



Offshore  
Wind Evidence  
+ Change  
Programme

# ProcBe Annual Report No.1

Year 1

*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*



# ProcBe

Procellariiform Behaviour and demographics



# SUMMARY

This report forms the Year 1 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. The project was funded by The Crown Estate through the Offshore Wind Evidence and Change programme, 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 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<sup>1</sup>.

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.

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<sup>1</sup> <https://www.marinedataexchange.co.uk/>

# WP1: Manx shearwater at-sea distributions and behaviour

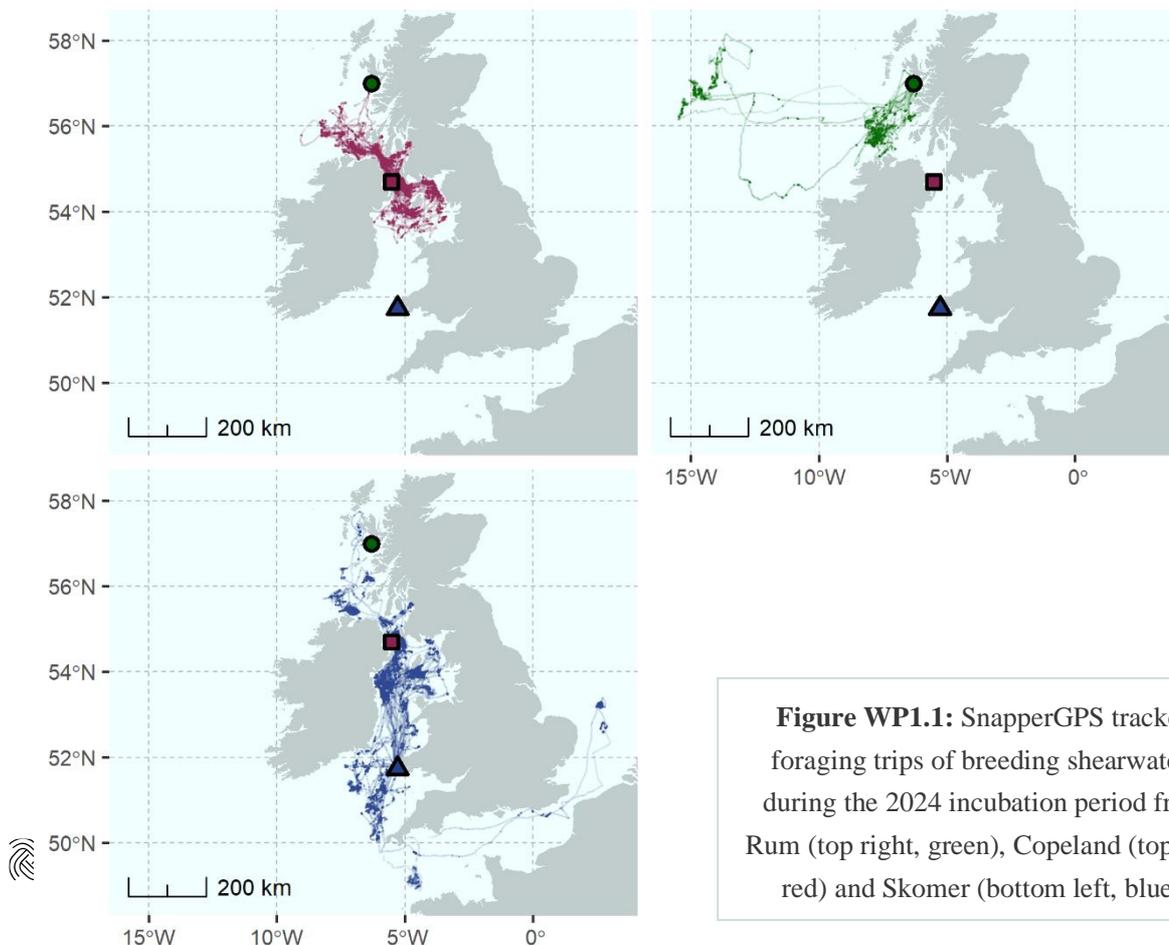
The majority of the global population of breeding MSW is to be found off the west coasts of Britain and Ireland, with birds from the three SPAs of Rum, Copeland, and Skomer/Skokholm utilising the seas off western Britain during the breeding season. In ProcBe WP1, we aim to increase understanding of the 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 So Far?

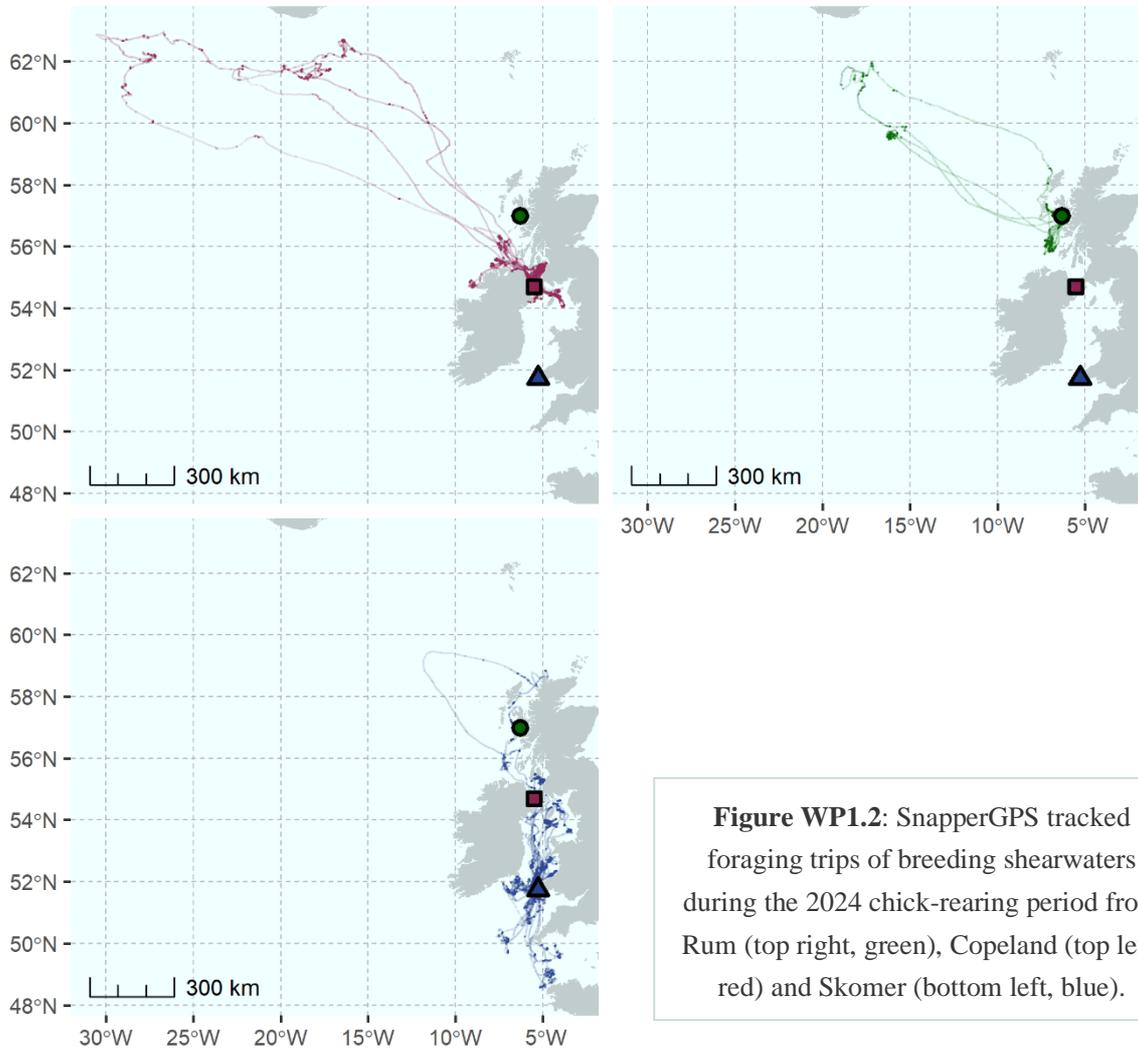
- Review of extant GPS tracking data.
- Review of potential remote download GPS tracking systems for fledglings.
- Established new shearwater study nest plot on Rum.
- GPS tracking of incubating shearwaters using archival loggers on Skomer, Copeland and Rum (c20 on each colony) during 2024 breeding season (Fig. WP1.1).
- GPS tracking of chick-rearing shearwaters using archival loggers on Skomer, Copeland and Rum (c20 on each colony) during 2024 breeding season (Fig. WP1.2).
- GPS tracking of immature shearwaters using archival loggers on Skomer and Copeland (c20 deployments and c10 retrievals on each colony), and remote download devices on Rum (10 individuals) (Fig. WP1.4).
- GPS tracking of 10 first-time migrating fledgling shearwaters on each of Skomer, Copeland and Rum using remote download devices (still on-going) (Fig. WP1.5).
- Geolocator-immersion logger deployments on breeding shearwaters on Skomer, Copeland and Rum (25 on each colony).
- Testing (Fig. WP1.6) and subsequent field deployment of six high-resolution Axytrek GPS/barometric altimeter loggers on breeding shearwaters on Skomer; limited preliminary analysis of flight heights (Fig. WP1.7).
- Collaborated with JNCC colleagues on Copeland to facilitate WP3.

## Preliminary Results

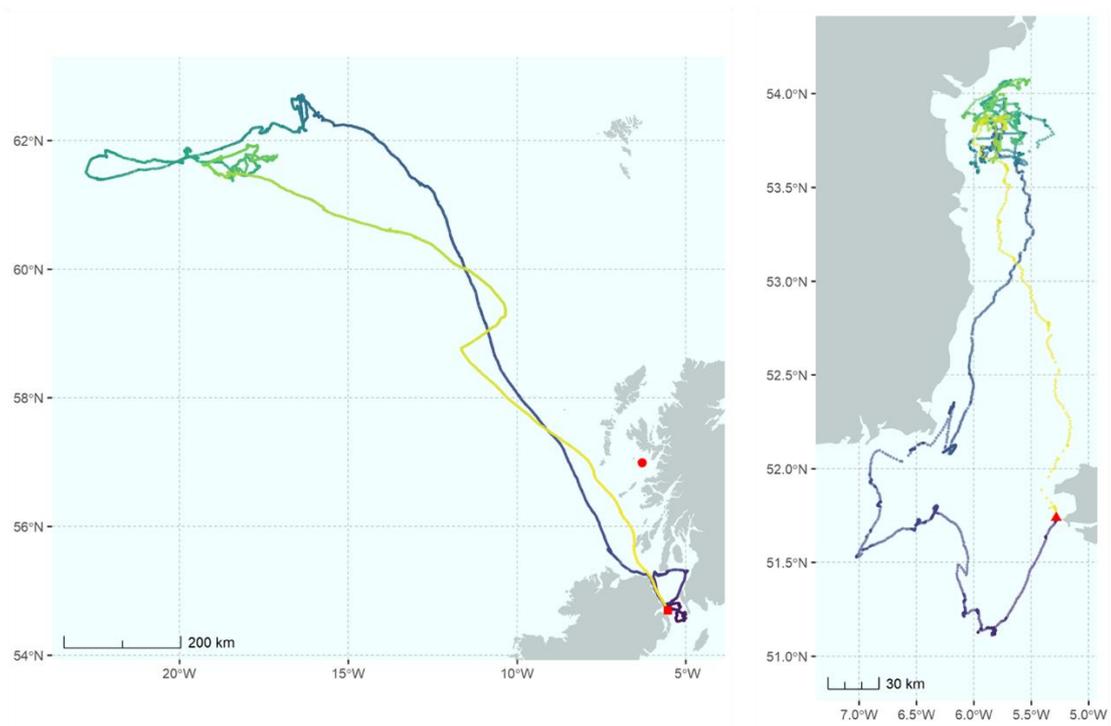
- So far, our tracking results are largely limited to map visualisations which give a qualitative picture of the extent of ocean space use by breeding shearwaters during incubation and chick-rearing, by immature (pre-breeding) shearwaters, and by fledgling shearwaters making their first migratory journey (see figures below).
- Breeding shearwaters from Copeland and Skomer SPAs make extensive use of the Irish and Celtic Seas, with Skomer birds particularly exploiting the Celtic Sea.
- Immature shearwaters show a mix of wide-ranging movements, including one circum-navigation of Ireland, and central-place foraging movements with frequent visits to the colony, behaviourally remarkably similar to breeding birds.
- Fledglings appear to spend more time than we expected foraging in UK waters before migrating.
- So far, all fledglings from Rum SPA have migrated outside the Irish and Celtic Seas routing to the west of Ireland, whilst all Copeland birds appear to be passing through the Irish and Celtic Seas. Only two Skomer birds have so far left UK waters, both through the Celtic Sea.
- Combining barometric pressure logging with an immersion device appears to provide sensible estimates of flight heights, but we did encounter technical issues.
- Using our standard archival GPS logging techniques was ineffective for tracking immature shearwaters on Rum because of the terrain and weather, but a switch to remote-download devices proved effective (although at lower resolution).
- Congestion of the SnapperGPS processing pipeline has led to unexpected delays in producing valid tracks, especially for long trips and those with unknown start times.



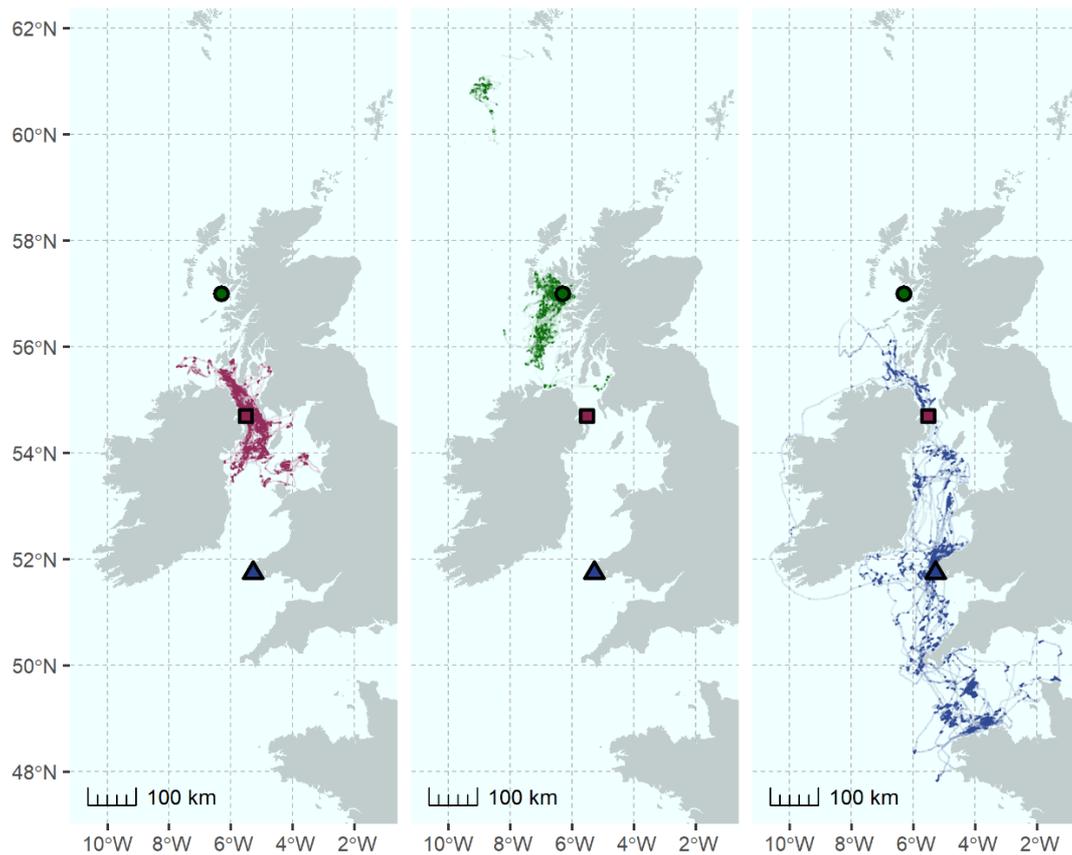
**Figure WP1.1:** SnapperGPS tracked foraging trips of breeding shearwaters during the 2024 incubation period from Rum (top right, green), Copeland (top left, red) and Skomer (bottom left, blue).



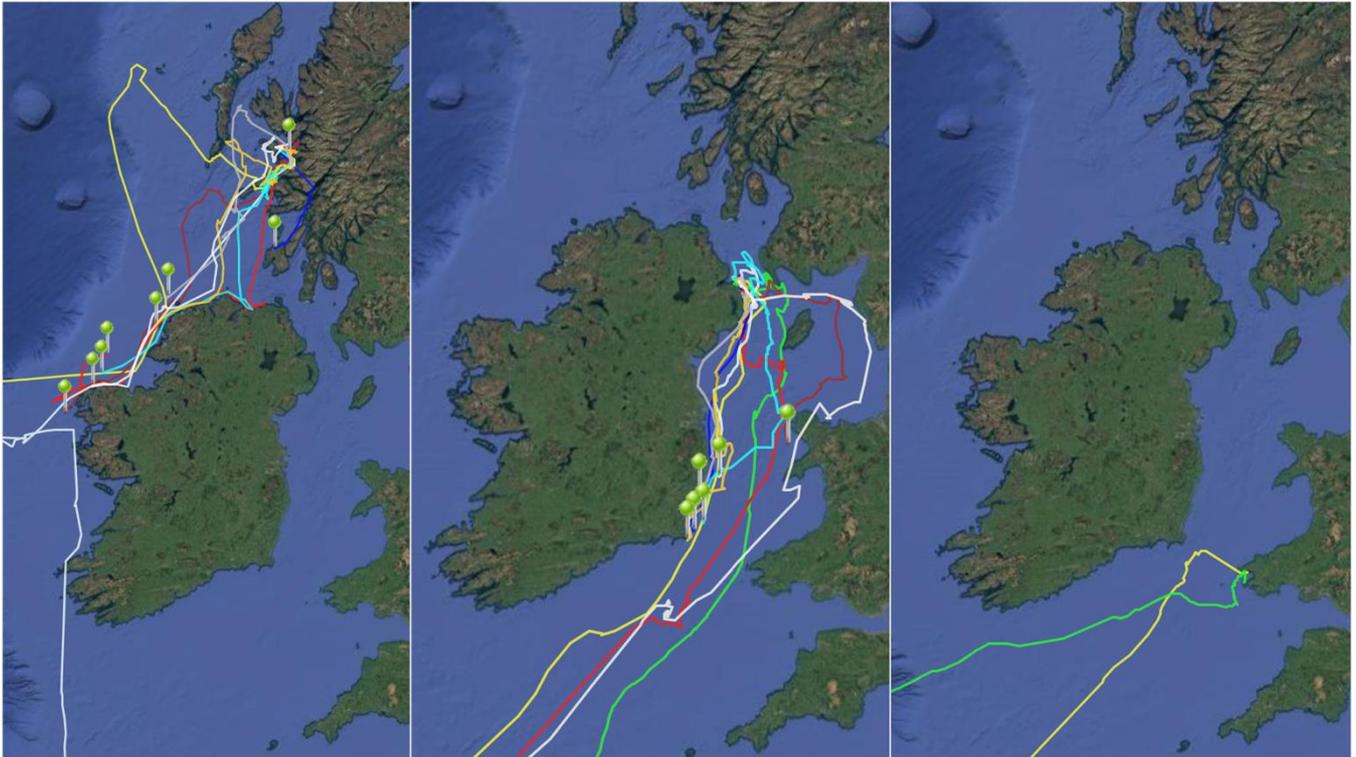
**Figure WP1.2:** SnapperGPS tracked foraging trips of breeding shearwaters during the 2024 chick-rearing period from Rum (top right, green), Copeland (top left, red) and Skomer (bottom left, blue).



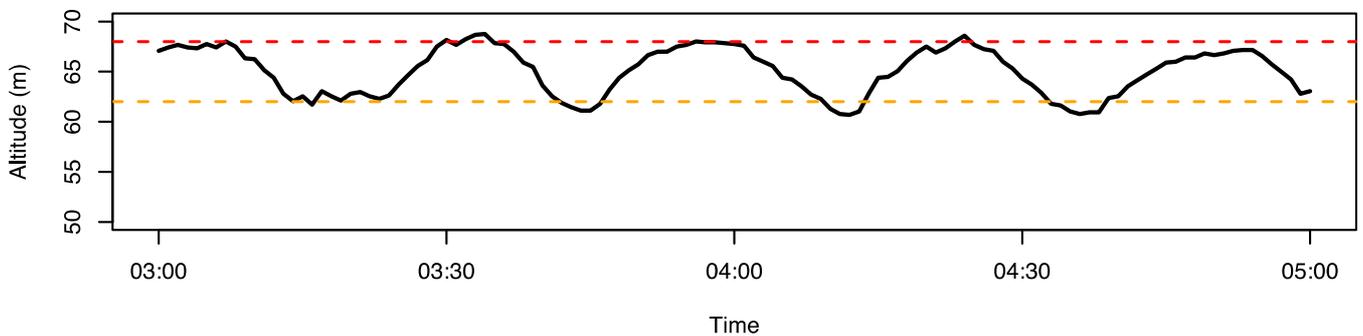
**Figure WP1.3:** Example high resolution foraging tracks (SnapperGPS post-processing loggers, 2 minute fix interval) from Copeland (left) and Skomer (right), dark colours at start of trip (outbound).



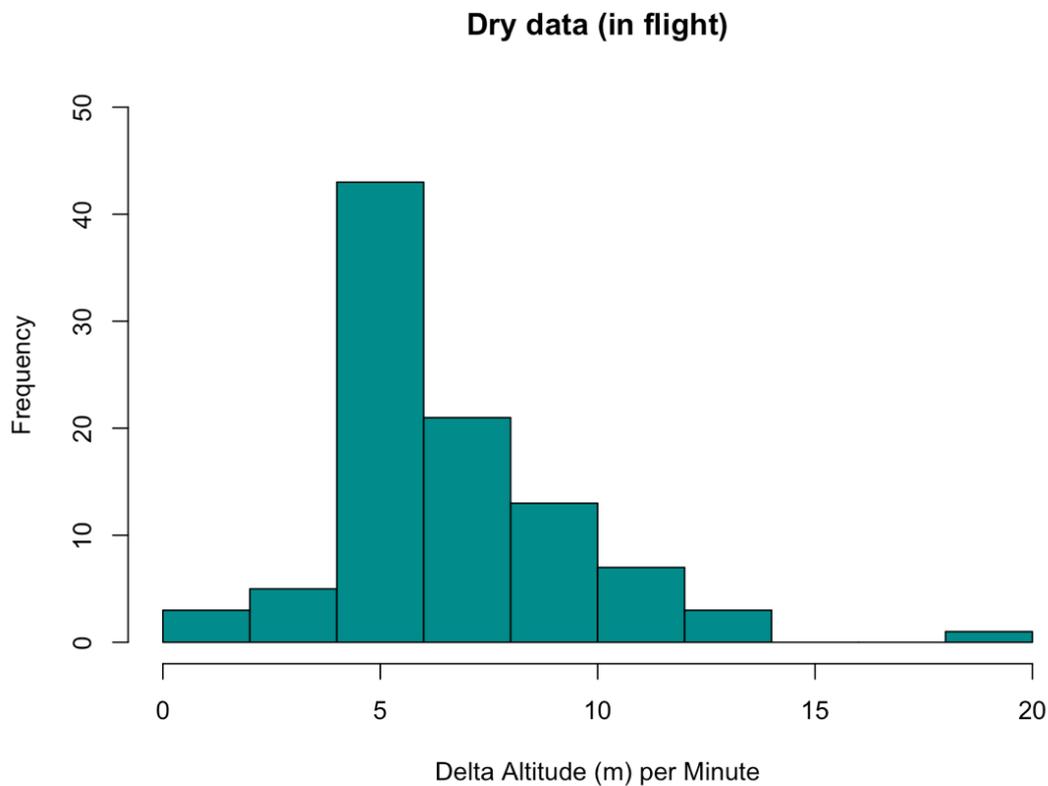
**Figure WP1.4:** Immature shearwaters tracked by SnapperGPS from Copeland (left, red) and Skomer (right, blue), and tracked by Ornitrack-9 GPS from Rum (centre, green).



**Figure WP1.5:** Flight paths and current known locations of fledgling shearwaters tracked using Ornitrack-9 and Ornitrack-11 remote download devices from Rum (left panel), Copeland (centre panel) and Skomer (Right panel) SPAs, at 23<sup>rd</sup> September 2024. This work is still on-going.



**Figure WP1.6:** Example Axytrek barometric altimeter trace during a test trial in which the device, attached to a long fishing pole, was moved slowly up and down between two approximately known altitudes (yellow and red dotted lines), indicating good accuracy.



**Figure WP1.7:** Despite technical problems retrieving data from the Axytrek GPS/barometric altimeter loggers, one three-hour section of 1Hz track was obtained from deployment on a breeding shearwater at sea. Using a co-deployed leg-mounted immersion logger we identified every 1 minute period when the bird was in flight (leg dry), and calculated the maximum change in altitude in each period. Assuming that the base of the values is the sea surface, they represent successive 1 minute estimates of max flight heights, plotted as a frequency histogram.

## 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 2025.
- Immature tracking using remote download devices on Rum proved effective and we would like to repeat this adaptation in 2025.
- Fieldwork on Rum proved more challenging than anticipated, largely because of inclement weather, and we may need to increase the planned duration of campaigns and consider deploying additional personnel for these.
- Barometric altimetry looks to be effective for measuring flight heights, but we may seek a different logger type to that used in 2024 which did not prove robust.

## WP2: European storm petrel and Leach's storm petrel tracking

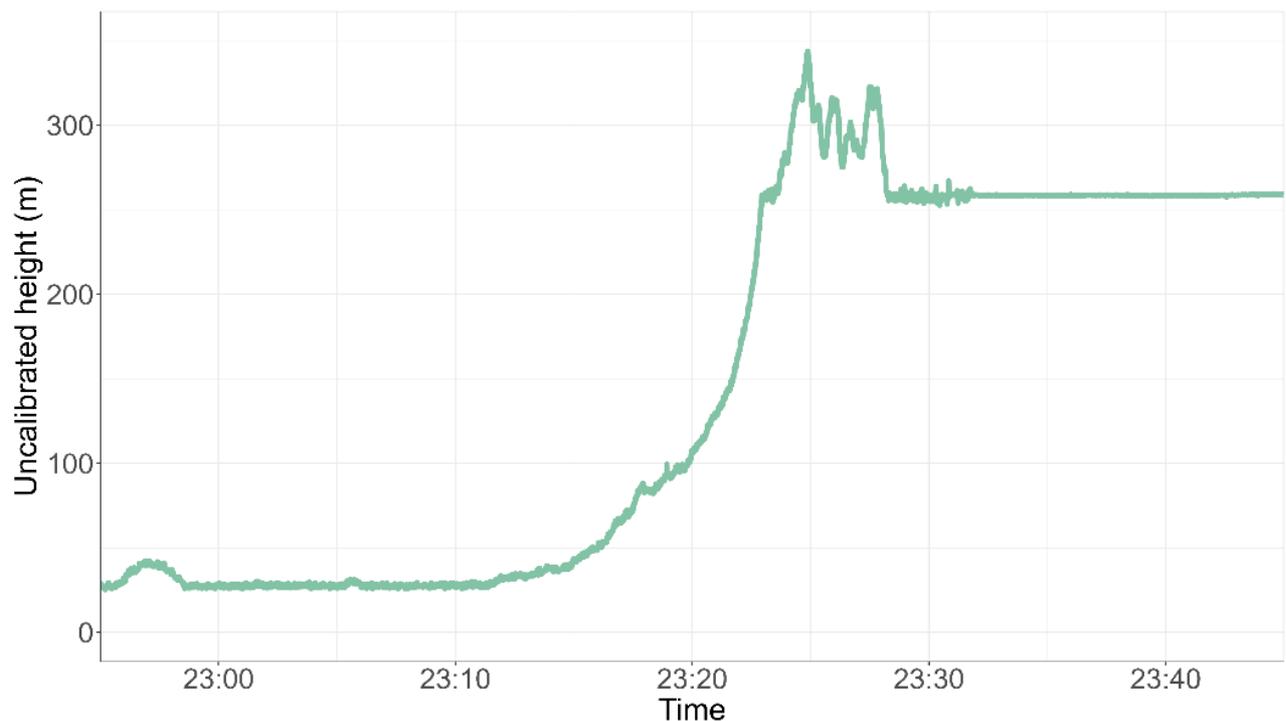
This WP aims to fill critical evidence gaps around how ESPs and LSPs interact with OWFs, particularly in areas of new development such as the Irish and Celtic Seas. Little is known about these species in terms of their distribution and flight behaviour and they have so far not been a focus of OWF impact pathways. The aims of this WP 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?

- Reconnaissance trips to find accessible ESP nest sites ahead of tagging were carried out in May - June 2024 at two new sites on the Isles of Scilly, and Lundy. Return trips for conventional GPS tagging then occurred in July - August 2024, with 1 of 4 archival tags deployed on ESPs on Scilly, and 1 of 2 tags deployed on Lundy, recovered for data retrieval. The small size of these birds precludes the use of remote download tags.
- A 2-week reconnaissance trip to Skokholm Island to assess the suitability of the SPA site for tracking ESPs in future years of the project was conducted.
- Nest boxes were built and installed on St Agnes (Isles of Scilly, n=32) in June and on Lundy (n=36) in August to facilitate tagging and tracking of ESP in future years of the project by creating sufficiently accessible nest sites to allow the capture of birds with minimum disturbance and stress to the bird.
- Two types of archival device designed to better estimate flight heights were trialled on LSP on St Kilda and ESP on Mousa: 1) high-resolution GPS loggers, and 2) barometric and accelerometer loggers. Eight of each type of logger were deployed and retrieved from LSPs, and 4 of 7 and 5 of 6, high-resolution, and barometric/accelerometer loggers were retrieved from ESPs, respectively.

## Preliminary Results

- Tracking data recovered from the first ESPs successfully tagged at English colonies have revealed large differences in at-sea space use, albeit only from two individuals. The small number of deployed and retrieved tags at these sites reflects the lack of accessible natural nest sites on Scilly and Lundy.
- Daily observations of the nest boxes installed on St Agnes early in the breeding season showed birds to already be prospecting and visiting these sites.
- The two types of flight height tags trialled in 2024 have the potential to greatly improve our understanding of storm petrel flight behaviour. For example, exploration of raw, uncalibrated flight height estimates derived from LSP barometric pressure data reveal timing of a bird's increase in altitude on return to its nest situated >200 m above sea level (Fig. WP2.1). Fewer tags deployed and retrieved on ESP compared to LSP was a result of a later than usual petrel breeding season on Mousa.



**Figure WP2.1:** Example uncalibrated height data recorded by a barometric logger from a Leach's storm petrel as it returned to its nest situated >200m above sea level on St Kilda in 2024.

## 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 improved apportioning estimates.
- Flight height and flight speed, key collision risk parameters, estimated for storm petrels 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

- The 2024 data will now be analysed in detail, including robust calibration of estimates of flight height obtained from both atmospheric and GPS data. This will likely involve the use of reference data collected when birds were known to be resting on the sea, and present in the nest, for which height above mean sea level is known.
- Conventional GPS tracking of ESPs in 2025 will depend on the uptake of artificial nest boxes by breeding birds. More nest boxes will be installed on the Isles of Scilly and Lundy prior to the 2025 breeding season in order to increase these chances.
- Tagging of storm petrels with flight height loggers is planned again for St Kilda and Mousa in 2025. A third and final bespoke tag, with combined conventional GPS and barometric altimeter, will be potentially trialled on both species (tag weight dependent). The fieldwork period on Mousa in 2025 will be extended to account for another late or delayed breeding season.
- Discussions on whether to track adult storm petrels during the non-breeding season using geolocators are ongoing.

## 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 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 in a range of environmental conditions, particularly during different wind and sea conditions. A key weakness in the current impact assessment of these species is that they 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 poor 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 WP3.1:** Calibration Trial, Strathbeg, Scotland (Mar 2024; left).

**Figure WP3.2:** Year 1 data collection Phase 1, Copeland Islands, Northern Ireland (May 2024; right).

## What Has Been Done So Far?

- Completion of a systematic and thorough Calibration Trial of the two main LRFs available to the project (Mar 2024).
- Reporting of the results of a comprehensive Feasibility Study and the Calibration Trial through deliverable D3.1 (Aug 2024).
- Extensive background work done to source suitable LRFs for Year 1 fieldwork and future fieldwork.
- Year 1 fieldwork Phase 1 undertaken on Copeland Island, Northern Ireland for one of the land-based fieldwork components (May 2024).
- Year 1 fieldwork Phase 2 undertaken at Strumblehead, Wales (Jul 2024).
- Year 1 fieldwork Phase 2 undertaken on Copeland Island, Northern Ireland (Aug 2024).
- Refinement of fieldwork methodology for land-based data collection of LRF flight heights.
- Secured agreement with CalMac Ferries for Year 2 boat-based fieldwork for MSW on a ferry route from Mallaig to the Small Isles, Scotland for fieldwork in Jul/Aug 2025.
- Secured boat-based contractor for Year 2 fieldwork for storm petrels off Scilly Islands in Jul 2025.
- Initial draft of deliverable D3.2 - "Interim report on suitability of LRF for land-based observations of MSW".

## Preliminary Results

- Successful Calibration Trial at the start of the season, which allowed training of fieldworkers and gave valuable information on the limitations of the two main devices.
- Land-based fieldwork was determined to be practically achievable, but with some challenges.
- Calibrating land-based heights, including observer height, was challenging at times due to difficulties in acquiring an accurate height above sea level at all times.
- Developed a new methodology for calibrating bird flight heights above sea level, using objects on the sea surface at a range of distances.
- Determined the limitations of both devices getting 'real world' data, compared with findings in the earlier Calibration Trial.
- The Nikon LRF appears to be most effective out to 100m, with declining accuracy beyond this distance.
- The Vector LRF appears to be most effective out to 100m, but also collects reasonable data out to 100-300m distance.
- The Calibration Trial using the Vector pointed to a marginal but consistent under-estimate of flight height (<1.0m) under 300m, while the field data pointed to a perhaps expanding under-estimate beyond 300m, although this requires further testing.
- Overall, the Vector LRF was found to be more accurate and precise than the Nikon.
- 79 records for MSW flight height were obtained in Phase 1 (May 2024) and 137 records in Phase 2 (Jul-Aug 2024).
- Not sufficient data at this stage to calculate representative flight heights, but data pointing towards a range of heights, with a positive (but non-significant, potentially due to limited data) correlation between flight heights and wind speeds.
- Opportunistic boat-based data in Year 1 indicated birds flew much closer to the vessel than on land.
- We anticipate that boat-based work in Year 2 will substantially eliminate some of these problems due to:
  - 1) improved devices available to the project,
  - 2) birds being closer to the vessel than earlier land-based restricted observations,
  - 3) reduced need to calibrate with objects on the sea surface, due to known height above sea level.

## Impact

- It is difficult to say at this stage the true impact of these experimental and preliminary results.
- However, signs look positive for further data collection in Years 2 and 3, where we hope an increased sample size will enable us to predict typical flight heights for both MSW and storm petrels in a range of environmental conditions.
- Evidence-based estimates of Procellariiform flight heights, in a range of conditions, are essential to future environmental impact assessments for these species in the Celtic and Irish Seas, and beyond.

## Next Steps

- Intention is to proceed with boat-based fieldwork, given that there is now a proven methodology for collecting flight height data using LRFs.
- A further (shorter) calibration trial is planned in order to;
  - Refine calibration tests across horizontal ranges more representative of bird distances observed in the field.
  - Test new LRF models only available to for Years 2 and 3 of the project (it is anticipated that there will be an improvement in accuracy on devices used this year).
- Roll out boat-based LRF work for both MSW and storm petrels in summer 2025, given the successful trials in Year 1.
- Continue as planned with Scilly fieldwork and boat-based charter to get flight height data on storm petrels (for which there is no previous data), based on the proof of concept of the land-based work, as well as the data collected on the Fishguard-Rosslare ferry.
- Continue as planned with Mallaig-Small Isles/Lochboisdale ferry (permission already granted for 2025 and 2026 field seasons) to collected flight height data on MSW in far greater abundance than was collected in Year 1 (sample size too small at this stage, and needs a greater focus on closer distances to ensure greater accuracy of readings).
- Switch land-based work planned for Strumblehead, Wales to boat-based (ferry) work out of Pembrokeshire between Pembroke and Ireland, in order to maximise the chances of sighting MSW at closer distances (100-300m ideally).

## WP4: Demographic Rates & Population Modelling

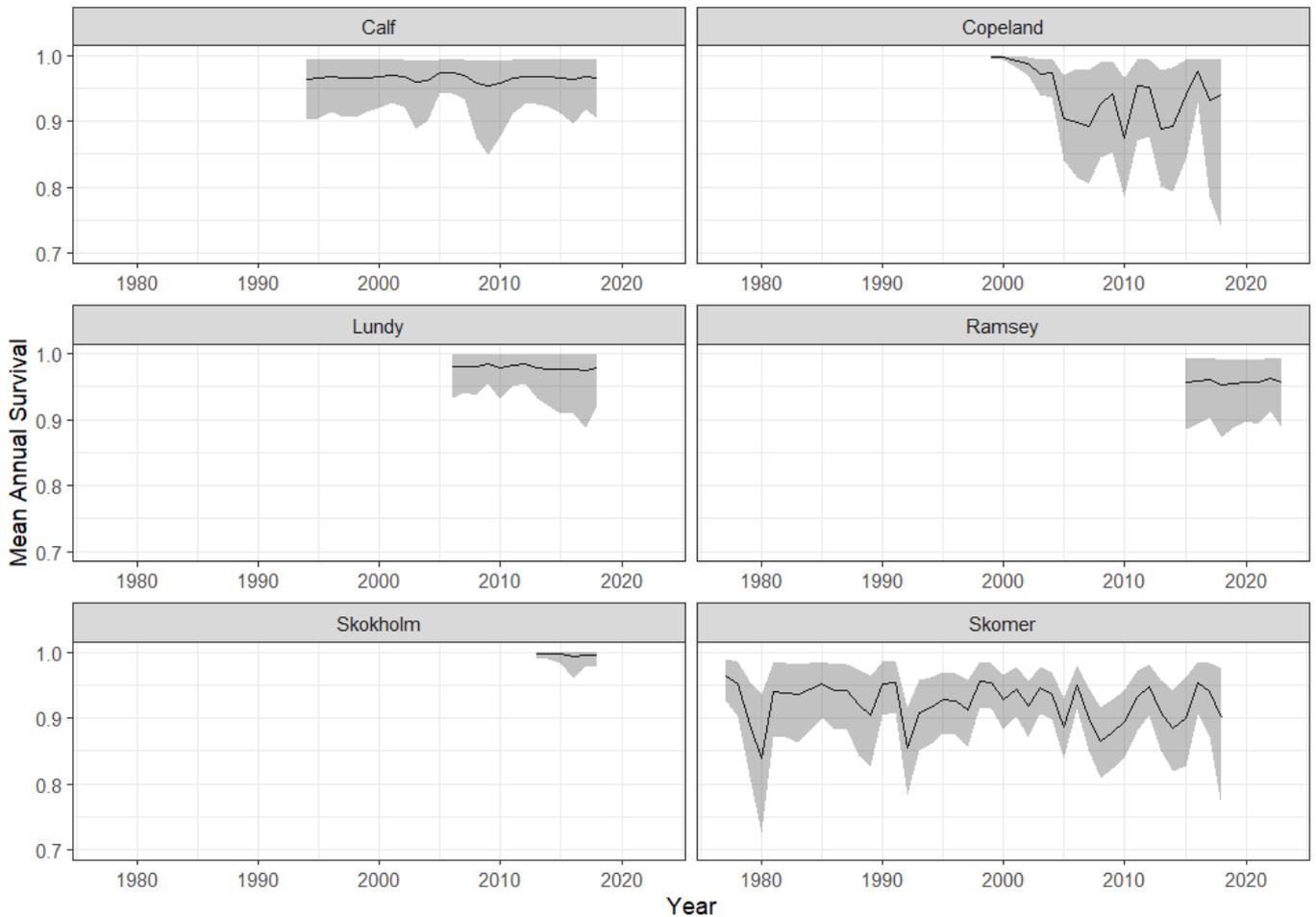
WP4 aims to fill significant knowledge gaps on demographic rates for MSW and through modelling of adult and juvenile survival rates which will improve the accuracy and precision of population viability analysis modelling for these species. The WP primarily focuses on the use of existing long-term datasets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

### What Has Been Done So Far?

- Recruitment of postdoctoral research fellow (Katie Bickerton; KB) to undertake demographic analysis.
- Training of KB in analytical methods for estimating demographic parameters.
- Collation of MSW ringing data for several key colonies in the Irish and Celtic Seas including Skomer, Skokholm, Ramsey, Lundy, Copeland and the Calf of Man.
- Preliminary analysis of MSW breeding adult ringing data to estimate survival rates for each colony.
- Presentation of preliminary results and proposed methods at the 16<sup>th</sup> International Seabird Group Conference in September.
- Comparisons of MSW survival trends across colonies and synchrony modelling to improve estimates for colonies with limited available data (ongoing).
- Collation of ESP ringing and productivity data (ongoing).

### Preliminary Results

- Preliminary estimates of mean annual survival for breeding adult MSWs (Fig. WP4.1) are high, as expected with long-lived species and vary over time, with variation more pronounced in colonies with longer term datasets. We are yet to test synchrony however it has previously been demonstrated between Skomer and Copeland.
- The results presented show analysis from the first available year of continuous data until 2019. This decision was made due to irregular monitoring during the Covid-19 pandemic in 2020 and 2021 and highly pathogenic avian influenza outbreaks in 2022. Ramsey was included up until 2024 as repeat captures of individuals only began in 2015 and a dataset of at least 5 years is required to give accurate results.



**Figure WP4.1:** Preliminary mean annual survival estimates of breeding adult Manx shearwaters across six colonies in the Irish and Celtic Seas using capture-recapture models and adult ringing data. Estimates are given for the years where continuous data was available.

## Impact

- Our refined estimates of demographic parameters, particularly survival, will improve the reliability of population viability analyses used in impact assessments for OWFs.

## Next Steps

- Collation of ESP ringing and productivity data.
- Finalise estimates of breeding adult MSW survival, using synchrony models to compare colonies and infer survival for data poor colonies.
- Analysis of MSW juvenile data to estimate juvenile survival using integrated population models (IPMs), KB to attend an IPM training course in October.
- Analysis of ESP breeding adult data to estimate survival using capture-recapture models and IPMs.
- Analysis of ESP juvenile data where available to estimate survival using IPMs.