being led by the University of Gloucestershire. The results to-date, next steps, and recommendations for each of the different WPs are the focus of this report.

[1] https://www.marinedataexchange.co.uk/

WP1: Manx Shearwater at-sea distributions and behaviour

The majority of the global population of breeding MSW is to be found off the west coasts of Britain and Ireland, with birds from the three SPAs of Rum, Copeland, and Skomer/Skokholm utilising the seas off western Britain during the breeding season. In ProcBe WP1, we aim to increase understanding of the detailed at-sea distributions and behaviour patterns of MSW in the region using a range of state-of-the-art bird-borne biotelemetry systems coupled with advanced ethoinformatics analysis. In particular we aim to enhance understanding of shearwater space use in the Celtic and Irish seas using precision GPS tracking of breeding and of immature birds frequenting the three focus breeding colonies (WP1a), including where possible comparisons with extant historical tracking data to help assess inter-year variability or long-term change. We aim to explore space use (albeit in less detail) by adult shearwaters during both the pre-breeding period and the post-breeding period as they return from or embark on migration (WP1b) using miniature archival geolocator/immersion loggers at all three colonies. The behaviour and flight paths of fledgling shearwaters present a significant gap in our understanding of this species, and in WP1c we aim to deploy novel remote download GPS technologies to gain the first insights into the shearwater's first-time migration. Finally, in WP1d, we aim to take a biotelemetric approach to understanding shearwater flight heights in detail in order to understand potential collision risks with OWF now that development is taking place in waters where the species is prevalent.

What Has Been Done in 2025?

- Reported on the 2024 tracking and the long-term consistency of new data (D1.1).
- Reported on the overlap of fledgling interactions with the crown estate Regions of Interest (D1.6).
- Reported on the initial feasibility of flight height measurements (D1.9).
- GPS tracking of incubating shearwaters using archival loggers on Skomer, Copeland and Rum (c20 on each colony) during 2025 breeding season (Fig. 1A, 2A, 3A).
- GPS tracking of immature shearwaters using archival loggers on Skomer (c20 deployments and c4 retrievals), and remote download devices on Rum and Copeland (c10 individuals on each colony) (Fig. 1B, 2B, 3B).
- GPS tracking of chick-rearing shearwaters using archival loggers on Skomer, Copeland and Rum (c20 on each colony) during 2025 breeding season (Fig. 1C, 2C, 3C).
- GPS tracking of 10 first-time migrating fledgling shearwaters on each of Skomer, Copeland and Rum using remote download devices (still on-going) (Fig. 4).
- Opportunistic geolocator-immersion logger downloads and re-deployments on breeding shearwaters on Skomer, Copeland and Rum.
- Field deployment of 25 high-resolution Axytrek GPS/barometric altimeter loggers on breeding shearwaters on Skomer; preliminary analysis of flight heights (Fig. 5).

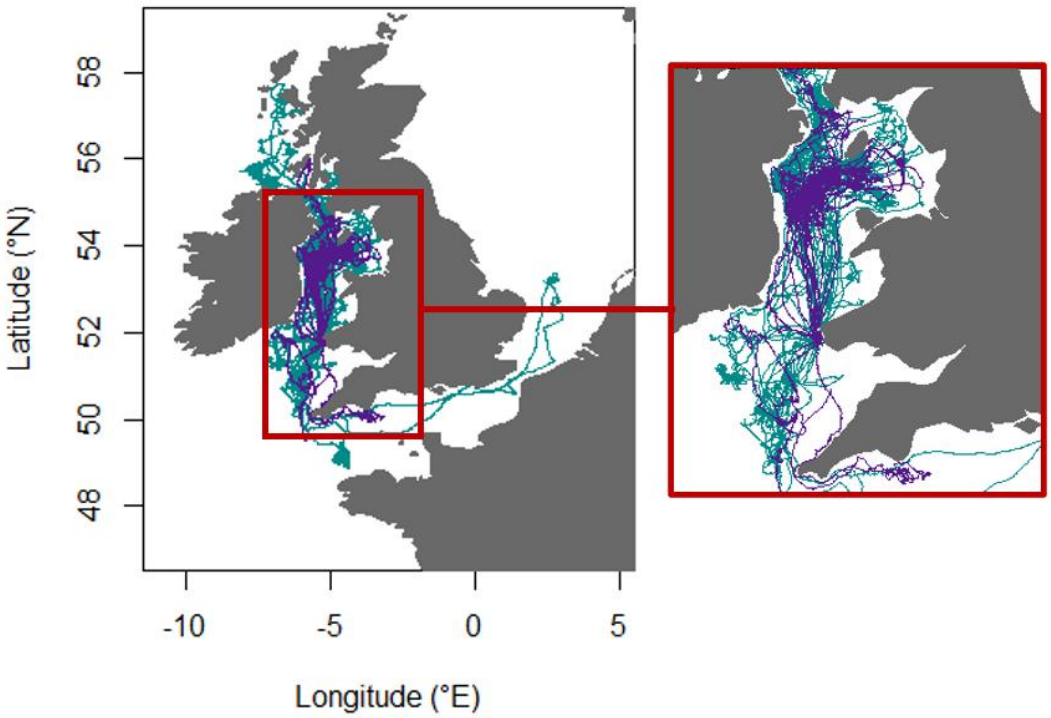

Figure 1A. Skomer incubation tracking for 2024 (teal: n=19 individuals) and 2025 (purple: n=15 individuals). The red panel indicates tracks recorded in the Celtic and Irish Sea.

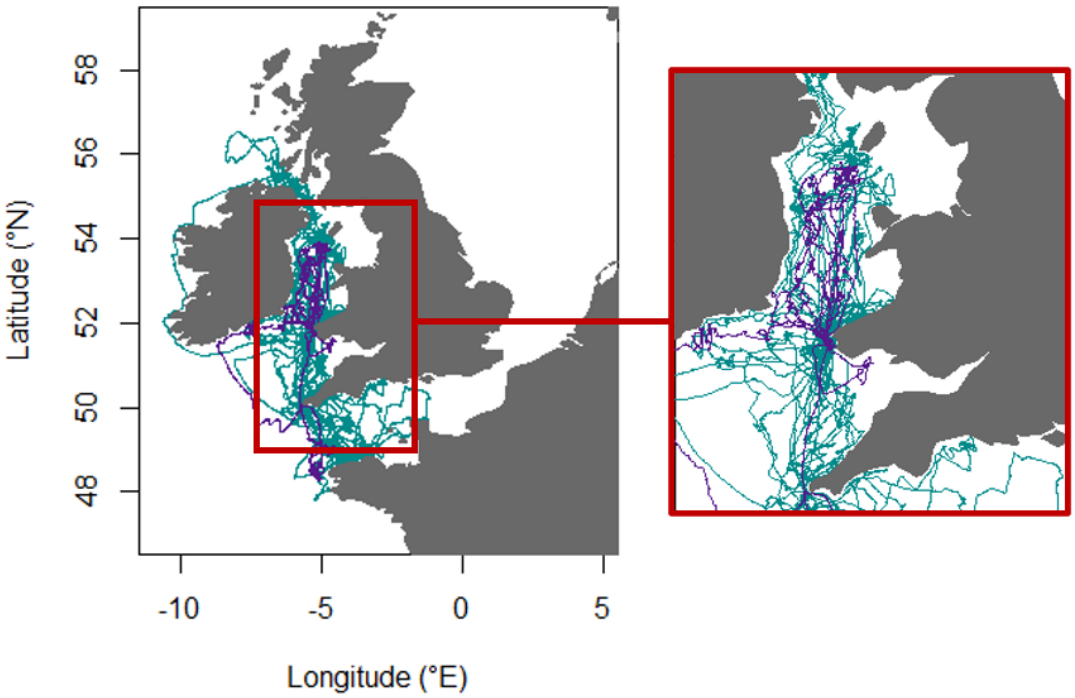

Figure 1B. Skomer immature tracking for 2024 (teal: n=11) and 2025 (purple: n=4). The red panel indicates tracks recorded in the Celtic and Irish Sea.

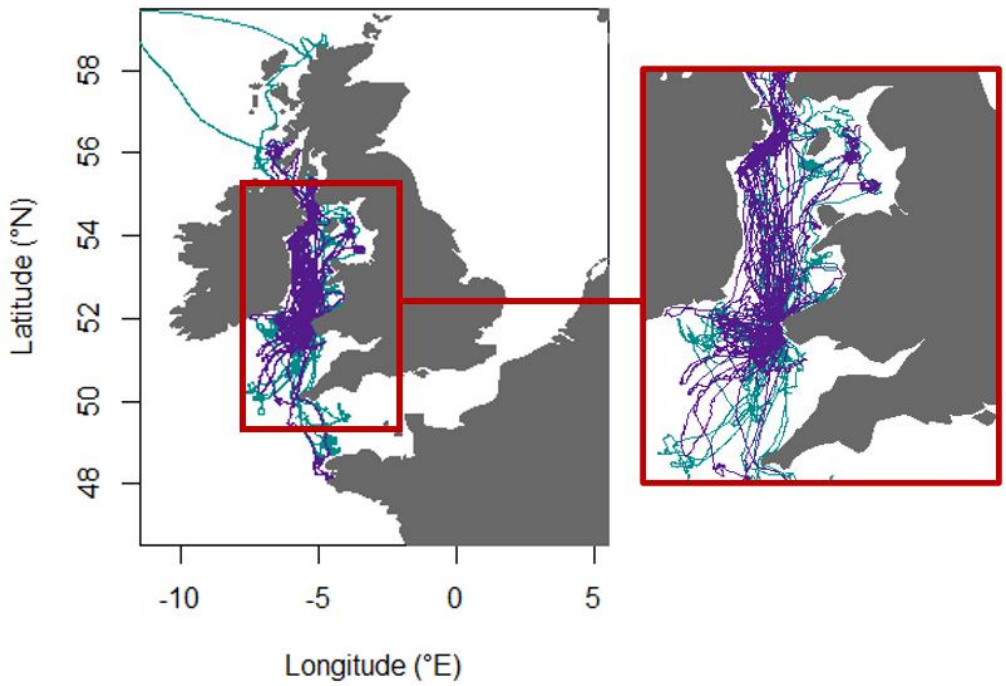

Figure 1C. Skomer chick-rearing tracking for 2024 (teal: n=13) and 2025 (purple: n=11). The red panel indicates tracks recorded in the Celtic and Irish Sea.

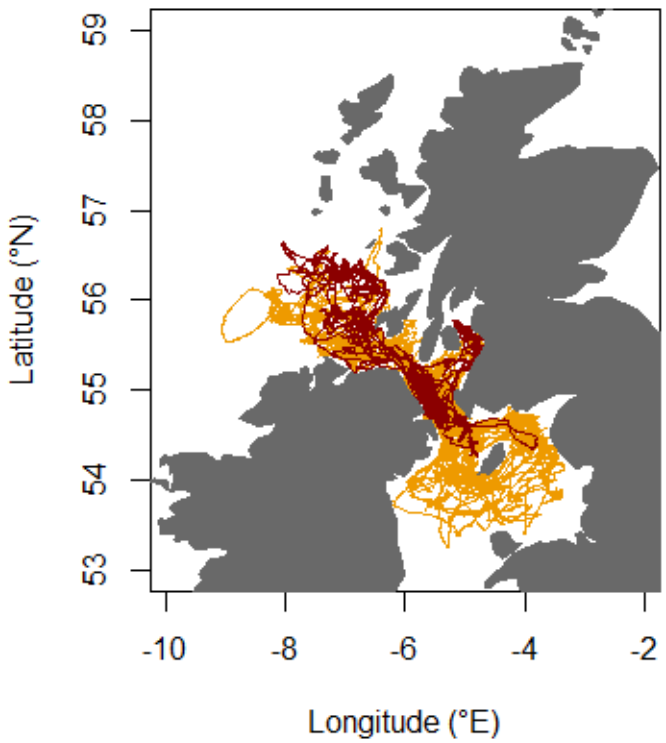

Figure 2A. Copeland incubation tracking for 2024 (orange: n=20) and 2025 (red: n=10).

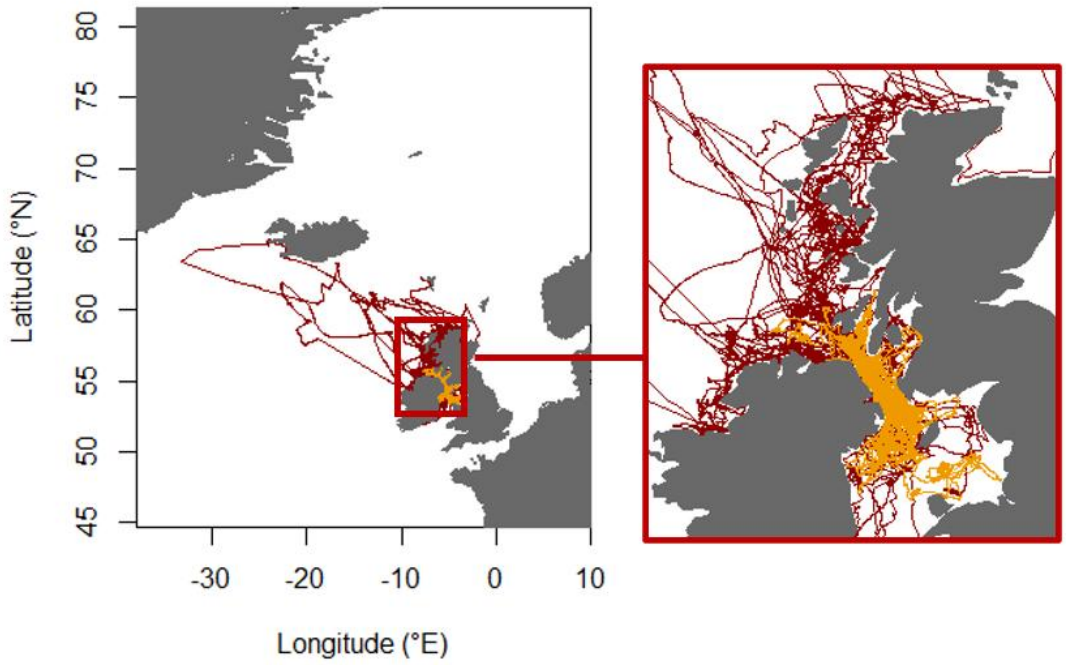

Figure 2B. Copeland immature tracking for 2024 (orange: n=13) and 2025 (red: n=13). The red panel indicates movements within the Irish Sea.

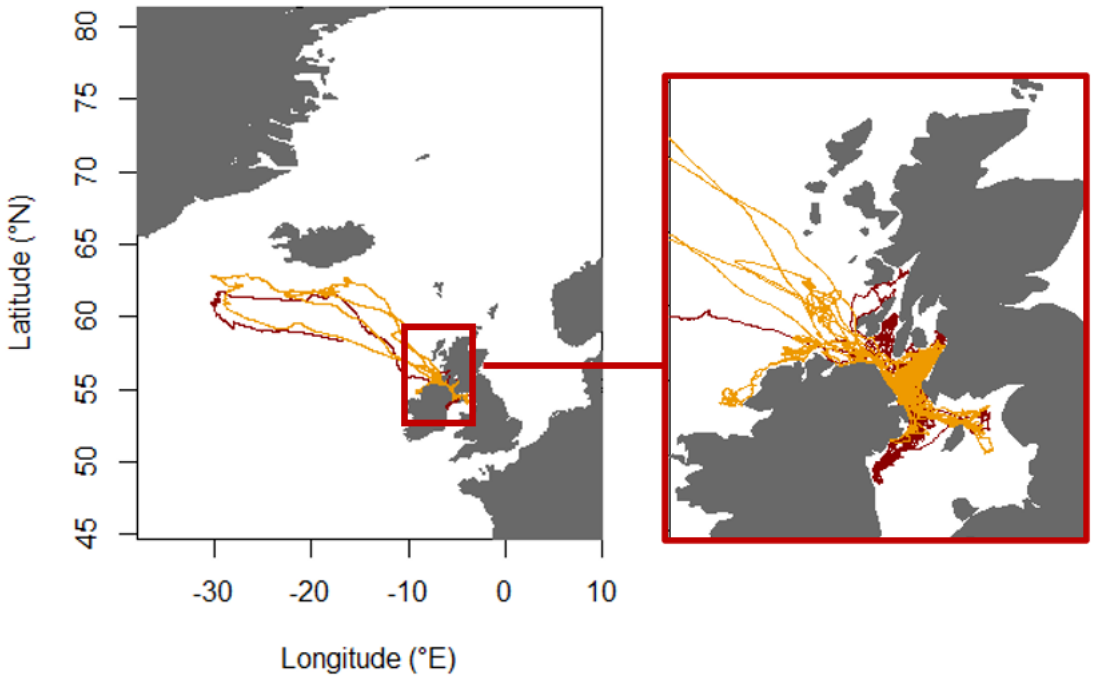

Figure 2C. Copeland chick-rearing tracking for 2024 (orange: n=16) and 2025 (red: n=16). The red panel indicates movements within the Irish Sea.

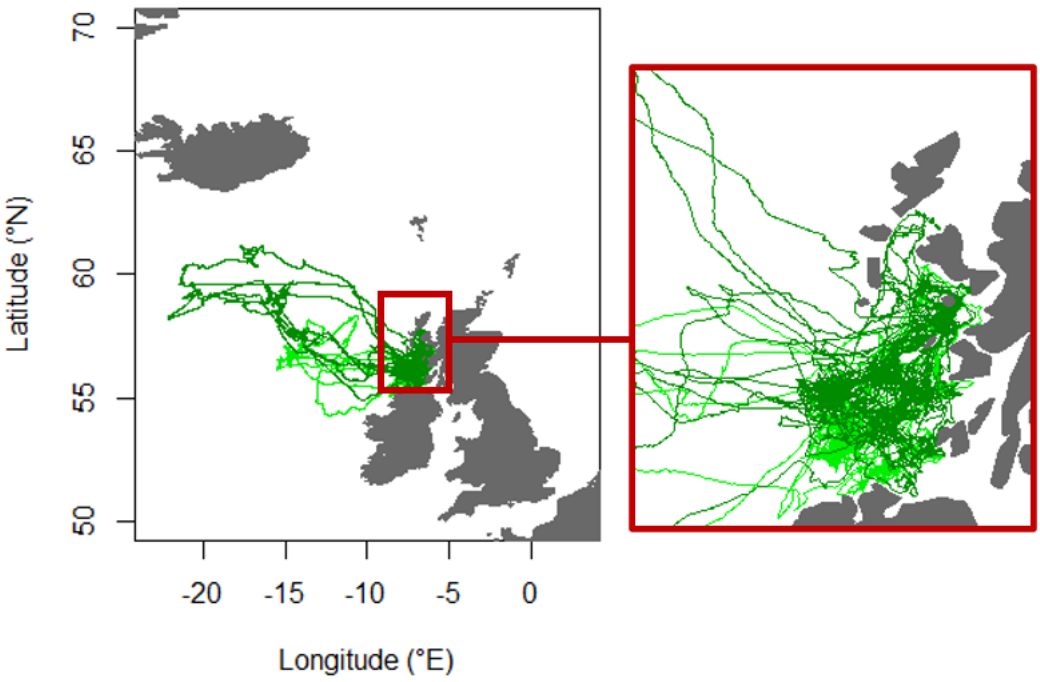

Figure 3A. Rum incubation tracking for 2024 (light green: n=9) and 2025 (dark green: n=17). The red panel displays local movements and shorter trips closer to the colony.

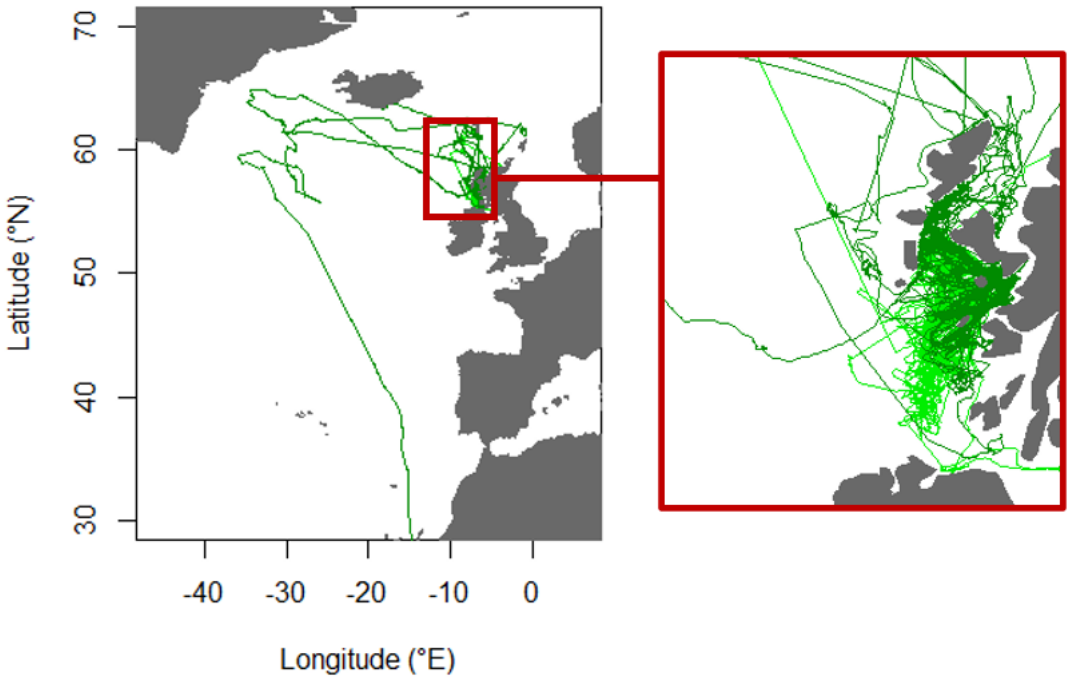

Figure 3B. Rum immature tracking for 2024 (light green: n=9) and 2025 (dark green: n=10), capturing the beginning of migration for one individual in 2025. The red panel displays local movements and shorter trips closer to the colony.

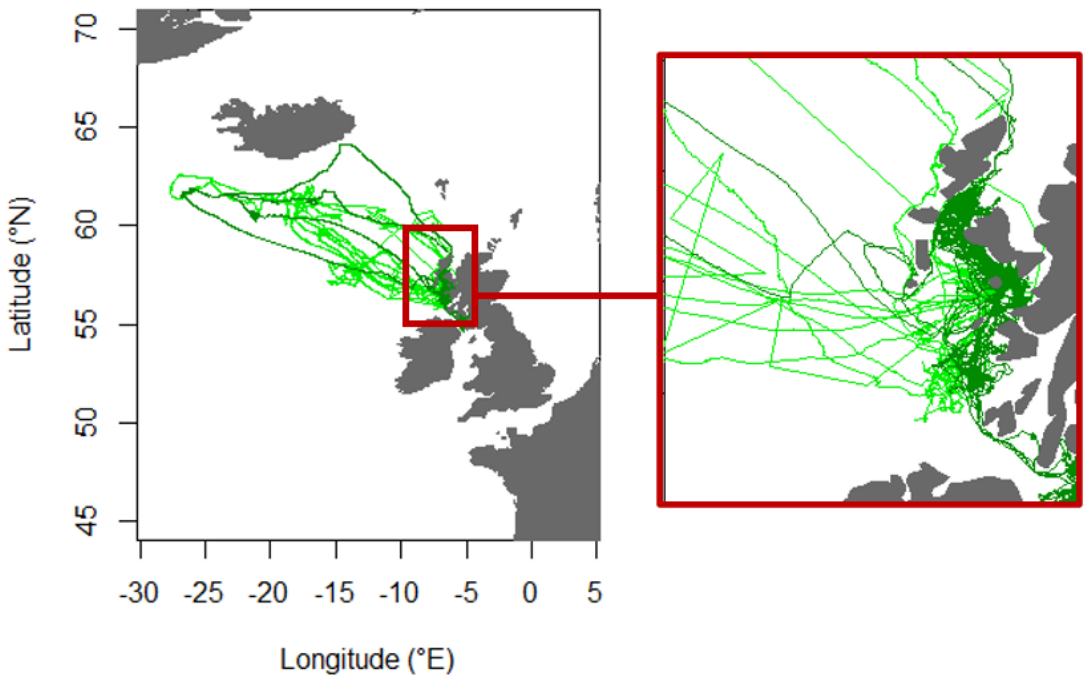

Figure 3C. Rum chick-rearing tracking for 2024 (light green: n=12) and 2025 (dark green: n=15). The red panel displays local movements and shorter trips closer to the colony.

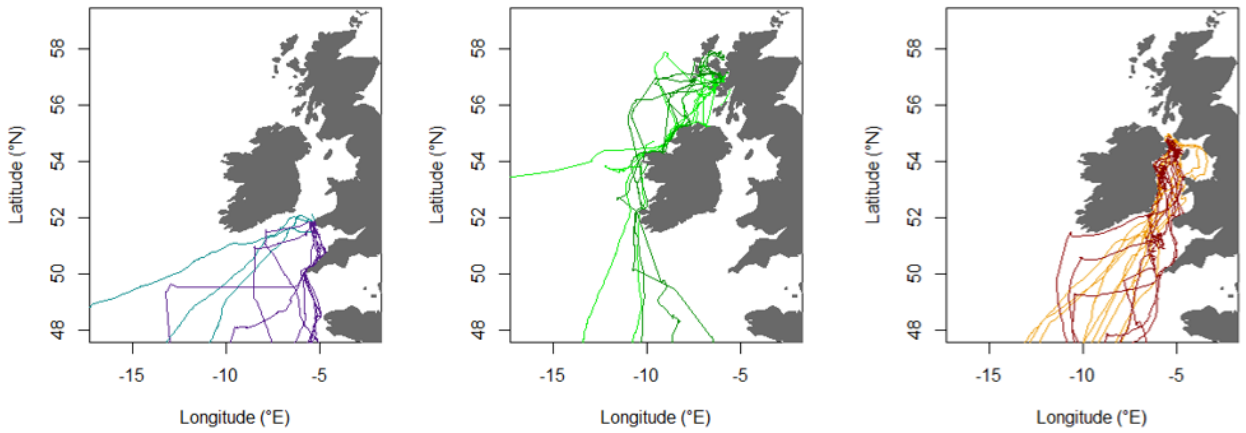

Figure 4. Fledgling tracking for Skomer 2024 (teal: n=10 individuals) and 2025 (purple: n=10 individuals), Rum 2024 (light green: n=10) and 2025 (dark green: n=10) and Copeland for 2024 (orange: n=10) and 2025 (red: n=10).

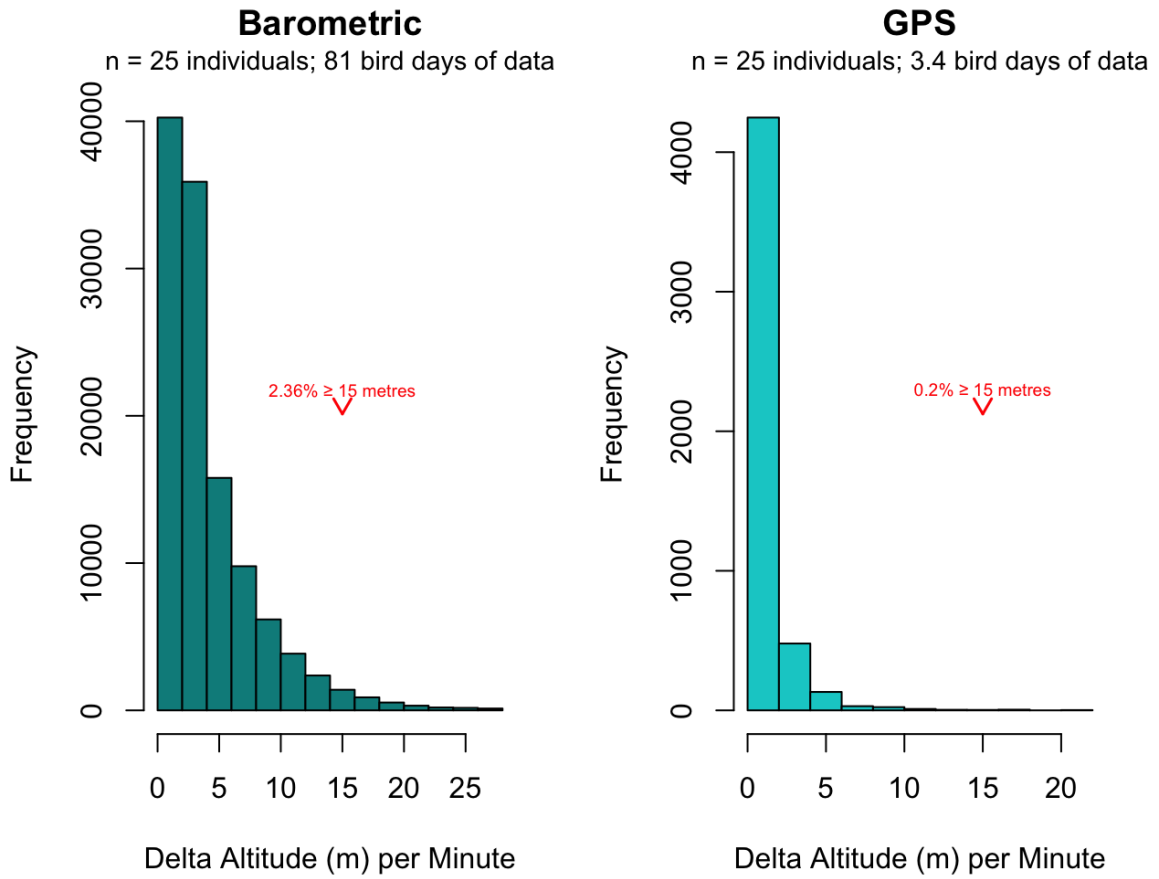

Figure 5A. A histogram of delta altitude (m) per minute for barometric and GPS derived altitude. Barometric data were recorded at 1hz for 25 deployments in 2025, whilst GPS data were recorded simultaneously for 1-2 hours a day during peak commuting hours (6-7AM UTC, 18-19PM UTC) to preserve device battery. 2.36% of barometric altitudes were recorded at >= 15 metres and 0.2% of altitudes were recorded at >=15 metres for GPS measurements.

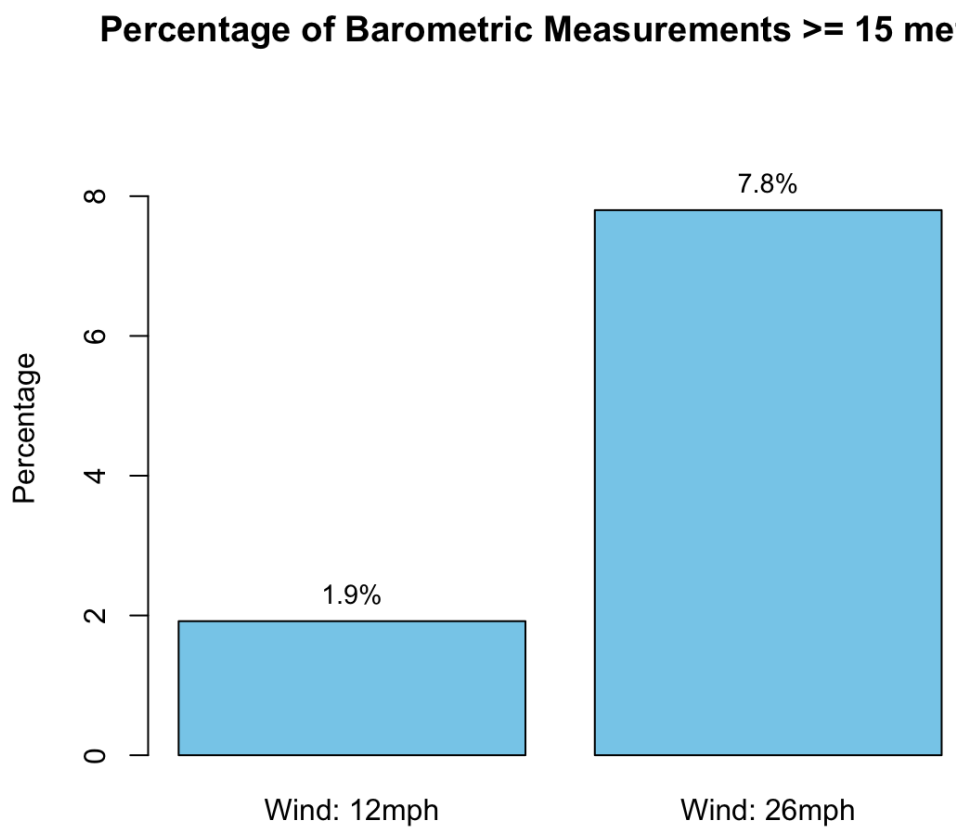

Figure 5B. A comparison of the percentage of all barometric measurement (calibrated to the sea surface using periods of sitting at sea surface level derived from immersion loggers) >= 15 metres on the 11th July (n= 5 individuals) where wind speeds recorded at the Milford Haven weather station reached a maximum of 12mph and the 19th July (n=3 individuals) where wind speeds reached a maximum of 26mph.

Preliminary Results

- Our initial report on the consistency of tracking with long term data shows that 2024 tracking of breeding Manx Shearwaters closely matches previous years, supporting its accuracy. However, observed long-term shifts in foraging patterns, likely driven by environmental change, highlight the need for continued, long-term monitoring across colonies and the inclusion of historical data. Through preliminary visualisations of our 2025 data (Fig. 1-3), chick-rearing and incubation tracking appear relatively consistent between 2024 and 2025. However, there are some inconsistencies in immature tracking. On Copeland Island, as part of a separately funded PhD project, we acquired remote download loggers to track immatures in 2025, whilst in 2024 we deployed archival loggers. Therefore, our data in 2024 was restricted to individuals which returned to the colony for retrieval, whilst in 2025 we recorded foraging trips that were longer and extended further northwest into the Atlantic (Fig. 2B). We retrieved only four immature loggers from Skomer island in 2025 and have concerns as to whether we are capturing the full extent of immature movements in the Celtic and Irish Sea through using archival loggers as we may be experiencing a retrieval bias to our data (Fig. 1B). Meanwhile, immature tracks on Rum, where we used remote download technology in both 2024 and 2025 appear consistent between years (Fig. 3B).
- Our initial report on 2024 fledgling interactions with ROIs reveals strong overlap between Copeland and Skomer birds and ROI development areas in the Celtic and Irish Seas. Additionally, we provided the first description of post fledgling foraging and identify the Celtic and Irish Sea as key foraging zones for first-time migrants. From preliminary investigation of our 2025 data, this overlap appears to remain consistent for Copeland and Skomer birds. Meanwhile, Rum birds in both 2024 and 2025 migrated west of Ireland with less overlap with ROI. In 2024 we retrieved sufficient data to show transit through the Celtic and Irish sea, from only three individuals fledgling from Skomer. In addition, in 2025 we retrieved data from six individuals, demonstrating that 4G technology is a suitable technology for investigating migratory movements within the Celtic and Irish Sea.
- Our initial report on flight height feasibility demonstrates that combining barometric pressure and GPS logging with an immersion device appears to provide sensible estimates of flight heights. We demonstrate two approaches for obtaining flight heights from biologging; one in which the maximum altitude change (delta altitude) per minute is taken, and one where co-deployed immersion loggers are used to calibrate altitude measurements according to the last period where the height of the sea surface was measured. In 2024 we received little data from our test deployments due to technical issues surrounding the capabilities of the devices in recording GPS 1hz data. Through purchasing devices with a larger battery, and recording only 1-2 hours of GPS 1hz data, we have retrieved data from 25 individuals in 2025 and recorded 81 bird days of 1hz barometric data and 3.4 bird days of 1hz GPS data. Preliminary analysis of 2025 data suggests that Manx Shearwaters fly at higher altitudes (>=15 metres) a small percentage of the time (Fig. 5A). However, it appears that this percentage may greatly increase depending on wind conditions (Fig. 5B).
- We have resolved issues surrounding congestion of the Snapper GPS processing pipeline through internally processing tracks via our own devices. This has allowed us to process our tracks more rapidly than in 2024, however is limited only to PCs that have sufficient processing power.

Impact

- Once fully analysed, GPS tracking will be able to provide valid estimates of detailed space use by shearwaters in the ROIs to OW developers and therefore evidence-based guidance on the importance or otherwise of impact assessments.
- For the first time, the behaviour and space use of both immatures and fledglings will have been assessed with respect to the ROIs of OW development potential.
- Evidence-based estimates of shearwater flight heights in a range of realistic conditions will aid in collision-risk assessments.

Next Steps

- WP1 has largely progressed as planned so we do not envisage any major changes to our original plans for analysing data over the winter, or for planned fieldwork in 2026.
- Given the low recovery rates this year of immature birds on Skomer, and the spatial difference on Copeland between the data received in 2024 by archival loggers and 2025 by remote download loggers (funded as part of a PhD project), we would like to request purchasing 10 remote download loggers for immature tracking on Skomer in 2026.
- Barometric altimetry, supplemented with bursts of high-resolution GPS data, looks to be effective for measuring flight heights, and we plan to continue sampling next year, targeting a range of wind conditions.

WP2: European Storm Petrel and Leach's Storm Petrel tracking

This WP aims to fill critical evidence gaps around how ESP and LSP interact with OWFs, particularly in areas of new development such as the Irish and Celtic Seas. Little is known about these species in terms of their distribution and flight behaviour and they have so far not been a focus for investigation around OWF impact pathways. The aims of this work package are therefore to collect at-sea distributional and behavioural data from storm petrels at a range of colonies where birds are likely to interact with OWF areas in the Celtic, Irish and North Seas, using bird-borne tracking devices, providing new data on SPA and OWF connectivity, and collision risk model relevant parameters.

What Has Been Done So Far?

- Pre-season trips to build and install additional nest boxes on St Agnes (Isles of Scilly) and Lundy in April/May 2025 was carried out to facilitate future tagging and tracking of ESP during the project by creating sufficiently accessible nest sites to allow the capture of birds with minimum disturbance and stress to the bird. Another 20 boxes were installed in addition to those from 2024, providing a total of 52 and 56 nest boxes on Isles of Scilly and Lundy, respectively. Solar-powered sound systems playing storm petrel calls at night were also deployed to further attract prospecting birds into the area.
- GPS tagging of ESPs on the Isles of Scilly and Lundy was conducted in July – August 2025. Three of five archival tags deployed on Lundy, and all four tags deployed on Scilly, were recovered for data retrieval, drastically improving the sample size from 2024 where only one individual was tracked from each site. Despite the provision of artificial nest boxes, all birds tracked in 2025 were from natural nests.
- Co-deployment of digitally coded UHF tags with some GPS tags at ESP sites to increase recovery rates of tagged birds by allowing remote detection of tagged birds returning to the nest.
- Trialling of two newly improved archival devices to better estimate flight heights were conducted using stationary and mobile (UAV-equipped) tests prior to deployment on LSP on St Kilda and ESP on Mousa. Improvements from 2024 include the addition of 1) accelerometery to the high-resolution GPS loggers, and 2) conventional GPS fixes to the continuous barometric and accelerometery loggers. Of those deployed, twelve of each type were retrieved from LSPs, and seven and eight high-resolution GPS and barometric/accelerometer loggers were retrieved from ESPs, respectively.
- A total of 18 light-level geolocators were deployed on LSPs on St Kilda to collect data over the non-breeding period. Retrieval of these devices are scheduled for 2026.

Preliminary Results

- Regular monitoring of artificial nest boxes revealed storm petrels to be prospecting boxes; however, uptake by breeding birds was not observed until mid-July. Therefore, GPS tracking on Lundy and Scilly was conducted using birds breeding in natural sites again. A total of six nest boxes on Lundy were occupied this season, five of which failed during incubation, and one of which (as of writing) still contains a chick which will hopefully fledge.
- Increased sample size of ESPs successfully tagged at English colonies has greatly improved our knowledge of petrel at-sea distribution for birds from these colonies. So far, tracking results are largely limited to map visualisations, but show extensive use of the Celtic Sea, with some overlap in foraging areas among colonies.
- The co-deployment of GPS tags with digitally coded UHF tags greatly aided tagging efforts; however, interference with GPS fixes was noted and will be examined in further detail prior to any deployments next year.
- The two improved flight height tags trialled in 2025 have the potential to greatly improve our understanding of storm petrel flight behaviour, with tags deployed across a range of weather conditions. Fewer and less reliable data than expected were collected per deployment for LSPs due to issues with the tag firmware. This was however resolved in time for deployments on ESPs on Mousa.

Impact

- The at-sea distributional data of storm petrels from all sites will provide connectivity data from relevant petrel colonies (including SPAs) and OWF development sites, thus improving apportioning estimates.
- Data on flight height and flight speed for storm-petrels, key collision risk parameters, will be used to improve Environmental Impact Assessment tools by increasing their biological realism and reducing uncertainty as these data are currently lacking.

Next Steps

- All data collected thus far will be analysed in detail, including robust calibration of estimates of flight height obtained from both atmospheric pressure and GPS data. This will involve the use of reference data collected when birds were known to be resting on the sea or present in the nest (for which height above mean sea level is known), as well as using reference pressure data measured using independent loggers at the colony.
- Conventional GPS tracking of ESPs on the Isles of Scilly will be conducted in 2026, hopefully using birds breeding in both natural sites and nest boxes. We would like to repeat tracking on Lundy, but this is dependent on discussions.
- Discussions on whether to conduct further tagging of storm petrels with flight height tags are ongoing and will be dependent on analysis of previously collected data.
- Retrieval of the 18 geolocators deployed on LSPs on St Kilda will be attempted.

WP3: Observational bird behaviour data collection

In ProcBe WP3, JNCC are complementing the tagging data collected as part of WP1 and WP2 through the use of an alternative platform to collect additional flight height data. This increases the resilience of the project and also allows us to cross-sense check the various flight height data collection methods within the project. WP3 aims to collect land-based and boat-based observational data of MSW and ESP flight heights using Laser Range Finder (LRF) technology. This is a novel and experimental work package, as LRF data have not previously been collected for these species in a systematic way. A key component of the work is to collect data across a range of environmental conditions, particularly during different wind and sea conditions. A key weakness in the current OWF impact assessments of these species is that both species are assumed to fly close to the sea surface, as most data have been collected on vessels in relatively calm conditions. The absence of MSW flight height data collected during strong wind weather conditions may bias estimates of the proportion of birds at collision risk (Johnston et al. 2014). MSW may have higher flight altitudes during strong winds (Spear and Ainley, 1994), something that is predicted by the flight dynamics of shear soaring, their specialist flight mode in stronger winds (Gibb et al., 2017; Kempton et al., 2022). We recognise that collecting data with LRFs from vessels in stormy conditions will be challenging, but the use of land-based and ferry observation platforms will optimise opportunities.

Figure 6. ESP observed in Scilly Isles (July 2025). Copyright: Joe Pender.

Figure 7. Nikon LRF use in very stormy conditions on pelagic vessel 10 miles off Scilly Isles (July 2025). Copyright: Orea Anderson.

What Has Been Done So Far?

- Sourcing of new Vector X LRFs (Feb 2025).
- Completion of additional calibration trials (II and III) for newly acquired Vector X LRFs (Mar 2025).
- Ruling out of new Vector X LRFs due to hardware and inaccuracy issues identified through Calibration Trials II and III.
- Successful Year 2 fieldwork undertaken on Scilly Isles for ESP (July 2025).
- Successful Year 2 fieldwork undertaken on Welsh ferries for MSW (July 2025).
- Successful Year 2 fieldwork undertaken on Scottish ferries for MSW (Aug 2025).
- Secured boat-based contractor for Year 3 fieldwork for storm petrels off Cork (July/Aug 2026).
- Secured agreement with CalMac Ferries for Year 3 boat-based fieldwork for MSW on a ferry route from Mallaig to the Small Isles, Scotland (July/Aug 2026).
- Secured agreement with Stena Line for Year 3 boat-based fieldwork for MSW on a ferry route from Fishguard to Rosslare (July/Aug 2026).
- Currently undertaking analyses of data collected from three sites this year for ESP and MSW, but fieldwork successful in acquiring data from all three sites.
- D3.3 – "*Interim Report on Efficacy of LRF Boat-based Fieldwork*" on schedule to be produced for end Jan 2026.

Preliminary Results

- Calibration trials earlier in the year confirmed the accuracy of the Nikon LRF and supported its use in the field.
- Calibration trials identified significant issues with the new Vector X devices as well as the two units that were supplied as replacements. All devices produced inaccurate and unreliable measurements of flight height, which was disappointing.
- The decision was taken to pursue data collection primarily with Nikon devices and supplemented with the old Leica device.
- 3,542 data points were collected across all three sites and across both species.
- In Scilly, LRF data collection was successful, but tricky in poorer weather. Additional staff onboard enabled us to develop a secondary method to collect visual observation data in addition to LRF data.
- Data were collected in a range of sea conditions (from Sea State 1 – 7) and wind conditions (from 0m/s – 20m/s).
- Next year need to collect more data in stormy conditions.
- Preliminary examination of Flight Height (FH) data indicates that **ESP data were typically below 5m**, and most commonly in the **<0.3m range**.
- Preliminary examination of Flight Height (FH) data indicates that **MSW data** predominantly in the **first few metres** but also some up in the **15-20m** range (needs further checking and calibrating).
- We identified a fairly minimal decline in FH estimates with increasing horizontal distance from the observers, alongside some minor over-estimation at shorter distances. However, this in generally in line with the level of error that may be expected to result from the LRF devices themselves.
- Swell height is a confounding source of error in our FH estimates, changing both the absolute height of observers and birds to the water surface, and relative height between observers and birds.
- Variation in adjusted FHs may increase with greater swells. Unpicking this is challenging though, as there are several confounding variables, which could simultaneously impact adjusted FH (e.g. horizontal distance between observer and bird, wind strength, etc.). Correlation between swell height and wind strength may make it tricky to tease apart the relationship with FH and wind strength. Something we are going to work on in the coming months.
- LRF data collection methods were demonstrated to be effective on both ferry and pelagic vessel platforms.
- The Scilly pelagic worked well for getting ESP FH data, while both ferry sites (Wales and Scotland) working well for MSW. MSW data were slightly easier to collect in Wales, but rougher weather conditions were experienced in Scotland.
- These are the first data collected on ESP FHs using LRFs.
- Very preliminary analyses indicate FHs were higher for MSW in stormier conditions than in calmer conditions, and this is something we hope to explore further in 2026 field season.

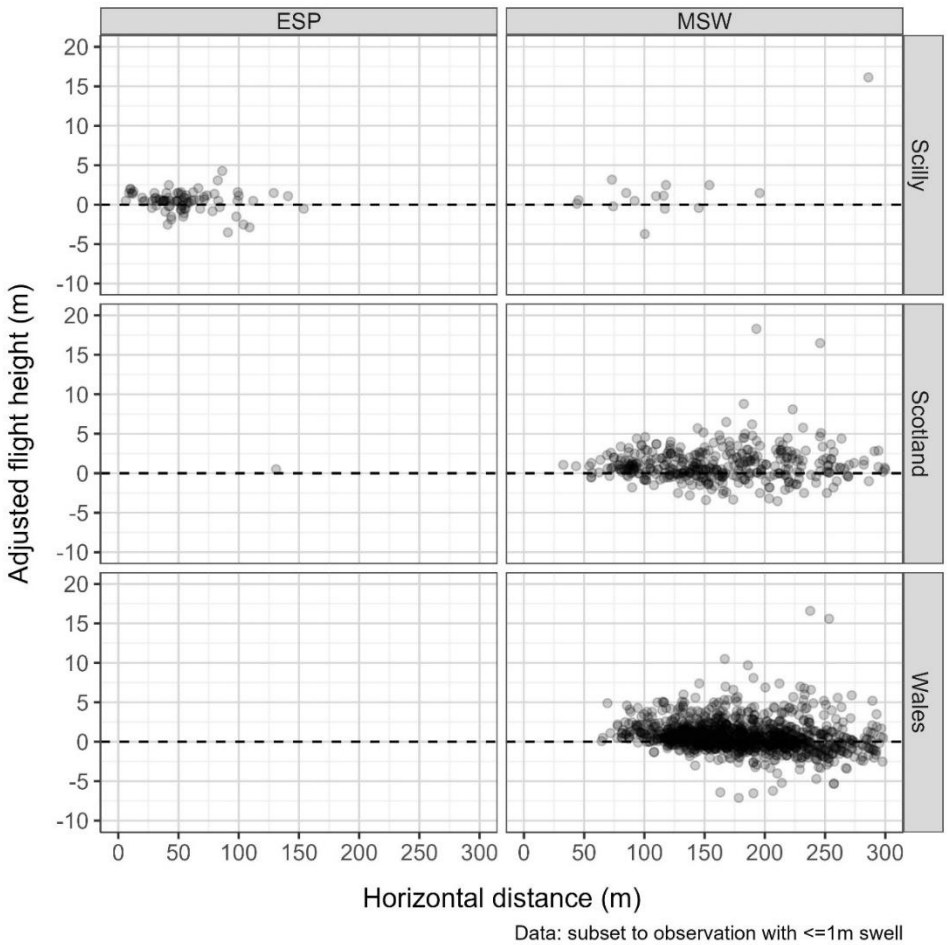

Figure 8. Observer eye-height adjusted LRF flight height estimates for European Storm Petrels (ESP) and Manx Shearwaters (MSW) with horizontal distance across low swell (<=1m) observation conditions.

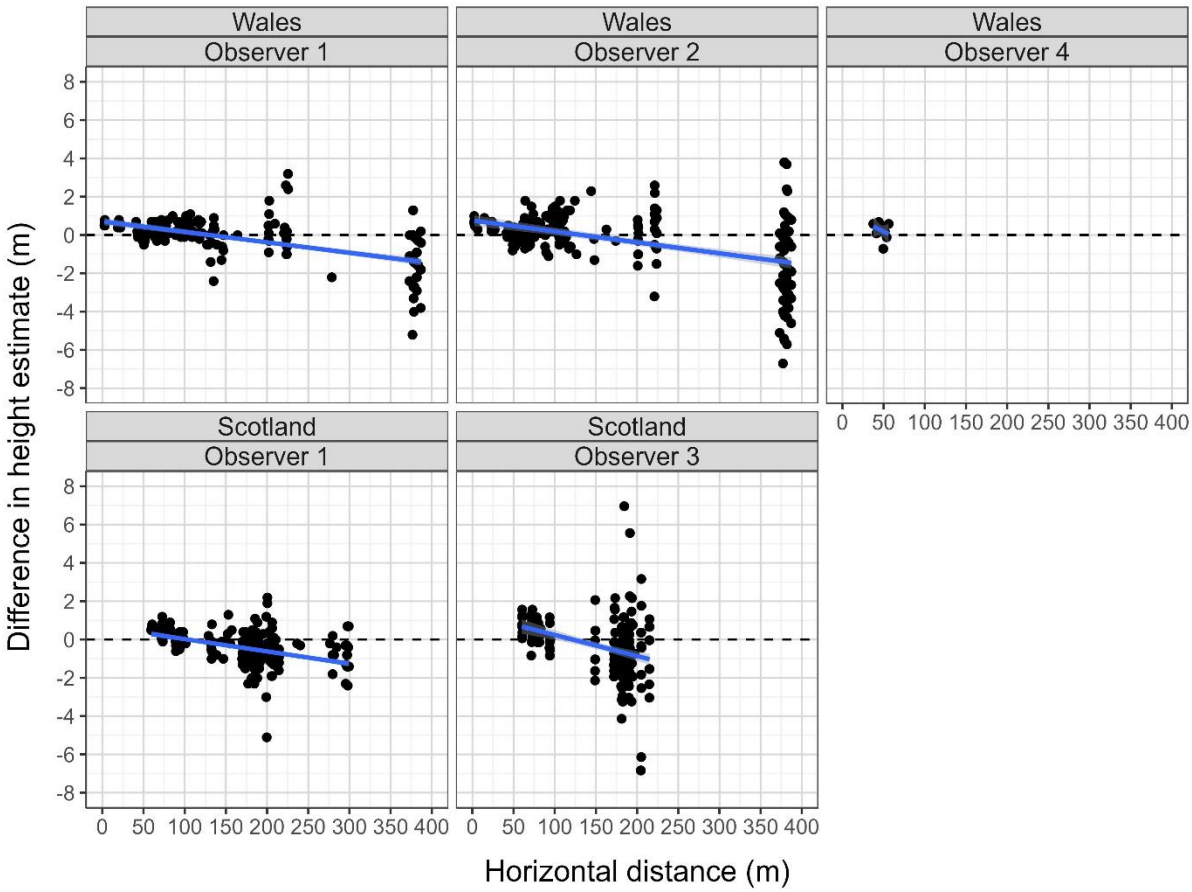

Figure 9. Comparison between Nikon LRF estimated observer heights and "true" height (as given by deck height and observer's eye height) across horizontal distances, observers and sites. Positive values indicate that the LRF overestimated observer height, and negative values that the LRF underestimated observer height.

Impact

- We continue to characterise sources of error in the production of FHs from LRF data. This is an important consideration that has not been sufficiently addressed in all other LRF FH data collection historically.
- These are the first ESP FH data collected using LRFs.
- A final year of fieldwork data collection in 2026 will hopefully allow us to increase sample sizes, which in turn will enable us to estimate typical FHs for both MSW and ESP in a range of environmental conditions.
- Evidence-based estimates of Procellariiform FHs, in a range of environmental conditions, are essential to future environmental impact assessments for these species in the Celtic and Irish Seas, and beyond.

Next Steps

- Collect more data in stormy conditions.
- Collect more data calibrating objects on the sea surface from vessels while at sea.
- Further statistical analyses needed to look at weather interactions, device efficacy, and swell height as a component of FH analyses.
- Need to improve sample size for both species.
- Roll out boat-based LRF work for both MSW and storm petrels in summer 2026, given the successful trials in Year 2.
- Discontinue Scilly ESP fieldwork for Year 3, as achieved sufficiently consistent results in Year 2 to not be necessary to return to this site.
- Continue as planned with Cork pelagic vessel work for ESP, to provide a secondary site to Scilly and improve on sample sizes. Additional benefit of this site is that we can collect LRF FH data on MSW at the same time, which will provide a good comparative source of information to the ferry MSW data from Years 2 and 3. It may also allow us to access a further range of weather conditions (and platform heights) compared with the ferry work. Finally, some potential behavioural interactions were observed anecdotally between the bow of the ferry in Wales and MSWs, which is something we'd like to explore comparatively with the future Cork MSW dataset.
- Continue as planned with Scottish and Welsh ferry fieldwork to collected FH data on MSW to improve sample sizes and collect more data in a range of weather conditions.

WP4: Demographic rates & population modelling

WP4 aims to fill significant knowledge gaps on demographic rates for MSW and ESP through modelling of adult and juvenile survival rates which will improve the accuracy and precision of population viability analysis modelling for these species. The WP primarily focuses on the use of existing long-term datasets collected by multiple organizations across the UK.

What Has Been Done So Far?

All data for MSW and ESP have now been collated, exceeding project expectations (Fig. 10).

- Adult ringing data for MSW: Copeland (NI); Skomer, Skokholm and Ramsey (Wales); Rum and Sanda (Scotland); Lundy (England); and the Calf of Man (Isle of Man).
- Chick ringing data for MSW: Copeland (NI); Skokholm and Ramsey (Wales).
- Breeding success data for MSW: Copeland (NI); Skomer and Skokholm (Wales); Rum and Sanda (Scotland).
- Population census data for MSW: Copeland (NI); Skomer and Skokholm (Wales); Sanda (Scotland) and Calf of Man (Isle of Man).
- Adult ringing data for ESP: Priest Island, Lunga and Sanda (Scotland; from the BTO's Retrapping Adults for Survival (RAS) scheme); Skomer (Wales); Molène and Biarritz (France).
- Chick ringing data for ESP: Molène and Biarritz (France).
- Breeding success data for ESP: Skokholm (Wales); Mousa (Scotland); and Molène (France).
- Population census data for ESP: Skokholm (Wales); Priest Island (Scotland); Molène and Biarritz (France).

Adult Survival Analysis:

- Preliminary and final reports on adult survival (D4.1 & D4.3) in MSW and ESP using adult ringing data completed and sent to TCE.
- Analysis compared a standard Cormack-Jolly-Seber model with an inferred approach designed for estimating survival for colonies where data is sparse.

Juvenile Survival Analysis:

- Our preliminary report on juvenile survival (D4.2) completed in April 2025 and outlines the approaches we intended to use with initial results for MSW for Skomer.
- KB attended a course on integrated population models in October 2024.
- Approaches have been subsequently implemented and we have constructed Integrated Population Models (IPM) for both species to estimate juvenile survival from adult survival, breeding success and census data.
- For comparison, we have also used a multistate capture-recapture modelling approach using ringing data.

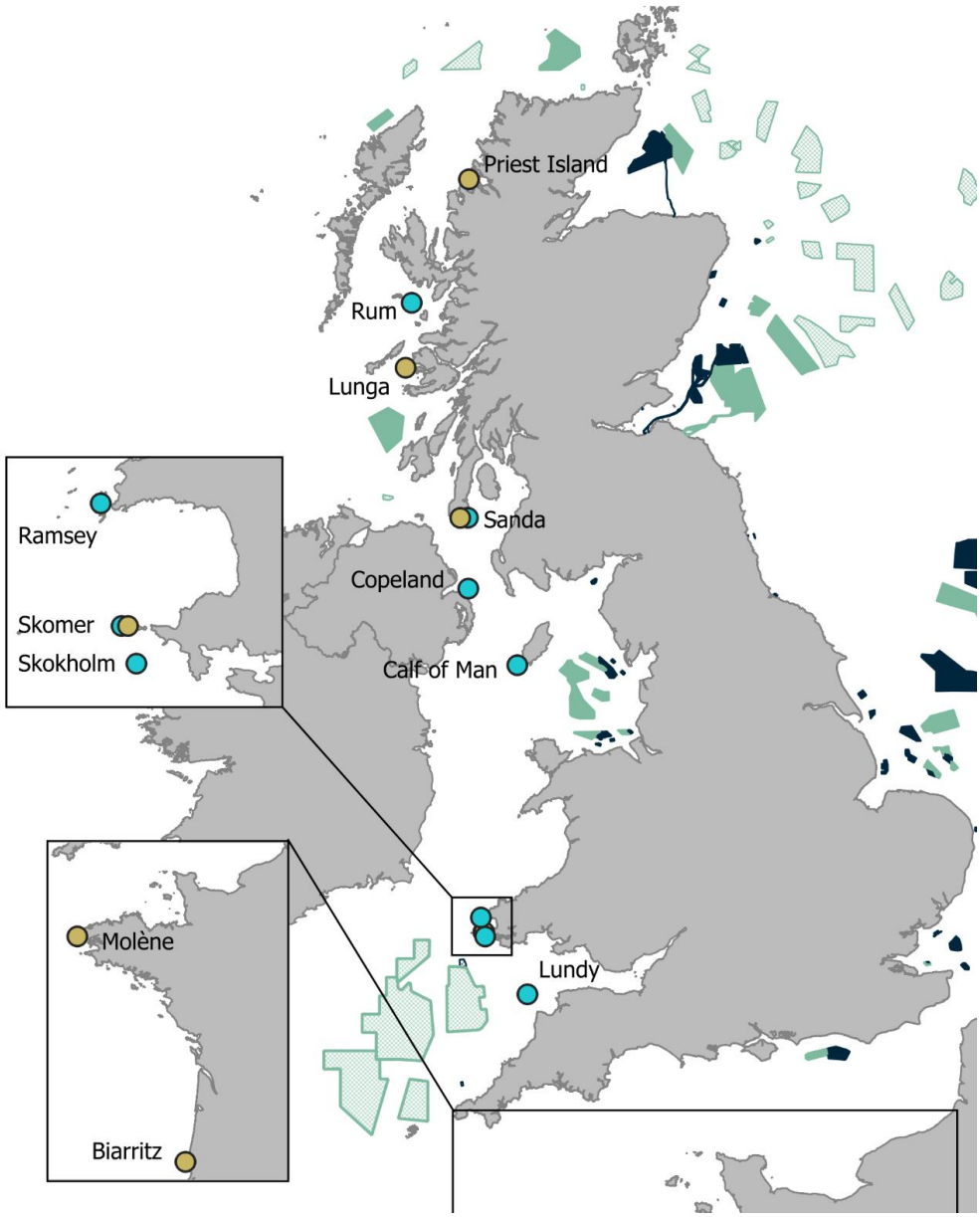

Figure 10. Location of Manx Shearwater (blue) and European Storm Petrel (yellow) colonies in the UK and France used in the study relative to the location of UK existing fixed offshore wind farms (navy), proposed fixed offshore wind farms (green) and proposed floating offshore wind farms (light green). Top left box shows locations of Welsh colonies and bottom left box shows locations of French colonies.

Preliminary Results

- We have provided updated estimates of adult survival for MSW and ESP, extending the time-series for previously published estimates and provided colony-specific estimates for eight MSW colonies (Fig. 11) and six ESP colonies (Fig. 12).
- Report D4.3 represents the most comprehensive analyses to date of adult survival in both MSW and ESP.
- Estimates of juvenile survival are being finalised ready for our next report, with our initial estimates for MSW juvenile survival from our IPM for Skomer shown in Fig. 13.

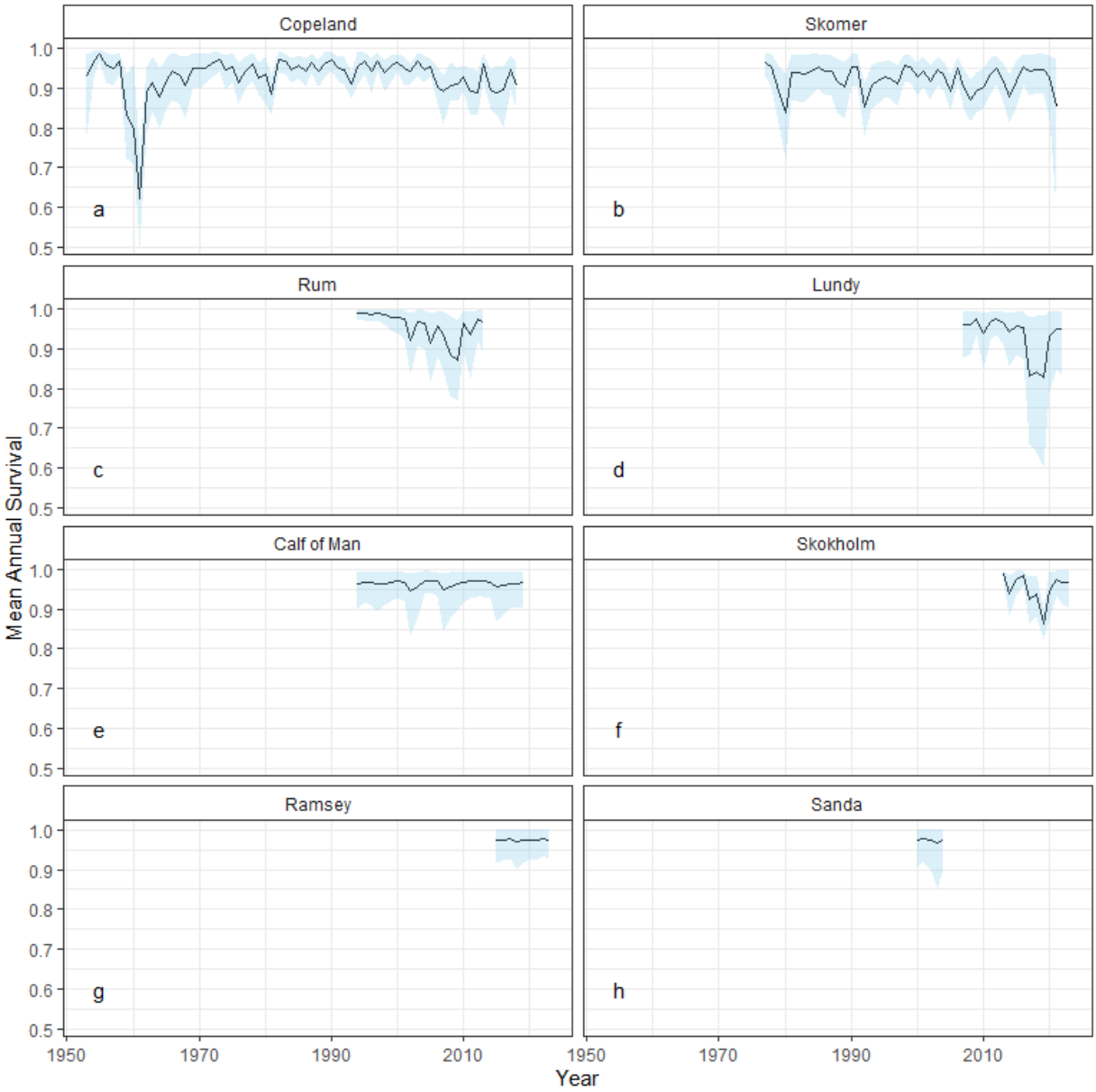

Figure 11. Mean survival estimates for Manx Shearwater colonies (1952–2024) from method 1 (fully time-dependent CJS model), shown with 95% credible intervals.

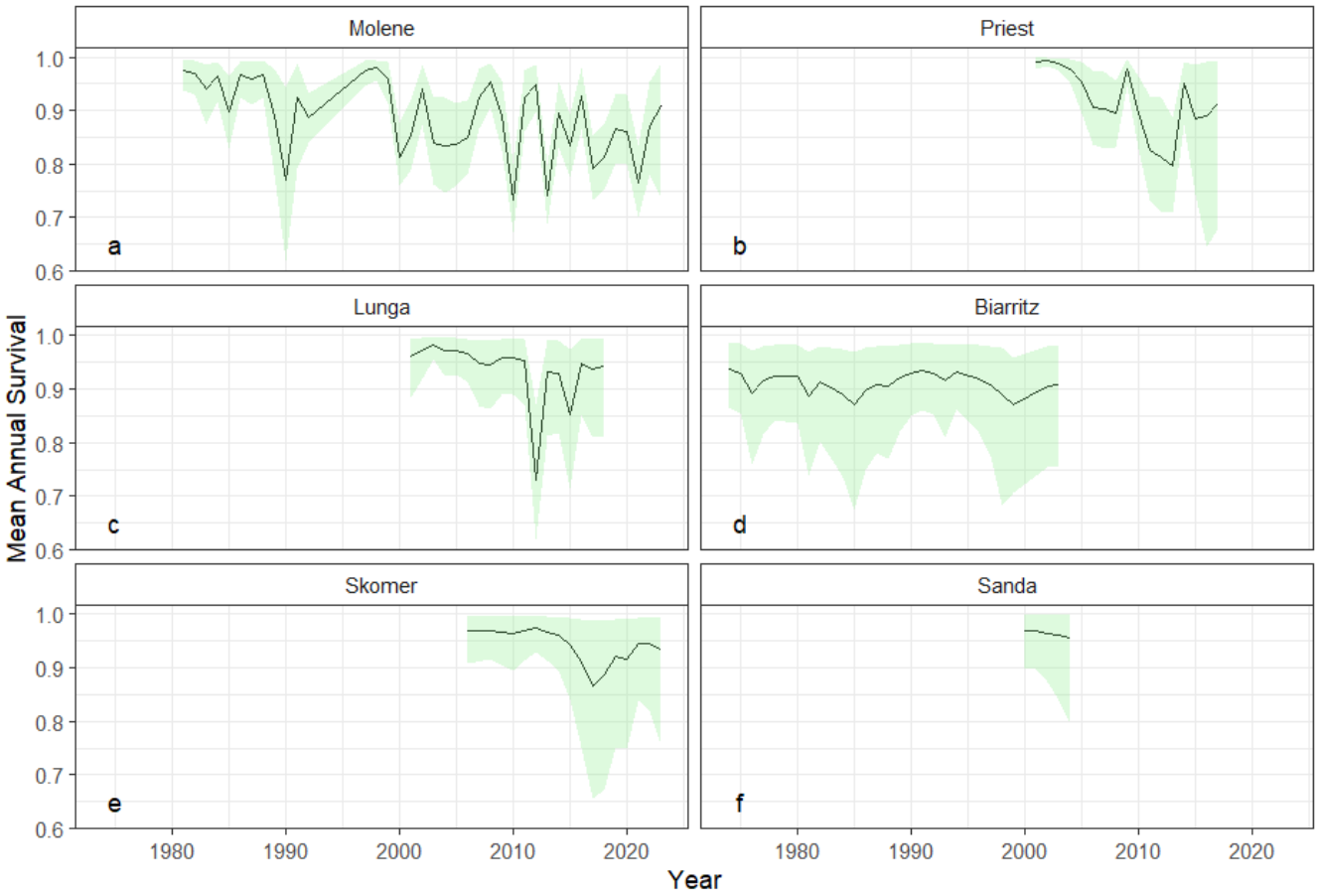

Figure 12. Mean survival estimates for European Storm Petrel colonies (1977-2024) from method 1 (fully time-dependent CJS model), shown with 95% credible intervals.

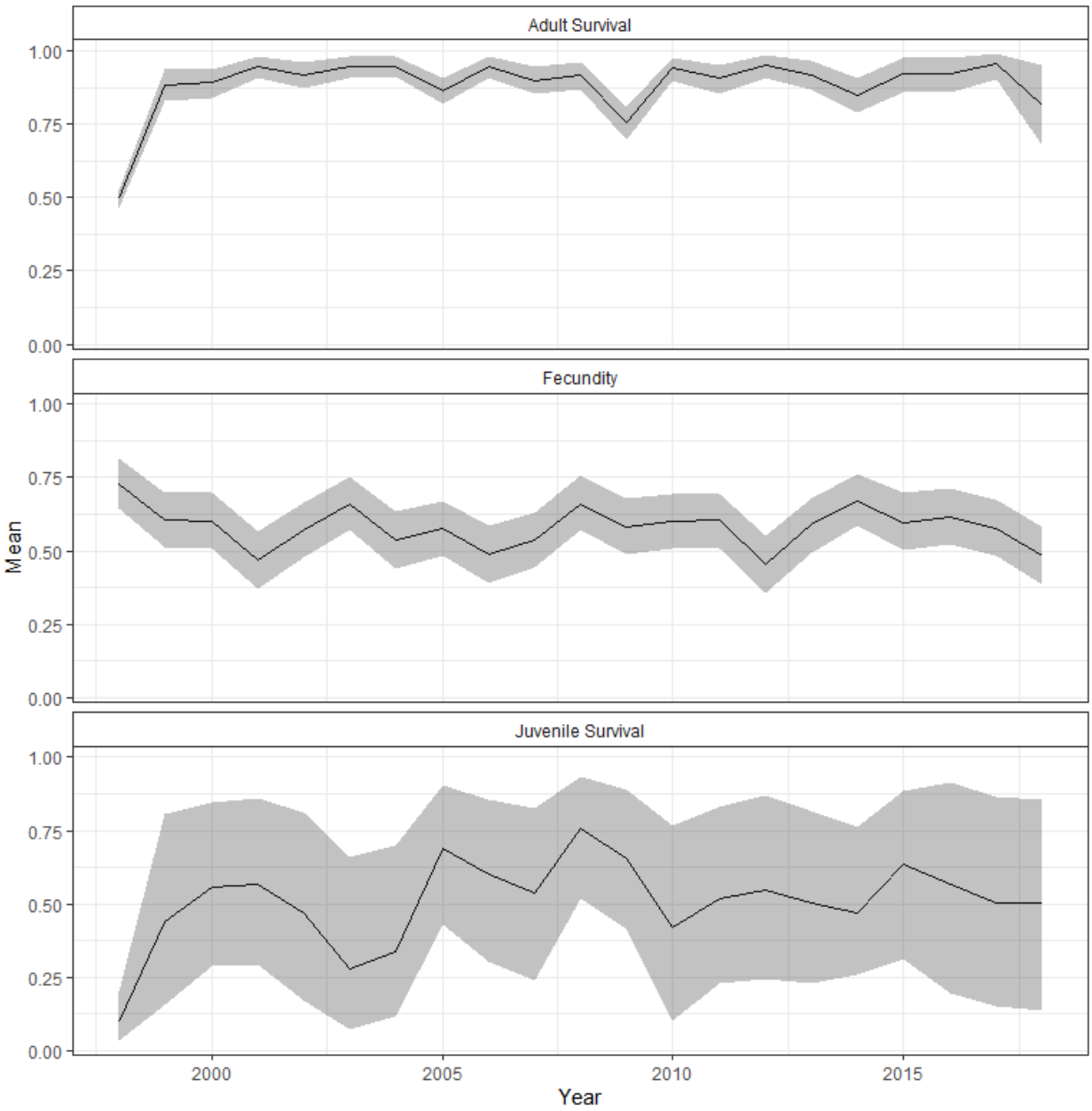

Figure 13. Preliminary estimates of Manx Shearwater fecundity and adult and juvenile survival (1998-2019) from our initial IPM model for Skomer with 95% credible intervals.

Impact

- We demonstrate the value of large, long-term monitoring datasets for improving the accuracy of survival probability estimates.
- Estimates of demographic parameters, particularly survival, will be used in Population Viability Analyses (PVA) which are widely used in impact assessments for OWFs.
- Estimates also provide a baseline against which post-development monitoring can detect impacts on seabird populations that might otherwise remain hidden.
- We aim to provide guidance on the minimum data requirements for building a robust PVA and how to estimate these components using the methods detailed in our adult and juvenile survival reports.

Next Steps

- We are finalising our juvenile survival analysis and report, with an aim to circulate the report in November 2025.
- We aim to produce a publication from this report outlining how we have applied our methods to estimate juvenile survival for a species that is challenging to monitor.
- The final part of our work package consists of comparing how different approaches to PVAs may alter projections and provide guidance on the minimum data requirements needed to create robust projections for MSW and ESP.