Workshop Report

Gull foraging offshore and onshore: developing apportioning approaches to casework

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This report should be quoted as:
Quinn, L.R. 2019. Workshop Report on Gull foraging offshore and onshore: developing apportioning approaches to casework. *Scottish Natural Heritage, Workshop 31st January 2019.*

Table of Contents **Page**

ACKNOWLEDGEMENTS

SNH would like to thank all those who attended the workshop and who had input into this workshop report. We would especially like to thank the presenters who provided a varied and interesting programme for all. Thanks also to the discussion group facilitators (Liz Humphreys, Emma Philip and Ruedi Nager) and scribes (George Lees, Helen Wade and Nina O'Hanlon), to Glen Tyler for input into the casework example and for reviewing the first draft of this report, and to Bob Furness, SNH Board, for chairing the presentation sessions. It was fantastic to have European colleagues join us and we appreciate everyone's travel time in being able to join the workshop day. Finally, we'd also like to thank the SNH Service Delivery Team at Great Glen House for helping with room set ups.

Everyone who attended the workshop made valuable contributions towards the discussions throughout the day, and the workshop has undoubtedly helped us focus our next stage of work.

GLOSSARY/ ABBREVIATIONS

Term	
BLHGU	Black-headed gull (*Chroicocephalus ridibundus)*
BS	Breeding Season
COMGU	Common gull (*Larus canus)*
EDPR	EDP (Energias de Portugal) Renewables
EIA(R)	Environmental Impact Assessment (Report)
ESAS	European Seabirds At Sea
EU	European Union
GBBGU	Great black-backed gull (*Larus marinus)*
HERGU	Herring gull (*Larus argentatus)*
HRA	Habitats Regulations Appraisal
LBBGU	Lesser black-backed gull (*Larus fuscus)*
LITGU	Little Gull (*Hydrocoloeus minutus)*
mmfr	Mean maximum foraging range
Natura	Natura sites (SACs and SPAs) have been set up by the EU 'Habitats' and 'Birds' Directives. They protect the most important sites for habitats and species across Europe and form the largest network of protected sites in the world. In the event of the UK leaving the EU on 31st October, or another date, then the Natura sites will be known in Scotland as the 'UK site network' and in England and Wales, the 'National site network'.
NBS	Non-breeding Season
NE	Natural England
OR. (X)	Ornithological Research gap, as identified by ScotMER (see below). These identify gaps where research should focus in the future.
OR.01	Baseline at sea distribution and abundance.
OR.02	Movement/ destinations of Scottish breeding birds during the non-breeding season- linking breeding and non-breeding locations.
OR.03	Movement/origins of birds present in Scottish waters during the non-breeding season.
OR.04	Age structure and breeding status of birds at sea.
OR.07	Variation in distribution, abundance, and behaviour with weather conditions and diel cycle.
OR.08	Level and type of nocturnal activity at sea, and variation across space and time.
OR.09	Colony of origin of birds at sea during the breeding season.
OR.11	Baseline colony population data.
OR.14	Seabird flight heights.
OR.16	Influence of age, sex, environmental conditions, etc. on collision risk.
OR.23	Change in demographic rates resulting from displacement/ barrier effect.

OR.26	Forecasting population level consequences of predicted effects.
OR.32	In-combination effects of renewables with other managed activities.
OWFs	Offshore Wind Farms
ScotMER	Scottish Marine Energy Research (https://www2.gov.scot/Topics/marine/marineenergy/mre/research)
SEAPOP	SEAbird POPulations (http://www.seapop.no/en/about/)
SIA	Stable Isotope Analysis
SMP	Seabird Monitoring Programme
SNCB	Statutory Nature Conservation Body
SPA	Special Protection Area
UvA-BiTS	University of Amsterdam – Bird Tracking System

EXECUTIVE SUMMARY

The key objective of the workshop was to establish how the current scientific understanding of gull foraging behaviour can be used to inform the development of a robust, evidence-based approach for combining onshore and offshore wind farm impact assessments, to enable SNH to provide proportionate advice. The specific aims of the workshop were to enable participants to explore how existing knowledge can be applied to policy and casework approaches and to identify current knowledge gaps in gull foraging behaviour and research needed to fill these gaps. More generally, it was a goal of this workshop to facilitate better communication between policy advisors, casework officers, consultants who work alongside developers and researchers, with specific regard to gull foraging and wind farm impact assessments.

Through a number of presentations and two discussion group sessions, it became clear that this is a hugely complex issue and not one with an easy solution. Common topics arose from the workshop and suggestions were made as to how to progress the work. The workshop demonstrated that there is huge value in bringing together specialist experts to help inform future policy and advice decisions. To tackle such a complex issue as gull foraging and their potential interactions with renewable developments both onshore and offshore, further collaborative thinking and working in this area is essential.

A summary of the main topics discussed is shown below, with some recommendations as to how this topic could be progressed.

1. Gull population dynamics:

- Factors affecting gull populations and the importance of offshore and onshore wind farm impacts on gull populations, relative to other stressors/pressures.
- Gull population management and if reduction in gull population control could be used as mitigation of wind farm impacts, in Scotland.

Recommendations:

a) Discuss with Scottish Government if a review of the impacts of gull control / management practices on gull populations could be initiated. Could link to ScotMER evidence gap OR.32.

b) Collate what is known about current gull control practices and extent in Scotland. Important to involve licensing team members with the data collation.

c) Commission research on gull population dynamics. Could link to ScotMER OR.02, 12, 23, and 26 (if latter two are extended to include gulls).

2. Surveying and monitoring:

<u>Colony/roost site survey data:</u>

- Monitoring of gull populations at SPA and non-SPA colonies. Fundamental to have up to date site/SPA population estimates and, where possible, a better understanding of non-SPA population estimates to help inform apportioning. This is required for all wind farm gull assessment work.
- Winter gull survey: a repeat of the 2003/04 survey is overdue.
- There is a lack of information on urban gull populations.

<u>Movement/Foraging survey data:</u>

- Post-construction monitoring for gull mortality and non-lethal effects due to wind farms.
- Analysis of colour-ring datasets.
- Use of technology to look at foraging movement at night as well as during the day.

Recommendations:

a) *Link future work to ScotMER evidence gap OR.11: Baseline colony population data.*
b) *Commission research on existing colour-ring datasets currently available in Scotland.*
c) *Scope potential for volunteers to help monitor inland colonies – initiatives within the SMP potentially could be developed.*
d) *Undertake further analysis of post-construction monitoring required to help inform future impact assessments (both UK datasets and European datasets).*

3. Foraging variability:

- It was clear through the discussions during the workshop that there is a huge amount of variability in gull foraging behaviour, be it diurnally, seasonally, annually, breeding state, colony-specific, regionally, or between individuals.
- Further work on the non-breeding foraging of large gulls has been identified as a knowledge gap. Whether gulls undertake longer migrations (such as individual LBBGUs) or remain in UK waters (more common in HERGUs), there is a need to understand what proportion of gulls could come into contact with wind farms over the non-breeding period.
- There is a particular lack of information on urban gull foraging behaviour over both breeding and non-breeding seasons. In turn, we lack information on apportioning effects to non-SPA populations but also how SPA and non-SPA populations may interact in urban environments.
- Species-specific deficiencies in knowledge are apparent, particularly for great black-backed gulls and common gulls, due to the lack of tracking studies. Non-*Larus* species (little gulls and black-headed gulls) also mentioned as lacking foraging and distribution data.

Recommendation:

a) *Conduct a meta-analysis of distributional data (tracking and ringing data) from across many colonies. This would substantially help with seeing if any general foraging patterns emerge. Would also help our understanding of where spatial segregation occurs for gull foraging areas.*
b) *Apply technology to look at foraging movement at night as well as during the day.*
c) *Look to commission future research on species with deficiencies, e.g. trial of GBBGU year-round tagging.*
d) *Many of these gaps in knowledge could feed into ScotMER (e.g. OR 02, OR 03, OR 04, OR 07, OR 08, OR14, OR 16[1]). Ensure the recommendations from this report are included in the next ScotMER review process.*

4. Habitat and prey data

- Regional differences in gull diet (e.g. terrestrial-based diet versus marine-based diet, and/or anthropogenic food sources versus 'natural' prey sources), as a result of individual behaviour differences being influenced by different resource landscapes.
- Further understanding required on distribution of foraging habitat inland.

Recommendation:

a) *Analyse land-use maps to determine potential gull foraging areas.*
b) *Conduct a meta-analysis of gull diet from previous studies to help reveal general patterns.*

[1] See https://www2.gov.scot/Topics/marine/marineenergy/mre/research/ornithology for link to details on ornithology evidence gaps and section 2.2.5 in this report for more detail on ScotMER.

c) *Commission research on habitat and prey distribution, ensuring data from recent and current PhD projects on gull diets and foraging is included (e.g. Nina O'Hanlon, Rebecca Lakin, Liam Langley, Anouk Spelt).*

5. Guidance document:

- Combined onshore/offshore gull apportioning guidance document for casework.
- Joint (UK) approach to apportioning, if possible.

Recommendation:

a) *Write apportioning guidance including onshore and offshore distribution and covering both breeding and non-breeding seasons.*
b) *When guidance document is being drafted ensure the other SNCBs can comment on it should they wish.*
c) *Look more closely at how NE have dealt with gull apportioning casework recently*.

6. Public involvement:

- Public perception of some, particularly larger, gull species, is still largely negative in certain areas. This can lead to potential conflict situations and may in some cases lead to more gull control licences being requested in certain areas (which also links to gull population dynamic knowledge gap).
- Citizen science contributions to gull studies.

Recommendation:

a) *Encourage gull researchers to use the Clyde Muirshiel Tag 'n' Track[2] work and the Bristol Urban Gull project[3], as an inspiration for engagement of local communities and the public with their work.*
b) *Review where areas of conflicts are arising and why that particular habitat is so attractive for gulls, could help inform our information on gull foraging (also links to habitat and prey knowledge gap).*
c) *With other SNCBs be more proactive with press releases when gull research has been commissioned and ensure positive, interesting stories about gulls are put into the media.*
d) *Design a project where citizen science could help gather information on gull relative abundance and foraging behaviour which can in turn help inform guidance and advice.*

There was an initial attempt to prioritise these research needs, and possible next steps, in order to progress this research area were identified.

[2] Further information see: http://clydemuirshiel.co.uk/things-to-do/widlife/tag-n-track/teamgull/
[3] Further information see: https://twitter.com/urbangulls?lang=en

1. INTRODUCTION

This report is a record for participants in the SNH Gull Workshop of: the presentations and resulting discussion points; a summary of the group session discussions; and recommendations, including next steps. Participants included representatives of: the Statutory Nature Conservation Bodies (SNCBs) (Natural England, Scottish Natural Heritage and Joint Nature Conservation Committee (JNCC)), The Royal Society for the Protection of Birds (RSPB), environmental consultant companies (Natural Power, APEM, MacArthur Green) and research bodies both from the UK (BTO, University of Glasgow, ERI, University of Exeter) and Europe (University of Amsterdam, FTZ Christian-Albrechts-University of Kiel, NIOZ). The workshop report has also been commented on by other members of interested parties who were unable to attend the day itself (see Annex 2b).

1.1 Context of the Workshop

The focus was on larger *Larus* gull species[4] as they more typically breed and forage in coastal, offshore, rural and urban areas. As such, they have the potential to be at risk of collision from both offshore and onshore wind farms (collectively referred to hereafter as 'wind farms'). Gull numbers are declining within Special Protection Areas (SPAs) where they have been listed as qualifying features both in Scotland and in the wider context of the UK (JNCC, 2018). Lesser black-backed, great black-backed and common gulls are currently classified as having an 'Amber' conservation status and herring gulls are showing such a decline that they are classified as having a 'Red' conservation status as well as a 'Declining' European population status (BirdLife International, 2017; Eaton *et al.* 2015). However, we still have little understanding of how different gull foraging strategies influence the scale of impact from onshore or offshore wind farms as birds commute between breeding/non-breeding areas and marine and/or terrestrial foraging areas.

For all SPAs if there is a plan or project that, either alone or in combination with other plans or projects, is likely to have a significant effect on the qualifying species of the site, there is a process of assessment required by Article 6(3) of the Habitats Directive and regulation 48 known as the 'Habitats Regulations Appraisal' (HRA). In the absence of knowledge and where there is no evidence to suggest otherwise, SNCBs are obliged to adopt a precautionary approach to HRAs using the best available evidence. Currently the approach taken by SNH in apportioning impacts on gulls to breeding SPAs is to assume all gulls from the SPA either forage in the marine environment (for offshore wind farm work) or forage in the terrestrial environment (for onshore wind farm work). This could potentially lead to an over representation in apportioning, and therefore lead to an over precautionary assessment of the impact of wind farm plans or projects on gulls in some instances. This may be particularly important when considering cumulative impacts of both offshore and onshore wind farms.

1.2 Workshop Aims

The specific aims of the workshop were to enable participants to:

1) Explore how existing knowledge of gull ecology can be applied to policy and casework approaches, with specific regard to apportioning impacts to wind farms
2) Identify current knowledge gaps in gull foraging behaviour; and
3) Identify research needed to fill these knowledge gaps.

[4] Specifically concentrating on the larger UK/Scotland breeding *Larus* species: lesser black-backed gull *Larus fuscus*, herring gull *Larus argentatus*, great black-backed gull *Larus marinus* and common gull *Larus canus*.

More generally, it was a goal of this workshop to ensure policy advisors, casework officers and consultants who work alongside developers, could share their viewpoints and needs with the researchers, who in return could share their knowledge of gull foraging behaviour. It was important to present sufficient information for researchers to gain a better understanding of how their research can be used to support policy and guidance and the context in which it sits.

1.3 Workshop Objectives

The key objective of the workshop was to establish how the current scientific understanding of gull foraging behaviour can be used to develop a robust, evidence-based approach for combining onshore and offshore impact assessments. This will enable developers to reduce uncertainty within impact assessments, and SNH to provide proportionate advice.

1.4 Workshop Format

The workshop combined a series of presentations each followed by a short discussion in the morning, and group discussion sessions in the afternoon. The presentations were divided into three main topics:

- policy context; gull assessments for wind farm work;
- UK-based research; and
- wider European-based research.

There were two discussion group sessions; one which focused on working through a fictional casework example, and a second session of mind-mapping on the three workshop aims.

1.5 Terminology

When discussing casework on gulls and renewables there are a number of ways in which the terms 'apportion' and 'proportion' are used. The two terms relate to subtly different points, as outlined below. The term 'connectivity' is also used throughout and is explained below.

Apportioning: this relates to how the predicted impacts of a renewables development on seabirds are related back to the source populations, i.e. how the impacts can be 'apportioned' to multiple source colonies. SNH interim guidance on this is available for marine renewable developments to breeding seabird populations in SPAs (SNH, 2018).

Proportion of birds from an SPA using the marine or terrestrial environment for foraging: this relates to understanding what number of birds from the same colony feed in the marine environment versus the number of birds that feed in the terrestrial environment. (It is noted that individuals may indeed feed in both environments). Understanding how many birds from each colony are expected to feed in the marine environment versus feeding inland is necessary to then estimate how many birds at the development sites are expected to be from SPAs with connectivity to the site.

Connectivity is the establishment of a plausible link between the source population and the development impact. Establishing the extent of connectivity between birds using development areas and designated sites is an important element in assessing how designated sites may be affected (SNH, 2011). Seabirds using a development site may originate from more than one colony and potentially more than one designated site. The relative connectivity to the various candidate colonies therefore needs to be apportioned in a reasoned way (see above for apportioning definition) (SNH, 2011).

2. PRESENTATION SUMMARIES AND DISCUSSIONS

Section 2.1 provides a summary of the main points drawn from the presentation session. Further detail is provided in sections 2.2-2.4, where the presentations and subsequent discussion points are summarised. This section provides talk abstracts for each of the presentations and includes any points discussed as a result of the talk.

2.1 Summary of main points drawn from the presentation session

Topic	Brief summary
Foraging variability (both at an individual and colony level)	There is huge variability in gull foraging e.g. between sexes, within individuals, intra and inter-colonies, intra and inter-years, which has consequences on the number of individuals and colonies, and the length of studies required to provide representative data. Collective tracking and dietary studies have much value in providing empirical data into the apportionment process, enabling quantification of variability and uncertainty. We need to consolidate available knowledge on gull foraging movements and diet. Whilst diet cannot give spatial resolution to assess connectivity to wind farms, it may help differentiate between marine, coastal/intertidal and terrestrial food sources. It was also noted that there has also been a bias in studying gull colonies in more 'natural' habitats as opposed to studying urban breeding birds, where data are sparser.
Non-breeding foraging	There is a lack of information on non-breeding foraging which needs to be addressed for future guidance documents.
Non-adult gulls	There is a lack of information on immature and sub-adult foraging patterns and their post-natal dispersal and movements before reaching breeding maturity. These issues need to be addressed for future guidance documents.
Habitat mapping and prey items	There is large variability in habitat used and prey items consumed in gull foraging. Gulls most likely exploit whatever is in the landscape surrounding their colonies. Analysis of land-use maps could determine potential gull foraging areas, particularly for onshore wind farm cases. Non-invasive diet sampling techniques could be used to differentiate between the reliance of terrestrial versus marine food sources. There could also be survival or reproductive consequences of eating different prey items.
Additional factors influencing gull populations	Understanding other factors affecting gull populations (e.g. landfill site closures, discard bans, gull control management etc.) will help determine the relative importance of impacts resulting from collision or displacement due to wind farms.
Flight behaviour modelling	Flight heights may vary depending on whether the gull is flying over land, coast or sea, and will also depend upon the wind conditions. Flight modelling is also now moving to a more 3D approach, quantifying the xyz axis together (e.g. as used in Thaxter *et al.* 2018). There is a need to understand the variability in flight behaviour and the consequences this has for collision risk in gulls. There is

	also a need to understand the characterisation of behaviour in terms of what the gulls are doing in wind farms e.g. sitting, foraging, commuting, etc.
Approaches to HRA/EIAR assessments	Apportioning guidance for gulls needs to include onshore and offshore distribution and cover both breeding and non-breeding seasons. Differences in approaches to apportioning between the SNCBs exist. Thinking is needed about appropriate spatial scales for apportioning impacts.
Research feeding into policy	What underpins the whole process of assessment for gulls and wind farms is evidence informing policy and decision-making. Increasing awareness and incorporation of knowledge regarding variation in time spent at sea vs on land, in trip ranges and in behaviour, would be very valuable and should be integrated into guidance, regulatory processes and mitigation for wind energy developments. This will involve close working and better communication between researchers, caseworkers, developers, consultants, regulators and policy-makers.

Further detail relating to the topics identified are summarised below:

Individual variability:

- Individual specialisation could especially relate to sex/age/quality/breeding state of the bird/location of the colony, as well as being related to the habitat/prey availability – specialisation can occur where multiple foraging options are available.
- Whilst specialisations can occur, gulls may demonstrate foraging flexibility when a particular prey item is not as readily available.
- Daily, seasonal, and inter-annual variation in foraging habitat use has been noted.
- Seasonal differences in foraging have implications for the representativeness of tracking data (e.g. if in breeding season birds tend to forage closer to the colony or use different foraging locations compared to the non-breeding season).
- Individual variability may influence intra- and inter-specific competition.
- Individuals adapt their foraging behaviour to human activity: there is a need to understand what adaptations are observed in what circumstances, and what the implications are.
- Consistency in diet/use of foraging habitat affects how easily general assumptions about gull foraging can be made.
- Some gull species occasionally make long distance movements particularly in the non-breeding period. There is a question over how one-off movements are considered, compared to movements associated with clear migration routes. It would also be useful to know how frequent their large-scale movements occur.

Colony-specific considerations:

- Colony size is a factor to consider, e.g. see NE's approach (Section 2.2.3). Distance weighting factors assuming even density across the foraging range risk overestimating the proportionate occurrence at an offshore wind farm site of birds from the largest, most distant colonies. An overestimate of the weight for a large, distant colony will lead to an underestimate of the proportion from a smaller, closer colony.
- Spatial segregation between neighbouring gull colonies, as seen in tracking work of herring and lesser black-backed gulls on mainland Europe (e.g. Enners *et al.* 2018, Corman *et al.* 2016), has implications for apportioning techniques. It has been shown in a recent review of seabird tracking data (Bolton *et al*. 2018), that if colonies

segregate in their foraging area, the current practice of apportioning impacts which assumes overlapping foraging distribution, may lead to over or under-estimation of impact in cases where segregation occurs.

- There is an opportunity to come up with empirically derived decay functions (similar to those that were available on the previous BirdLife International wikispace webpage). These do not assume even density across the foraging range, as density tends to decrease with distance from the colony. There is a question as to whether or not data exists to be able to do this.
- There may be an influence of sex and morphology in foraging behaviour (e.g. see O'Hanlon's work in Section 2.3.3 where it was demonstrated that larger individuals used more intertidal habitat during the non-breeding season). This effect may be may be colony specific (i.e. there is an interaction between sex, morphology and colony).
- There is a need to better understand the extent to which results from tracking studies (e.g. foraging ranges) are colony specific.
- Where multiple SPAs or multiple sites within an SPA (e.g. Firth of Forth Islands) are involved, there may need to be consideration of how many colonies should be tracked to be representative, as well as minimum sample sizes required for each colony.
- Researchers working together can provide an overview of the extent and importance of colony-specific patterns.

Non-breeding foraging:

- There is a lack of information for migration and non-breeding seasons (some species lack information more than others, e.g. more data exists on LBBGUs than on other species). There is a need to better understand the linkage between breeding SPAs and non-breeding season aggregations/distributions. There are challenges in thinking about migratory versus resident species.
- The contribution of non-breeding birds to foraging/at sea gull populations during the breeding season needs to be understood and, ideally, quantified. A better understanding is needed of how to apportion breeders associated with a protected site and non-breeders in the breeding seasons that may come from elsewhere.
- Understanding of the assessment process for sites designated for wintering populations/assemblages will have different needs compared to assessments for sites designated for breeding populations.
- In the non-breeding period individual gulls spread out over a much larger range than during breeding although each individual may occupy a relatively small home range within the non-breeding distribution. This is posing challenges in assigning connectivity of breeding populations with particular proposal sites during the non-breeding season.
- Colour ringing re-sighting data could inform apportioning during the non-breeding period.

Non-adult gulls:

- More information is required on foraging ecology, spatial distribution and dispersal distances in immature and sub-adult gulls including, specifically, how it differs to adult gulls.

Habitat mapping and prey items:

- What resources SPA gulls are foraging on could be determined – there is scope for using land-use maps to assess possible resources that are available to the gulls.
- Trip statistics and habitat characteristics should be compared in order to see what general patterns emerge.

- Understanding of the effect of different prey items, and the local availability of these different resources (e.g. availability of intertidal prey versus grain versus fishery discards, etc.), on breeding success, needs to improve.
- Gulls exhibit significant dietary variation and opportunism – there is unlikely to be a single main foraging habitat/prey.
- Diet data could play a role in looking at marine versus terrestrial use.
- Foraging movements have been recorded as relating to prey movements (e.g. worms in a field (morning foraging more profitable) or fish in the sea (for example diel or seasonal migrations)), or associated with timings of human food sources (for example, school lunchbreak timings or weekend/week day timings of fishing vessels).
- Ruedi Nager stated: "Gulls - wherever there is food, they will use it". It is important to note that gulls are driven by what is available for them to forage on, and this needs to be taken into account for assessments. Conversely, the point was also made that tracking data does show individuals have specific preferences as to where they find their food and can be highly site faithful at the fine scale.

Additional factors influencing gull populations:

- Landfill closures – early results from Liam Langley's PhD work on LBBGUs demonstrated that landfill closure had no effect on foraging range but foraging effort increased, and the overall landfill utilisation reduced. No effect on adult body condition was recorded.
- Past and future changes in foraging habitat and prey e.g. discards ban, landfill closures, changes in farming practices, requires further examination.
- Further consideration is required of the role gull management has in influencing gull populations.
- Assessment is required of the relative importance of different influences e.g. gull management versus wind farms versus landfill closures versus discard bans etc.

Flight behaviour modelling:

- Consideration of flight behaviour is required, e.g. flight heights, flight speed, and collision avoidance, for wind farm mitigation.
- Flight behaviour is shaped by aerial environmental conditions e.g. weather, wind speed, wind direction etc.
- Atmospheric modelling would be helpful to identify potential flight corridors.

Research feeding into policy:

- Advice is required on how best to carry out impact assessments given the diversity of foraging strategies observed in gull species. In particular, the extent to which generic assumptions and parameters can apply to individual assessments.
- ScotMER as a route to commission new research, to address some of the current research gaps identified in this report.

2.2 Presentation session 1: Policy context

2.2.1 Context for the gull workshop and reiteration of workshop aims (Bob Furness/Lucy Quinn)

There was a brief overview on SNH's role as statutory advisors for HRAs and EIAs on onshore and offshore wind farms. By 2020, the Scottish Government wants to have 100% of Scotland's gross annual electricity consumption generated by renewable sources of energy. The resultant increase in the number of onshore and offshore developments to fulfil the 100% renewable energy goal, and the upcoming plans for more wind farm developments, means that there is a concurrent increase in the potential for interaction between wildlife and renewable developments.

The workshop aims were introduced (see Section 1). A brief background of the requirement to assess effects for SPA gulls was given:

- Natura sites[5] (i.e. Special Protection Areas and Special Areas for Conservation) are a network of protected sites across Europe, based on legal protection put in place as a result of the EU Habitats and Birds Directives.
- For all Natura sites, if there is a plan or project that either alone or in combination with other plans or projects is likely to have a significant effect on the qualifying species of the site, there is a process of assessment required by Article 6(3) of the Habitats Directive and regulation 48 known as the 'Habitats Regulations Appraisal' (HRA). Likely significant effects (LSE) require connectivity between the potential interactions with the plan or project and the qualifying features of a protected site, and an impact pathway.
- HRA must assess impacts of the plan or project against the conservation objectives of the site.
- The qualifying species are protected under the Habitats Directive *throughout their life cycle*: if there is an SPA for a breeding qualifying species, this does not preclude their protection outside this point in their annual cycle, i.e. a non-breeding season assessment may be appropriate even if the SPA only defines protection for a breeding species.
- The HRA process adopts a precautionary approach: it needs to be ascertained whether the proposal will not adversely affect the integrity of the site.

It was pointed out that workshop participants were all linked in the process of carrying out an HRA; SNH relies on input from others e.g. academia, other SNCBs, research institutes, ecological consultancies. Developers provide information to inform an HRA, SNH advises on the scope, content and conclusions of the HRA and will provide it to the Competent Authority (e.g. Scottish Government, a Local Council, etc.), who then carry out the HRA and decide on the project or plan based, in part, on SNH's advice. What underpins this whole process is evidence.

2.2.2 SNH examples of gull assessment casework in Scotland (Helen Wade (marine casework example), Matt Burnett (terrestrial casework example))

Offshore wind developments and potential impacts on gulls: how do we consider this in casework?

Offshore wind developments have the potential to impact gulls, primarily through risk of collision. However, a lack of understanding of gull movements and foraging behaviour can lead to challenges assessing impacts on gull populations. Using the Moray Firth region as an example, some of the challenges associated with quantifying potential impacts of proposed offshore wind farms on protected gull populations were discussed. The Moray Firth contains

[5] In the event of the UK leaving the EU on 31st October, or another date, then the Natura sites will be known in Scotland as the 'UK site network' and in England and Wales, the 'National site network'. All of the transposing domestic regulations in the UK have been amended so that those parts of the Regulations which would no longer work when the UK leaves the EU can continue to fulfil the objectives of the EU Habitats and Wild Birds Directives which we are retaining in UK domestic legislation. The statutory instruments which are the vehicle for these amendments are: Conservation of Habitats and Species (Amendment) (EU Exit) Regulations 2019, The Conservation (Natural Habitats, &c.) (EU Exit) (Scotland) (Amendment) Regulations 2019 and Conservation (Natural Habitats, etc.) (Amendment) (Northern Ireland) (EU Exit) Regulations 2019.

three wind farm sites at varying stages of development, including the Beatrice wind farm, which is under construction; Moray East, which has consent for development; and Moray West, which has recently been granted consent for development. Each of these wind farms is within foraging range of East Caithness Cliffs SPA (ECC SPA) (Thaxter *et al.* 2012), for which breeding HERGU and GBBGU are features. Both HERGU and GBBGU were recorded in baseline surveys at each of the three wind farms. Because of potential connectivity between the wind farms and ECC SPA, an HRA is required to assess whether the development could have an adverse effect on the integrity of the protected site.

Given the lack of knowledge around the foraging behaviour and movements of GBBGU at ECC SPA, Moray East and Beatrice funded a project to track GBBGU breeding in the ECC SPA (Bogdanova *et al.* 2015). The tracking project observed that individuals equipped with data loggers undertook predominantly inshore movements, with no overlap with the three Moray Firth sites. This tracking project provided useful information and represents a good first step towards better understanding GBBGU movements from the ECC SPA. However, the authors of the tracking project report acknowledge several limitations of the study. These include:

- A relatively small sample of birds were tracked (n=10).
- Birds were tracked in one year, which doesn't enable consideration of inter-annual variation.
- The tags were deployed for relatively short periods of time.
- The deployments occurred during a restricted period in the breeding season – during late incubation/early chick rearing.
- Challenges in accessing the birds meant a subset of the colony was tracked. This included birds mostly breeding in the south of the SPA.
- The study was not able to evaluate potential tag effects, which could alter the bird's natural behaviour.

On the basis of the limitations of this study, it is not possible to conclude with certainty that there is no connectivity between GBBGU from ECC SPA and the Moray Firth wind farm sites.

In addition to this, the ECC SPA GBBGU population has declined since site designation. Therefore, relatively small impacts could lead to an adverse effect on site integrity. Also, because a large proportion of the Scottish GBBGU population breed outside SPAs and there are long time periods between censuses, it is difficult to place population trends observed in the ECC SPA in the context of the wider GBBGU population.

Conclusions and limitations of approach:

- Understanding of great black-backed gull movement and foraging behaviour is a key knowledge gap. For example, there is a lack of knowledge about how much individuals, and what proportion of the colony, forage onshore vs offshore. Addressing this knowledge gap would enable better estimates of connectivity with both onshore and offshore wind farms. There is also a lack of understanding of how foraging behaviour and movements may vary according to season and by year.
- Impacts on great black-backed gull could be overestimated if it is assumed that all birds forage offshore.
- Conversely, impacts on great black-backed gull could be underestimated as a result of not considering the in-combination effects of onshore wind farms and offshore

wind farms, should great black-backed gulls employ a combination of foraging strategies.

Onshore wind developments and potential impacts on gulls: how do we consider this in casework?

Tormywheel onshore wind farm

Site summary:

Tormywheel is around 30km from the Forth Islands SPA. The proposal was for an extension to an existing wind farm. The existing wind farm had gone through planning with no assessment made on the qualifying features of the nearby Forth Islands SPA. The proposal was next to a landfill site which is an attractive feature for the gulls.

Assessment and assumptions:

Using Thaxter *et al.*'s (2012) mean maximum foraging range the wind farm extension was within foraging range for both HERGU and LBBGU, qualifying features of the Forth Islands SPA. Visual tracking of gulls, using data from work carried out on behalf of Edinburgh airport, demonstrated connectivity to the SPA. Therefore, there was a likely significant effect on the Forth Islands SPA. An appropriate assessment was undertaken to consider the impacts of the wind farm on the SPA, which required bird survey work. Flight lines from Edinburgh airport survey data showed intense flights through the collision risk window for the gull species. There was no information on other possible source colonies for these gulls, and therefore an assumption was made that all the gulls passing through the survey site were from the SPA population at the Forth Islands. Both breeding season and non-breeding season impacts were assessed for both HERGU and LBBGU and an influx discount was applied to the SPA population for the non-breeding period assessed, taken from a paper on Scandinavian birds coming to the UK to winter (Coulson *et al.* 1984). Collision risk was assessed using avoidance rates previously agreed upon by all the SNCBs[6]. The flight line survey data showed that the non-breeding season posed more risk for the gulls overall.

Conclusions and limitations of approach:

There were a few issues which became apparent during the assessment.

- Key periods had been missed from data collection.
- Insufficient data had been collected.
- Many of the surveys had been undertaken after construction of the consented wind farm had begun, and so were carried out under a disturbed environment.
- Difficulties were experienced in assessing the cumulative impacts with the recently constructed wind farm in the same area, as no assessment had been undertaken when this original wind farm went through planning and therefore no data was available.

Summary from both SNH examples:

Unless evidence can be provided to the contrary, there is an assumption that coastal and island SPA populations forage offshore for marine casework and forage onshore for terrestrial casework, due to the precautionary principle. This could potentially lead to an over representation in apportioning, and therefore lead to an over precautionary assessment of the impact of wind farm plans or projects on gulls in some instances. This may be particularly important when considering cumulative impacts of both offshore and onshore wind farms. In marine casework, it is currently not common practice to consider onshore

[6] Joint Nature Conservation Committee (JNCC), Natural England (NE), Natural Resource Wales (NRW), Northern Ireland Environment Agency (NIEA), Scottish Natural Heritage (SNH). Nov. 2014. https://www.nature.scot/sites/default/files/2018-02/SNCB%20Position%20Note%20on%20avoidance%20rates%20for%20use%20in%20collision%20risk%20modelling.pdf

wind farm developments and therefore we could be underestimating cumulative impacts of developments (both onshore and offshore) on a population[7]. A note was also made that if developers do not adhere to advised survey methodology or subsequent advice, this can lead to a delay in the consenting process.

2.2.2.1 Discussion points from talks

- *Question: With regards to offshore developments: is there a possibility to catch birds at sea and then colour mark them or track them to see where they go?* There is potential for this to be a way forward and it could be particularly useful for considering effects outside of the breeding season, or for non-breeding individuals.

- *Comment:* Year-round gull tracking using different tags might help with lack of GBBGU data.
  Question: how do GBBGUs respond to the year-round tags? Some workshop participants had experience of this and commented the harness-style tags would be possible for GBBGUs. These types of tags have also been used in Ireland and with the BTO.

- *Comment:* raised as to why there should be an onshore wind farm planned for next to a landfill site in the first place. This isn't the only place this has happened (e.g. see Section 2.2.4 Lower Seater Wind farm).

- *Question: gull prevention management occurs at the landfill site; what potential effects might this have on the gulls being put into flight and therefore being more at risk of collision?* Further consideration of gull management and the role it potentially plays in gull populations/how it relates to SPA gull populations is something that should be taken forward.

- *Question: Landfill sites due to close – question raised as to what effects will this have on gulls?* Current research is beginning to look at this and this point was noted.

2.2.3 NE examples of gull assessment casework in England and recent research (Alex Banks/Liam Langley)

Most large gull casework in England is centred on LBBGUs *Larus fuscus graellsii*, as Natural England (NE) oversees five SPAs for the species, typically within mean maximum foraging range of offshore wind farms (OWFs), with declines evident for at least three of these SPAs. NE's approach to apportioning of impacts from OWFs stems from the Galloper OWF, an extension project in the southern North Sea which was examined in 2012. NE's view was that weighting approaches based on at-sea distribution in the breeding season should rely on empirical data where possible.

The alternative geometric approach, such as 1/distance^2, makes an assumption that seabirds are distributed evenly across their foraging range – an assumption recognised to be unlikely given the patchy nature of food resources available to central place foragers like seabirds. Instead, NE relied upon cumulative curves of foraging distance, formerly publically hosted by BirdLife International, to make predictions about density in relation to increasing distance from source colonies. Unlike the geometric approach, smaller, closer colonies are not disproportionately weighted in favour of larger, more distant ones; however, as no empirical data were available for LBBGU foraging distributions, it was necessary to use

[7] Note that other species may also demonstrate this overlap between marine/terrestrial environments e.g. red-throated divers (breeding inland and foraging at sea), or possibly even tern species. However, the focus for this workshop was large gull species.

proxy species (black-legged kittiwake and northern gannet). This required an assumption that LBBGU density at sea changed with distance from colony in a similar way to the proxies, and that using an intermediate apportioning value between the kittiwake and gannet examples was appropriate given the foraging range of LBBGU lies between that of kittiwake and gannet. (In practice, apportioning values derived from kittiwake and gannet data were within 2% of each other meaning the assumption is unlikely to lead to major differences).

Regardless, this approach has formed the template for all advice provided by NE in later large gull OWF cases. Unfortunately, the foraging distance data are no longer accessible, but the wealth of tracking data now available presents a timely opportunity for new analyses to supply accurate ecological information about foraging distribution in large gulls.

Furthermore, new insights into LBBGU ecology and movement are being provided by a CASE studentship between University of Exeter, Natural England and BTO. The PhD focuses on gull habitat and resource preferences in response to anthropogenic influences, seeking to better understand comparative differences between 'urban' and 'natural' nesting gulls, and exploring individual behavioural patterns as a means to inform management of protected gulls. Preliminary analyses of GPS tracking data has shown that SPA breeding gulls are altering their behaviour in response to landfill closures, with potential implications for advice on protected site management.

2.2.3.1 Discussion points from talk

- *Question: NE was asked about the source of the seabird density data?* In the case presented, it was from ESAS data and surveys carried out by the developer.

- *Question: A question was asked as to whether you could extract a density decay function from at sea data?* Could be a potential tool to explore what is the status of the birds.

2.2.4 Apportioning impacts upon Larus gulls for Scottish renewable energy developments: A consultant's perspective (Graeme Cook)

Consultant ornithologists input into the production of consent related documents on behalf of project developers. This includes contributing to Environmental Impact Assessments (EIA) and providing information for the Habitats Regulations Appraisal (HRA) process. For certain proposals the impacts of developments upon *Larus* gull species can be of particular importance in relation to whether planning consent is granted. Apportioning predicted impacts to contextualise potential effects in relation to relevant biogeographic populations of these species, or their designated populations at protected sites, may be necessary in the determination of impact significance.

At present, for Scottish developments, information on spatial apportioning of impacts is provided in a single interim guidance document (SNH, 2018). This document covers suggested approaches for undertaking apportioning for marine developments, and for breeding season effects. Currently there is no published formal statutory guidance in relation to apportioning the impacts of terrestrial developments, or for non-breeding season effects. Likewise, advice in relation to non-spatial components of apportioning (such as considering impacts upon key demographic groups), also currently lies outwith the remit of official guidance. Where no statutory guidance exists, consultants undertake impact apportioning by following the precedence of accepted approaches used for similar developments and/or consultation advice.

Larus gulls, being to various degrees marine and terrestrial in their habits, and present during both breeding and non-breeding seasons, are currently only partly covered by

existing formal statutory guidance in relation to apportioning, i.e. for offshore developments it's possible to follow guidance to apportion breeding season impacts to SPAs in their vicinity. The following examples summarise how consultants have conducted apportioning of predicted collision impacts for herring gull for three recent proposed wind farm developments, one offshore and two onshore, in and around Caithness, namely:

- Moray West Offshore Wind farm (where the ornithological consultant was NIRAS);
- Golticlay [onshore] Wind farm (where the ornithological consultant was Natural Power), and
- Lower Seater [onshore] Wind farm (where the ornithological consultant was Natural Power).

<u>Moray West Offshore Wind farm (EIA Report submitted 2018 – consented June 2019)</u>
For this large offshore development east of Caithness, spatial apportioning for breeding season collision impact to surrounding SPAs was undertaken as per the 2016 iteration of SNH interim apportioning guidance (SNH, 2016). This followed a two-stage approach:

- Firstly, breeding season collision impacts to herring gull were split into SPA and non-SPA components. This was done by using mean maximum foraging distances (Thaxter *et al.* 2012) to determine species specific areas of connectivity around the proposed development. Counts from Seabird 2000 (Mitchell *et al.* 2004) were then considered for all colonies within these areas to determine proportions of the population within and outwith SPAs. Breeding season collision mortalities were then multiplied by these proportions to attribute total SPA and non-SPA impacts.
- Secondly, total SPA breeding season impacts were apportioned to each of the SPAs within the area of connectivity. Impacts were assigned to each SPA using a three-parameter model which incorporated SPA colony size, SPA distance from the proposed development, and a sea area weighting factor to account for available marine habitat (as opposed to land) around each SPA. Larger proportional impacts were attributed to larger SPA colonies and those closer to the proposed development.

Further correction factors to apportion impacts to key demographic groups (specifically adult breeding birds) were also applied for each SPA population. Spatial apportioning of non-breeding season collision impact was also undertaken. Impacts upon each SPA were considered in terms of each SPA's estimated contribution to the relevant regional non-breeding population. This regional population utilised the concept of Biologically Defined Minimum Population Scales (Furness 2015).

<u>Golticlay Wind farm (EIA Report submitted 2016 – awaiting determination)</u>

Golticlay Wind farm was presented as an example of an onshore wind farm development where the approach for apportioning collision impacts was considered to be relatively straightforward. This 19-turbine development lies within 5 km off the East Caithness Cliffs SPA and observed herring gull flight activity indicated connectivity with that SPA. As this SPA was the only known breeding herring gull colony within the estimated area of connectivity for the development, the impact was therefore apportioned to the East Caithness Cliffs SPA.

As for Moray West, additional correction factors were used to apportion impacts to key demographic groups for the East Caithness Cliffs SPA. Proportions of adults and breeding birds were once again accounted for, and a correction factor to account for migrant overwintering birds was also incorporated.

For onshore developments, for *Larus* gulls, the potential for connectivity is generally determined by applying a 25km radius around the development area. The application of this apparently arbitrary radius is a noticeable departure from the approach taken for offshore sites (where species-specific foraging ranges are applied (Furness 2015)).

Lower Seater Wind farm (EIA Report submitted 2014 – planning consent denied on landscape and visual grounds)

This three-turbine development was presented as a less straightforward example of collision impact apportioning for an onshore wind farm. Due to the presence of a nearby landfill site, herring gull flight activity levels at Lower Seater were very high, and potential connectivity with surrounding breeding colonies (some of which were designated features of the East Caithness Cliffs SPA) was less apparent. As such, a spatial impact apportioning approach analogous to that advocated in stage 1 of the interim guidance for offshore developments was applied following consultation with SNH, in addition to the demographic correction factors outlined above for Golticlay Wind farm.

2.2.4.1 Discussion points from talk

- *Comment:* Apportioning in the context of EIA – point made that it's not only relevant for HRAs.

- *Comment:* Point made that where possible the use of relevant empirical datasets in apportioning should be carried out (as has previously been advised in the 2018 interim SNH guidance on apportioning).

- *Request:* Formalising guidance for non-breeding season apportioning and apportioning impacts from onshore developments – which is currently left out of SNH guidance.

- *Question: Appropriate spatial scales for apportioning of impacts from onshore developments – why has 25km been used for onshore, whereas the range for offshore is much greater?* Spatial scales to be considered for future guidance document.

- *Comment:* Colony population estimates should be updated where possible. It is important to ensure up to date colony references for use in assessments of SPA colonies in particular, especially where citation data may be many years old.

- *Question: Displacement apportioning - is this something that would differ from thinking about apportioning effects in relation to collisions?* Displacement apportioning approach would be the same as that for collisions.

2.2.5 Foraging ecology in gulls: insights from Sweden and a viewpoint from MSS (Tom Evans)

The talk was given in two parts, the first presenting GPS tracking research of gulls in Sweden (part of Tom's PhD studies), the second covering the Scottish Government's Marine Energy Research (ScotMER) programme and highlighting evidence gaps identified through ScotMER relating to apportioning and gulls.

Larus gulls have a generalist and opportunist foraging ecology. Their foraging distributions often show strong daily and seasonal variation reflecting variation in the quality of prey available in space and time and the varying demands of different breeding stages. For LBBGU breeding at an island colony in Sweden foraging trips are primarily either to marine

or terrestrial sites, with the majority of land visits to agricultural fields. Foraging activity on land was more common in the early breeding season and rare later in the summer. The gulls primarily forage on agricultural fields early in the day which may reflect when earthworms and other invertebrates are most available (closer to surface with damp soil during morning).

Foraging patterns and distributions were presented for four species (common -, herring -, lesser black-backed -, and great black-backed gulls) tracked concurrently from a common breeding site. This illustrated variation in the extent to which different *Larus* gull species may overlap in foraging habitat use when co-occurring in an area. The tracking data also showed how species-level generalisms may occur from either individuals specialising in different prey/habitats, or all individuals using a wide variety of prey/habitats.

Some gull species make very large-scale movements. GPS tracks for LBBGU tracked from two breeding colonies in Sweden illustrated how individuals ranged across the whole Baltic Sea on occasional trips ranging over several hundred kilometres.

The above case studies demonstrated how complex *Larus* gull foraging ecology is and thus why it is challenging to produce simple approaches to apportioning gulls observed at a foraging site to a given colony. Changes in availability of prey sources (e.g. fisheries discards) may lead to future changes in foraging distributions.

The ScotMER programme has produced evidence maps (see: https://www.gov.scot/Topics/marine/marineenergy/mre/research) highlighting key knowledge gaps in the consenting process for marine renewables. Some of the key gaps identified for gulls were presented. These included:

1. Baseline at sea distribution and abundance data (OR.01 – evidence map identifier).
2. Movement/destinations of Scottish breeding birds during the non-breeding season (OR.02).
3. Colony of origin of birds at sea during the breeding season (OR.09).
4. Age structure and breeding status of birds at sea (OR.04).
5. Variation in distribution, abundance, and behaviour with weather conditions and diel cycle (OR.07).

The Scottish Government has recently commissioned a project that is partly addressing points 3 & 5 above. This study will analyse GPS tracking data for a variety of species to understand how distribution and behaviour may be affected by weather conditions and the diel cycle.

2.2.5.1 Discussion points from talk

- *Comment:* ScotMER evidence gap mapping – ensure workshop suggestions can feed into this research programme.

2.3 Presentation session 2: UK-based research

2.3.1 Understanding how gull tracking studies can inform the apportioning process in relation to wind farms (Liz Humphreys)

A key aspect of the environmental impact assessment process for developments, including wind farms, is the need to understand the likely impacts on the features of protected sites such as Special Protection Areas (SPAs). The UK has a high international responsibility for seabird populations and many species during the breeding season are listed as qualifying features of SPAs. These species may forage at significant distances from their colonies where they may interact with wind farms. Some species can also migrate to different parts of the country or even outside Britain during the non-breeding season. The consequent mixing

of birds from different colonies means that there are often significant challenges associated with attempting to apportion the impacts from proposed developments to SPAs during both the breeding and non-breeding seasons. This is a particular issue for gull species which use both inland and offshore foraging areas and thus which may be affected by both onshore and offshore wind farms. A lack of data has meant that a number of assumptions have been made with respect to the apportionment process although the rapid advances in tracking technology may help fill in some of these gaps in knowledge.

Since 2010, the BTO has undertaken a programme of GPS tracking studies that has aimed to assess how two species considered sensitive to collision with wind turbines, LBBGU and HERGU, interact with proposed and operational wind farms across different spatial and temporal scales. Studies have been undertaken at sites across England and Wales, and have principally been funded by government and developers. Data from the breeding season have highlighted variation in birds' use of onshore and offshore areas, which has informed impact assessment and post-consent monitoring, and might also be used to update previously published estimates of foraging ranges of value in the apportioning process. Analysis of year-round movements has identified vulnerability hotspots, that may be useful to spatial mapping and cumulative impact assessment, and which may thus also be of value in apportioning non-breeding season impacts.

For most seabird species, including gulls, it is not possible to track birds from all colonies of potential relevance to developments and thus generic information is also required for the apportioning process. There are a number of key aspects which therefore need to be considered for the future when developing further guidance for apportioning. First, the metrics that might be of value, from simple descriptors such as foraging ranges, to more complex understanding of habitat requirements and likely foraging opportunities. Second, the need to consider variation, e.g. between sexes, individuals, colonies and within and between years, and consequently the number of individuals and colonies, and the length of studies required to provide representative data. Third, the need for information on birds' movements in the non-breeding season to be able to make linkages back to breeding populations. Both individually, but most especially collectively, tracking studies have much value in providing empirical data into the apportionment process, enabling quantification of variability and uncertainty.

The BTO is also involved in a joint PhD project with University of St Andrews which is looking at the influence of anthropogenic diet on gull chick phenotype. Part of this work wants to see if there are programming effects of nutrition. Potentially dietary data can play a role in teasing apart the proportion of gulls that feed in the marine environment versus the terrestrial environment.

2.3.1.1 Discussion points from talk

- *Comment:* Point made that local councils have managed gulls (e.g. licenses granted to destroy nests etc.), such that all the accessible nests cannot be reached. This has hindered the ability to compare gull diets on gulls breeding in natural (off-shore island) environment versus the urban environment, within one of BTO's research projects.

- *Question: what could be a comparative site in a coastal population of 'urban' gulls to compare with the Isle of May data?* Suggestions were made.

- *Comment:* To distinguish between marine versus terrestrial in chick/adult diets – could use Stable Isotope Analysis (SIA). Would still be tricky to distinguish whether the 'marine' source came from fish foraged at sea, or from the urban environment. Other potential techniques that could be used were discussed (e.g. fatty acid

signatures). Point made that using chemical techniques to distinguish between diets might also require collecting multiple prey items and comparing signatures to that.

2.3.2 Gull foraging and research needs (Ruedi Nager)

We aim to look at some of the basic aspects of gulls' foraging behaviour that we have learnt from tracking studies. There is a good geographical spread of tracking studies mainly for HERGU, but very few studies for GBBGU. During the breeding season there are clear differences in range (maximal distance moved away from the colony) between colonies and species. Within HERGU colonies, the distribution of the foraging distances roughly conforms with the expected decline in frequency to the inverse of the squared distance. However, foraging trips of HERGU do not encompass all directions around the colony equally. The actual distances and bearings observed at any specific colony are most likely driven by the availability of resources in the colony's environment.

Within a colony different individuals may also specialise on different resources. Foraging range of a colony will also be constrained by neighbouring colonies; individuals from neighbouring colonies seem to visit different destinations, and a particular foraging spot is more likely to be visited exclusively by birds from only one colony rather than from several colonies. This observation challenges the current practice to apportion birds at a site to all surrounding colonies based on their distance from the proposal site.

Finally, in the non-breeding period individual HERGU spread out over a much larger range than during breeding although each individual may occupy a relatively small home range within the non-breeding distribution. This is posing challenges in assigning connectivity of breeding populations with particular proposal sites during the non-breeding season.

2.3.2.1 Discussion points from talk

- *Comment:* Within the study, bigger birds were found to forage more commonly on inter-tidal habitats and smaller birds in arable (specifically grassland) landscapes, within the same species.
- *Question: whether any of the observed differences in foraging observed in the work could be driven by sex differences in foraging.* In this case, all but two of the tagged birds were female, so the observed differences were not related to sex.

2.3.3 Differences in gull foraging behaviour/diet (Nina O'Hanlon)

The *Larus* gulls are generalist and opportunistic species, foraging on a huge diversity of resources, influenced by the relative availability of foraging habitats within their foraging range. The resources these gulls exploit may therefore change annually, seasonally and even daily. Investigating the diet of gulls can provide useful information on the use of onshore, inshore and offshore habitats, which may help establish whether the foraging areas of individuals from a population overlap with onshore or offshore wind farms. GPS tracking of gulls provides valuable information about the foraging strategies of individuals and data. For example, on the proportion of trips or time spent in different marine and terrestrial environments, as well as specific locations to determine if individuals' foraging ranges do overlap with existing or proposed wind farms. However, the number of individuals that can be tagged is often small and therefore may only represent the foraging strategies of a small proportion of individuals within a colony. Investigating the diet of gulls may compliment tracking data by providing information on a greater proportion of individuals within a colony.

Gull diet can be investigated in a number of ways. Two relatively non-invasive options are: collecting regurgitated pellets and collecting feather samples, from chicks or adults, for SIA. HERGU pellets collected from breeding colonies in south west Scotland and Northern Ireland in 2013 and 2014 revealed high consistency in the type of resources (offshore

marine, intertidal or terrestrial) consumed between and within years (incubation versus chick rearing). However, this consistency was not seen between years for several LBBGU colonies in Germany, highlighting how variable consistency may be between locations. Regurgitated pellets can provide useful information on gull diet and resource use at the colony level.

To explore variation in foraging strategies at the individual level SIA may be more useful. The moult pattern of *Larus* gulls is relatively well-understood. Therefore, we can sample different feathers from an adult gull to investigate resource use during both the breeding (brood patch and inner primary feathers) and non-breeding season (head and outer primary feathers). Carbon and nitrogen isotopes can be used to reveal where along a gradient between terrestrial and marine habitats, and from what trophic level, resources are consumed. SIA of feathers can then be used to investigate consistency of resource use between and within years, as well as between the sexes, individuals of difference sizes, breeding status or juveniles, immatures and adults. SIA of feathers can also be used to explore the niche width of resources being used by gulls at the individual and colony level, to establish the level of specialists and generalists within a population. Investigating the diet or resource use of gulls within populations of interest may therefore provide complimentary data to tracking data to determine what foraging habitats are being used, which might help in apportioning the risk to gulls from onshore and offshore wind farms.

2.3.3.1 Discussion points from talk

- *Question: whether Sulphur would be useful to use in future SIA studies as it's a good indicator for marine?* Some debate as to whether it has any more use compared to C and N, as the standard stable isotopes used for dietary analysis.

- *Comment:* SIA in guano has been used – could be a good technique to answer the question of diet in a non-invasive way.

- *Comment:* Mentioning that gulls are associated with fishing vessels – another factor to consider in their foraging repertoire.

- *Question: on foraging ranges – do these differ when over sea compared to inland?* Something that should be considered for future updates on Thaxter *et al.* (2012).

- *Comment:* Colonies where individuals foraged on intertidal prey more in this study had a higher breeding success than those foraging more on terrestrial items, which was largely grain, and some domestic refuge, as well as intertidal invertebrates.

2.4 Presentation session 3: European-based research

2.4.1 Gulls in northern Germany: population trends, foraging ecology and interactions with wind farms (Stefan Garthe)

<u>Population trends:</u> Numbers of gulls breeding along the German North and Baltic Seas have shown enormous changes over the last 75 years. At the North Sea coast, only HERGU bred until the 1950s while BLHGU, COMGU and LBBGU settled in this area later. The latter three species showed strong population increases, especially BLHGU and LBBGU that are now the two most numerous breeding gull species in this area. At the Baltic Sea coast, BLHGU and COMGU were the only two numerous species while HERGU started to settle and increase in the 1960s and LBBGU after 2000. Species-specific trends are remarkably different for the two sea areas.

Foraging behaviour: Recent studies based on tracking devices have revealed new and detailed insights into the foraging behaviour of Common, Herring and Lesser Black-backed Gulls during the breeding season. COMGU from the largest colony at the German Baltic Sea coast were almost exclusively foraging inland. They preferred to forage on vegetation that grew late in the season such as corn while they tended to avoid high vegetation such as winter cereals and rape. HERGU from a few colonies in the Wadden Sea performed both intertidal as well as terrestrial foraging trips, with colonies further away from land focusing more on intertidal food. The non-native American razor clam (*Ensis sp.*) has become one of the major prey sources. The largest data set is available for LBBGU. Birds from the different colonies showed mostly colony-specific foraging zones and little overlap with neighbouring colonies. In all colonies located along the coast, birds were exhibiting both terrestrial and marine foraging trips. The major terrestrial habitats used for foraging were grassland and corn fields, with a tendency to forage on fields with vegetation starting late in the season. At sea, foraging activities of LBBGU were most intense in areas with high fishing intensity, specifically shrimp trawlers at the outer edge of the Wadden Sea and beam trawlers at larger distances from the coast. Maximum foraging radius of breeding gulls were 40 km for COMGU (one colony, Baltic Sea), 55 km for HERGU (3 colonies, North Sea) and 139 km for LBBGU (6 colonies, North Sea).

There are some data sets on diet available that show changes in the foraging behaviour over time. In all three species, LBBGU, HERGU and COMGU, terrestrial food items (mainly earthworms and insects) increased over time while food from the marine zone decreased quantitatively.

Interactions with wind farms: Quantitative information on responses of gulls to onshore wind farms are not yet available. In a preliminary analysis, HERGU showed signs of partial avoidance of wind farms. More data are available from offshore wind farms, yet without any specific analysis finalised. All the three large gulls show neither obvious attraction nor avoidance patterns. However, their flight heights overlap considerably with those of the rotor-swept zone of the wind farms.

2.4.1.1 Discussion points from talk

- *Comment:* discussion of what potential new work could be looked at with the extensive German dataset in terms of wind farms and gulls. There is now tracking/gull distribution data from pre-wind farm construction and post-wind farm construction available for analysis.

- *Comment:* further work could look at distribution of fishing vessels, which may aggregate around the wind farms – these may even attract the gulls.

2.4.2 Factors influencing the daily movements of gulls on land and at sea (Judy Shamoun-Baranes)

Different external and intrinsic factors may influence the daily movements of gulls. Understanding drivers of variation in individual movement patterns within and among gull colonies can have important implications for mitigating negative impacts of human activities on gull populations. Using the UvA-BiTS tracking system, the daily movements of LBBGUs and HERGUs have been studied throughout an individual's annual cycle since 2008 and 2011, respectively, in the Netherlands. We combine GPS tracking and tri-axial acceleration measurements with information on environmental conditions to infer daily activities of gulls, including their flight modes. The aim of this presentation is to provide a brief overview of ongoing research and highlight potential areas of interest for wind energy risk mitigation.

LBBGU are considered dietary generalists. However, individuals within a breeding colony on the Wadden Island of Texel varied among each other in their habitat use along a continuum of almost exclusive use of marine habitats to terrestrial specialists. Time spent at sea, trip duration, and trip range (maximum distance from the colony) were all higher for males than females. Trip characteristics were also influenced by breeding state and males and females travelled further from the colony during chick care compared to incubation. We also show that individuals have specializations which are finely tuned in space and time to human activities for example, females which specialize on fishery discards in the Wadden Sea. While mean trip range (approximately 25 km) appears to be similar among several colonies, variation is often very high within a colony. When away from the colony, gulls may spend hours at a time resting at sea, even during active breeding. On average LBBGU spent 30% of their time in flight, using predominantly flapping flight and less than 30% of their flight time was spent soaring. The propensity to use soaring flight is influenced by atmospheric conditions and the underlying landscape. For example, over land gulls select areas where soaring conditions are favourable, and wind conditions and landscape features create flight corridors.

Increasingly, studies are revealing how diverse gull movements are and we are able to study movements and gull behaviour year round. We are just starting to understand the drivers of variation in movement patterns within and among colonies. Increasing awareness and incorporation of knowledge regarding variation in time spent at sea vs on land, in trip ranges, and in behaviour can be very valuable and likely integrated into guidance, regulatory processes and mitigation for wind energy.

2.4.2.1 Discussion points from talk

- *Comment:* researchers working together can help us get a better handling of colony-specific patterns. This would be really useful to take forward.

2.4.3 From foraging behaviour to population-level effects: current results and research gaps (Rosemarie Kentie)

In the Netherlands, breeding pairs of HERGU are decreasing while LBBGU have increased rapidly in the 1970s after they settled in the first half of the 20th century. Now LBBGU haved seemed to stabilize in numbers. Both these are generalist species, of which individuals are diet specialists. Therefore, those individuals that are most at risk from offshore wind farms, are the ones that are specialised on marine food. To understand the effects of wind farms on population growth rates, it is thus key to understand the effects of diet specialisation on population dynamics.

In 2006, Dr Kees Camphuysen at NIOZ Royal Netherlands Institute for Sea Research started a study on the demography and foraging ecology of HERGU and LBBGU in a mixed breeding colony on the island Texel. Previous results show that individual HERGU that forage on marine resources and human waste rear more offspring than those foraging on coastal bivalves. This differs with HERGU breeding in Scotland, however, as here foraging on bivalves produced most offspring. Whilst there may be regional differences, variation may also relate to the relative quantity, quality and accessibility of the food resources across different study sites.

We are going to study the effects of different diet specialisations on fitness (reproduction and mortality) and include how diet specialisation is formed within individuals to be able to construct an advanced population model. With this model based on empirical estimates, we will investigate effects of changing environments on population dynamics and structure, including the effects of increased mortality due to wind farms.

2.4.3.1 Discussion points from talk

- *Comment:* Population dynamics of species is important to understand when predicting effects of wind farms on gulls.

2.5 Summary of references provided within the presentation sessions

A summary of academic research references used in the talks is provided within the reference list in Section 7.2. Additional websites which were referenced within the talks are provided below:

- EIA guidance document: CIEEM (2018) Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, freshwater, coastal and marine. https://cieem.net/resource/guidelines-for-ecological-impact-assessment-ecia/
- Further information on Marine Scotland's ScotMER evidence gap mapping: https://www.gov.scot/Topics/marine/marineenergy/mre/research
- HRA handbook: Habitats Regulations Assessment Handbook https://www.dtapublications.co.uk/
- Publication list on tracking projects which have used the UvA-BiTS tags: http://www.uva-bits.nl/publications/
- Tracking maps from Judy Shamoun-Baranes' work can be viewed online at: http://cdb.io/1PGRqS6
- Seabird 2000 data: http://jncc.defra.gov.uk/seabird2000
- Scottish Marine Energy Research (ScotMER) website, including Ornithology Evidence Map https://www.gov.scot/Topics/marine/marineenergy/mre/research

3. DISCUSSION GROUP SESSIONS

3.1 Session 1: Casework example:

Each group was presented with a scenario, based on the map (Figure 1) and information provided (Annex 3a). Discussions revolved around 4 main questions (see below). Breeding herring gull is a qualifying feature at each of the SPAs (the population sizes given for the SPA are purely illustrative). Summaries of each of the group's discussions for their specific scenarios are provided in Annex 3b. General points which came out of the casework example are summarised below.

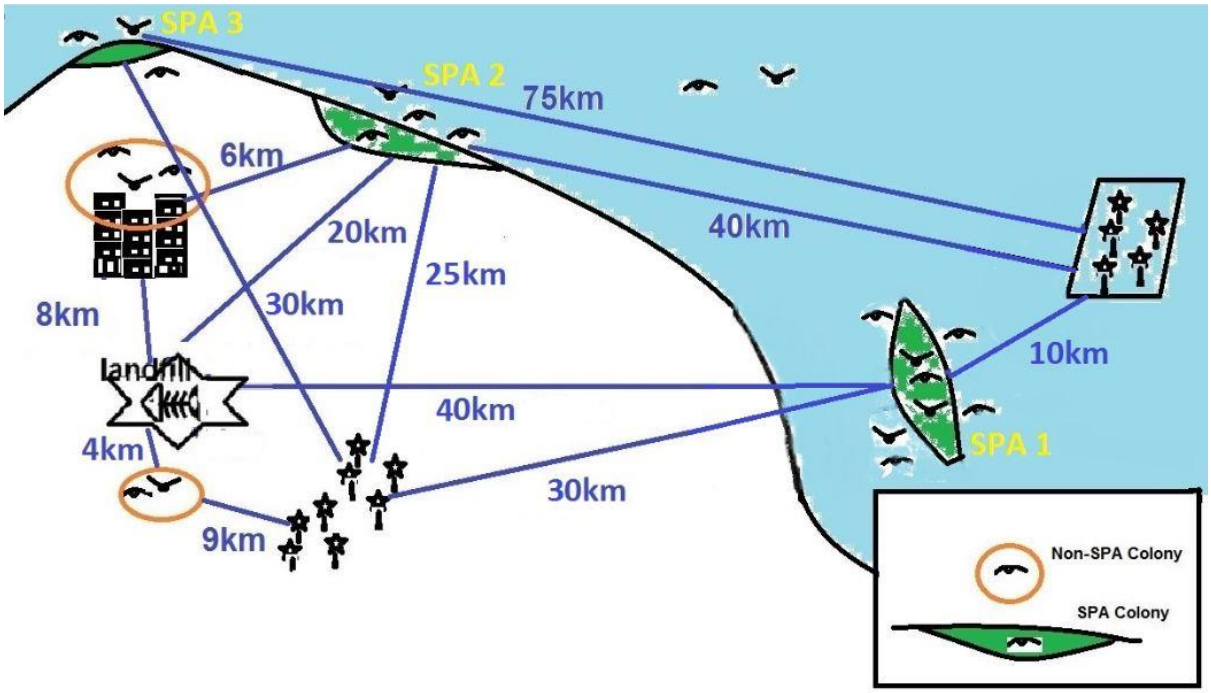

Figure 1. Map provided discussion group session on a fictional piece of casework.

Questions for the group to focus on for their scenario:

1. Establish which SPAs and non-SPAs show connectivity to the proposed offshore wind farm and onshore wind farm. Give brief reasons as to why and note down any which you would need further information on.
2. Assign proportions of birds recorded from survey data to colonies identified with connectivity, providing an explanation of why/how the group decided on apportioning.
3. Work out possible number of collisions that would be attributed to SPA 1 for adult birds. Actual numbers are not as important as the approach you used to get there.
4. How would you approach a cumulative assessment between onshore/offshore wind farm for SPA 1?

3.1.1 General Points from Casework example:

There is no 'one size fits all' approach available for apportioning offshore versus onshore foraging in gulls; it is a complex issue. Some general suggestions were made:

General recommendations on casework approaches:
1. Suggestion of moving away from an Excel approach to one which can build uncertainty and variability into the process and derive probabilistic outputs – as has been done for CRM, for example using R. Disadvantage means more complex modelling ability is required but a 'Shiny App' style interface could be developed. 2. Need to incorporate empirical and colony specific data into apportioning as correction factors or to validate our theoretical input data and model approaches. This could include factors such as colony size, any tracking information from the colony (or colonies), flight line data in the absence of other data, diet, etc. 3. Meta-analysis of data and reports from people working with gull datasets should take place to see if there are general patterns which emerge for gull foraging and diet. We need information on applicable behaviours which can help inform our advice when e.g. tracking data isn't available for the specific colonies in question. 4. Variability across regions in relation to foraging ranges should be taken into consideration. This may also be influenced by differences in population trends between the regions, which need understood based on up to date census information. 5. More thinking on juveniles/immatures, sabbaticals and non-breeding season gulls is required. 6. Concept of thinking more about the possible habitat types over which the gulls could forage and any potential 'hot-spot' areas for them (e.g. landfill site, etc.), as part of a site's assessment. 7. Connectivity – could consider tracking from the site of interest rather than from only the gull colony as a way of establishing where the gulls are coming from. Though acknowledged this may be logistically difficult. 8. It was noted that in almost all cases, onshore wind farms are not considered for offshore wind farm casework, and vice versa. Considered thinking for cumulative impacts of offshore and onshore developments should take place in future assessments. This is important for future consideration given that gulls use both environments, potentially in different ways and at different times of year.

3.2 Session 2: Guidance and knowledge gaps

3.2.1 Identifying existing research which would help inform guidance document on combining onshore and offshore assessments

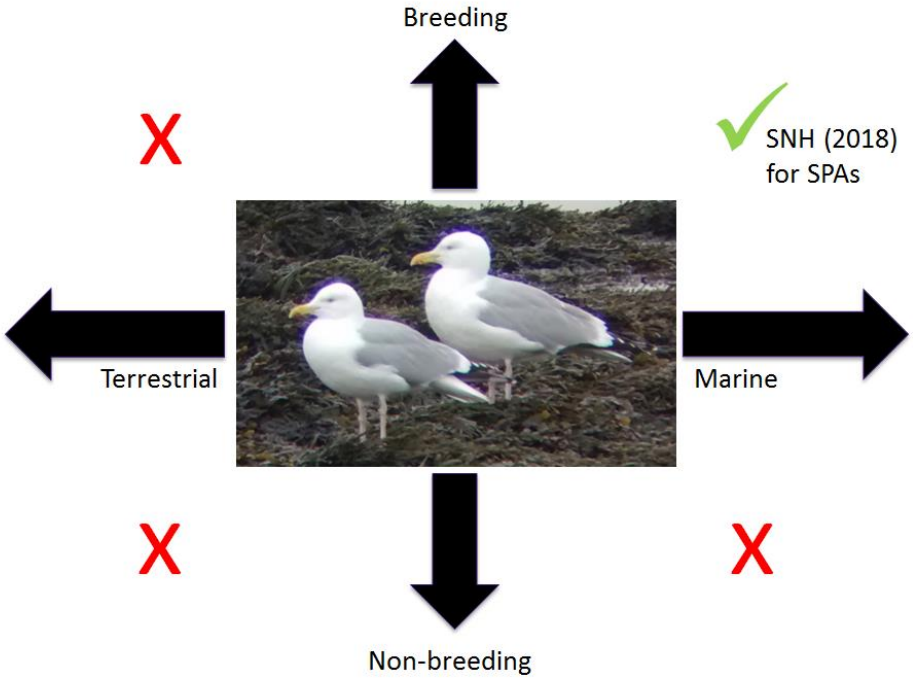

Figure 2. Summary of where we currently have published guidance for marine birds and apportioning. The tick represents where we do have guidance and the cross represents where formal guidance is still lacking[8] (image produced by G. Cook, Natural Power).

A number of recommendations were made on possible approaches for the combined onshore/offshore guidance document for gulls, and information which could be included. The points made are summarised below.

Guidance recommendations:
• Specific guidance on apportioning for *Larus* gull species to avoid (or at least reduce) over/under representation in onshore and offshore assessments is requested by ecological consultants. • An interim position on apportioning would be useful, then later guidance on apportioning completed. • Guidance should include how to incorporate empirical evidence – a Bayesian approach was suggested as a possibility. • Apportioning during the non-breeding season to be included. • Onshore apportioning to be included.

[8] It is acknowledged that for marine developments in the non-breeding season an advice note was produced by JNCC/NE in 2013 and distributed to developers and consultants. This advice note is no longer in use. Currently, assessments during the non-breeding season for marine casework uses information from the BDMPS in Furness 2015, adapted to fit the English/Scottish casework context accordingly.

Guidance recommendations:
• Incorporating cumulative assessment process into guidance. • Requirements for HRA versus EIA. • Include information on ‘Areas of Uncertainty’ or ‘Areas of Variability’ for example: ○ age structure ○ wintering foraging ranges ○ winter roosts ○ behavioural variability ○ sex differences in foraging ○ flight altitude **Approach for guidance document:** • Joint (UK) approach to apportioning if possible. This would help share best practice between the SNCBs. • Guidance must be visible/accessible – access up to date version online. Important that consultants are made aware of any updates. • Strategic thinking in funding streams – working together is crucial for research and the subsequent input into policy and guidance. • Options for presentation: could think about streamlined system e.g. similar to R Shiny. • Option for how to carry out apportioning: could develop a stochastic approach to apportioning. • Option for how to carry out apportioning: allow the entire foraging range around a colony to be used for apportioning as opposed to only the marine part or terrestrial part, depending on the casework (see Section 2.2.3 for NE example from marine casework using this approach).

The workshop participants gave suggestions of research currently in existence (but not necessarily all analysed), that could help inform a combined offshore/onshore guidance document for gulls. This is summarised below.

Summary of existing research to use in formulating guidance document	Data available to help inform guidance document.	Possible means of taking it forward
Flight altitude data	Analyse existing datasets (some of which are unpublished) on flight altitude which can help inform guidance document (e.g. marine foraging versus terrestrial foraging may occur at different flight heights). Also, existing datasets such as LiDAR data from BTO available via Marine Scotland website can be used for this.	Large scale project ScotMER or JNCC. Possible value in a more strategic survey to collect new data, where required.
Age structure information	Grey literature could help with this e.g. colour ringing data, visual observations.	BTO analysis of ringing data.
Density decay functions in the breeding season	Cumulative frequency curves and proportion of birds found foraging at different distances from their colony have been produced by BirdLife International for some seabird species (not *Larus* species).	Tracking data now available presents an opportunity for new analyses on foraging distribution in large gulls, potentially to produce density decay function curves for gulls for an apportioning option similar to NE's cumulative density approach (see Section 2.2.3).
Bird movements in the non-breeding period	Colour ringing data (e.g. Clyde ringing group) that has been collected over a number of years – would be good to have this analysed. Tagging data (e.g.Tag 'n' Track data, UvA-BiTS data) could also be analysed. WeBS could provide information on important freshwater used by bathing and loafing birds, especially in the NB season which might help determine flight lines/commuting routes for onshore wind farms. It also might help determine	Research commission – university or research body could potentially take this on and work with the colour ringing data and/or the tracking data. Could discuss with BTO if volunteers could be encouraged to record gulls during WeBS counts. (Currently, is optional to record gulls or record a 'not present' or 'not counted').

Summary of existing research to use in formulating guidance document	Data available to help inform guidance document.	Possible means of taking it forward
	where winter roosts are (and ideally how big they are). As recording gulls is only optional in WeBS and counts are undertaken in the day, may miss larger roosting numbers. WinGS – data available on roosting sites, though only a decadal survey (and current one is overdue). Data available from BTO currently includes: LBBGUs at Orford Ness, Skokholm, Belfast, Bowland, Ribble, Walney, Barrow, Forth Islands and Havergate; and HERGU from Walney, Belfast, Copelands, and Bangor.	Funding required for updated WinGS survey
Colony-wide gull tracking data	Meta-analysis for existing tracking data on gulls (e.g. Seabird Tracking database and beyond). Same could be done for non-tracking datasets (e.g. ESAS, WeBS, WinGS). Data available for BS (less for NBS) – could be collated into a central point. This would help assess foraging distributions across a range of *Larus* gull colonies and provide a useful starting point for developers carrying out an assessment.	Research commission; could work in collaboration with an organisation willing to take this forward. University of Amsterdam interested in collating LBBGU for GPS tracking data and carrying out subsequent analyses.
Post-construction monitoring	Collating what we have already and assessing how gulls distribute themselves once wind farms are in situ. Could also assess what methods of post-construction monitoring work best.	Research commission: MS/JNCC could perhaps initiate. Additionally, developers may be able to help with funding research relevant to their region, as part of their post-consent monitoring requirements. European datasets,

Summary of existing research to use in formulating guidance document	Data available to help inform guidance document.	Possible means of taking it forward
		such as those presented in Section 2.4.1, also provide promise if they were to be analysed.
Build upon previous guidance document, specifically for large gull species	Include onshore guidance, non-breeding season guidance within new document. Also reassess the appropriateness of current breeding season guidance for *Larus* species. Advice on cumulative assessment between onshore and offshore wind farm could be included. Ensure up to date links on other relevant reports included in the document, where appropriate (e.g. Furness 2019 report on avoidance rates of HERGU, GBBGU and COMGU).	SNH to lead on taking new gull guidance forward, including comment from other SNCBs with additional experience of specific cases. Work on cumulative assessments is a larger topic also being addressed by JNCC and MS. Could have a workshop specifically on cumulative assessments.
Ensure guidance is visible and that other SNCBs have had the chance to input into it.	Send any new guidance note directly to developers and promote guidance note on twitter, SNH website etc.	SNH to lead on this but a joint approach (UK) is desirable.

3.2.2 Identifying current knowledge gaps in gull foraging behaviour and research required to fill knowledge gaps in gull foraging and assessment for wind farm casework.

Participants were asked to think of knowledge gaps which are currently limiting our understanding of gull foraging behaviour. They were then asked to think of potential research which could be carried out which could help fill the research gap. A general comment was made that we should aim to **quantify uncertainties**, and **capture variability**. The main points from the discussions are summarised below. Further notes taken are provided in Annex 3c.

Monitoring and Survey

Knowledge gap	Possible research to fill gap
Up to date information on gull population trends (abundance), survival rates, breeding success, and colony sizes (including information on emigration/immigration where possible)	• Seabird census data should be able to help with this gap for the breeding period, but is only every 15-20 years. Annual data on abundance and breeding success is key. • New technologies for establishing population estimates could be developed/used. Would require ground-truthing time too. • Continue protected area monitoring to provide current population estimates and demographic rates. • Develop SMP database further to make it easier to search for colony sizes per species. • Long-term commitment is required.
Post-construction monitoring	• Collate what is known on avoidance rates from post-construction monitoring (see Dierschke *et al.* 2016 for European example at the macro avoidance scale; Skov *et al.* 2018, for some information on micro/meso avoidance behaviour). • More data (could be camera-based) on avoidance – empirical data is crucial. If data are to be used in Collision Risk Modelling, it is vital that density estimates are collected alongside camera data (see Bowgen & Cook, 2018). • PIT tag tracking of birds using a network of receivers could be an option (e.g. MOTUS system). Develop technology for radar to pick up.
Winter gull populations	• Overdue winter gull survey (WinGS) – this is required, but needs funding. Surveys have been undertaken once a decade, but last survey was 2003/04-2005/06. • WeBS counts could also provide useful information on gulls. • Could quantify numbers of NB birds back at the colony and see if it changes over time. • Work to update the influx discount which is applied to birds coming into UK waters from outwith the UK (SEAPOP project or similar may have information). • Broader regions of assessment may be required (e.g. North Sea region for NB birds)
Urban and inland gull populations	• Included in the seabird census, but a more regular national census of these populations would be beneficial, or at the very least a representative sample of survey locations in order to inform trends, should a full census prove too difficult financially. No current information on how these populations are faring. • Work has been undertaken by the BTO to review survey methods and design, and for pilot work to support volunteer-based surveys. Recommendations from the latter will be important in determining appropriate monitoring in the future.

Meta populations	• Better understanding of this – could identify source and sink colonies and possible drivers for this. • Could create links to habitat mapping.
At sea distribution	• Understanding where birds come from that are at wind farm sites – could work with developers to track birds from the wind farm site, rather than from the colony. It is acknowledged this would be difficult to carry out. (Also links to ScotMER OR.09). • Uncertainty in at sea survey data and behavioural variability under different conditions. A Scottish government-funded BTO project on understanding seabird behaviour at sea will look at variability in behaviour, diurnally and also in relation to a limited range of weather conditions for lesser-black back gulls only (of the large *Larus* species). Could extend to other *Larus* species.

Foraging characteristics:

Knowledge gap	Possible research to fill gap
Foraging range information/foraging distribution	• Work to update Thaxter *et al.* 2012 foraging range information, which takes into consideration foraging variability (e.g. marine forager versus inland forager, seasonal differences, diurnal differences, colony differences, regional differences etc.). A lot of usable data already collected for gulls could be collated. Scottish Government commissioned study by BTO on seabird behaviour at sea, may also provide relevant information for this for some species. Crown Estate funded work is being undertaken by BTO and NIRAS to help update Thaxter *et al.* 2012, for breeding seabird species and to incorporate tracking data directly where possible. • Develop maps for gulls similar to Wakefield *et al.* 2017 data, could then link to an apportioning tool. Marine Scotland is working on an apportioning tool which could be updated to incorporate such mapped distributions. • Development of appropriate 'foraging range' buffers to ascertain connectivity. Could be colony specific for onshore and offshore. • Citizen science project encouraging reporting of colour-ringed gulls could provide data on foraging ranges/locations, and foster a public interest in gulls.
Inter-colony variation	• Need to better understand what drives inter-colony variation and interactions, and whether it differs between the seasons. Think about how we can use this to determine what is happening at less well-known sites. • Identify regional trends in foraging behaviour. Should cross colony comparisons take place, there is a need to have standarsiation in data extraction for tracking data if being used for different projects. • Meta-analysis of existing data on: colonies

Knowledge gap	Possible research to fill gap
	regarding foraging, diet preferences, NB dietary data – needs analysis. • Spatial segregation has been noted for gulls and other seabird species (e.g. Corman *et al.* 2016, Bolton *et al*. 2018). It is possible that apportioning may overestimate the impact for one colony but underestimate it for another colony if spatial segregation occurs. Further analysis of available tracking data may help address this, but likely to be limited regional coverage available currently. Should segregation be occurring, would affect the apportioning advice.
Non-breeding period	• Combination of tracking and dietary analysis (SIA) to understand non-breeding foraging better for gulls. This could include carrying out a meta-analysis of exiting data for gulls where known. • Need more information on how far away NBs are from their breeding population SPA and what other NBs come across from Scandinavia etc. (Also links to ScotMER OR.3). • Tag effects on longer-term tracking need considered. Non-remote downloading tags (e.g. GLS) useful as smaller, with lower impact on birds to carry. Could compare between the smaller tags and the larger remote-download tags. • Possible development of improved means of attaching and detaching tags. • Developing biometrics and SIA methods of identifying origins of winter birds. • Better understanding of population relevance of migratory patterns required, for consideration of cumulative effects.
Foraging behaviour	• To determine representative foraging behaviour could carry out a power analysis or apply expert knowledge. Need to decide what is a representative sample (e.g. numbers of individuals, colonies, regions, etc.). See Thaxter *et al.* 2017 as example for lesser black-backed gulls. • If UK-wide guidance is being produced, consideration of e.g. Dutch, Belgium, Danish etc. birds need to be considered too. • Could try to come up with predictors of broad foraging strategies/behaviours – modelling may help with this. • Flight behaviour information – collate what we know on this in terms of spatial and scale, and flight speed. • Consider how changes in resource landscape affects behaviour.
Understanding urban/inland gulls foraging behaviour	• Track urban gulls living near a coastal environment/carry out diet sampling. Would help in understanding how often gulls from non-‘natural’

Knowledge gap	Possible research to fill gap
	sites may forage at sea (see Washburn *et al.* 2013 for study in USA on gulls at a coastal-urban interface; Rock *et al.* 2016 for breeding season tracking of 4 roof-nesting herring gulls). BTO is carrying out some urban gull tracking work in England, Wales and Northern Ireland on a small numbers of LBBGU and HERGU.
Understanding individual variability	• Review existing research and source material to establish what we know (literature review). Species specific, between and among individuals and between colonies.
Immature bird movements	• Analysis of colour-ringing data could provide useful information on post-natal dispersal and movements before reaching breeding maturity. • Using tracking data at higher resolution, e.g. UvA-BiTS tags - increased resolution in wind farm.
Dietary variation	• Could relate dietary data to habitat mapping. • Further studies relating diet to breeding success at a pair level over time. Requires longer term studies.
Analysis/modelling	• More robust, evidence-based correction factors required - could develop Bayesian framework approach. Or have a generic model but incorporating empirical data. • Non-excel apportioning tool (akin to RShiny App).

Species deficiencies:

Knowledge gap	Possible research to fill gap
GBBGU and COMGU	• GBBGU identified as a species with deficient information on foraging areas. Some tracking work has taken place (e.g. commissioned by EDPR for the Moray West/West wind farm applications see Section 2.2.2; T. Evans work in Sweden – see Section 2.2.5; and European work – see Section 2.4.1). Further tracking work would be a benefit for this species. PhD project would work well. Additionally, developers may be able to help with funding tag research relevant to their region, as part of their post-consent monitoring requirements. • Further understanding of COMGU foraging required - very few foraging range studies have been carried out. • These species to be prioritised for further work on foraging ranges and distribution.
Smaller non-*Larus*, wintering gulls	• Non-breeding little gulls and black-headed gulls – huge gap in our understanding. • No national population estimate for little gull – should be rectified.
Winter roosts	• Updated winter roost information required.

Knowledge gap	Possible research to fill gap
Variability	• Need to understand what drives variability between individuals and whether there are species-specific foraging characteristics. Could feed into literature review (see above in foraging characteristics). • Data required from a better geographical spread and representative range for each species (e.g. not just east-coast UK tracking data).
Sabbaticals	• Need empirical data to support sabbatical correction factor for species. Investigate if this is stable in time and between colonies. • Understand more on where sabbaticals go and the frequency and drivers for sabbaticals.
Age classes	• Work on obtaining survival rates for different age classes, per species. • Processes effecting demographic rates of sub-adults may have a large influence on population trajectories (see Genovart *et al.* 2018). Could question the general approach currently taken to apportioning to breeding adults and PVA modelling. Work presented in Section 2.4.3 by R. Kentie will be informative for this topic. In the longer term, may be possible to use more sophisticated models for HRA assessments.
Influx discount	• Update influx discount data on all gull species. Take into account that it will vary depending on region.

Factors affecting gull populations:

Knowledge gap	Possible research to fill gap
Effects to impacts: understanding relative impacts of different pressures	• Work on understanding if wind farms effect gulls at a population level – displacement, collision, barrier. • Understanding comparative/relative impacts of different pressures – e.g. between wind farms versus landfill closures, discard bans, gull controlling etc. • PhD research currently ongoing (e.g. Liam Langley looking at land-use changes, Dutch PhD students) should help with this question but it requires wider thought.
Understanding effects of gull control measures on gull populations	• Need to understand the demographic impacts of gull control. Mitigation of wind farm impacts could be offset by reduction of gull control mortality levels. • Research required on impacts of gull control – and a review of current gull control measures. • Engage with public with positive stories and information about gulls – Tag 'n' Track project as an example[9] - rather than them being perceived as 'pest species'.

[9] http://clydemuirshiel.co.uk/tag/tag-n-track/

Knowledge gap	Possible research to fill gap
Drivers for carrying capacity and drivers for decline	• Population modelling required.
Long-term consequences of wind farms.	• Research required on this, e.g. on how prey/resources could be effected.

Data sharing:

Knowledge gap	Possible research to fill gap
Data sharing between countries	• More communication required. • Review similarities/differences in approach and the implications for EIA/HRA. • Could have data sharing agreement between countries. • Better data sharing across developments (e.g. German database of all development data is given at the time of application to federal agencies), agencies (SNCBs), and between onshore and offshore caseworkers.
Multi colony analysis of ecological traits	• UK and international collaboration can inform variation between colonies, which can be used to inform guidance and policy.
Diet data	• Could have a shared platform for diet data.

4. SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS FROM THE WORKSHOP

There were many useful suggestions as to how to proceed with the next stage of producing a combined onshore/offshore gull guidance document and more generally for ways in which we can improve our understanding of gull foraging behaviour. There were also important points made on gull population dynamics and how this is crucial to understand when making any impact assessment for gulls. Some key points have been summarised below.

1. Gull population dynamics:

- Factors affecting gull populations and the importance of offshore and onshore wind farm impacts on gull populations, relative to other stressors/pressures.
- Gull population management and if reduction in gull population control could be used as mitigation of wind farm impacts, in Scotland.

Recommendations:

a) Discuss with Scottish Government if a review of the impacts of gull control/ management practices on gull populations could be initiated. Could link to ScotMER evidence gap OR.32.

b) Collate what is known about current gull control practices and extent in Scotland. Important to involve licensing team members with the data collation.

c) Commission research on gull population dynamics. Could link to ScotMER OR.02, 12, 23, and 26 (if latter two are extended to include gulls).

2. Surveying and monitoring:

Colony/roost site survey data:

- Monitoring of gull populations at SPA and non-SPA colonies. Fundamental to have up to date site/SPA population estimates and, where possible, a better understanding of non-SPA population estimates to help inform apportioning. This is required for all wind farm gull assessment work.
- Winter gull survey: a repeat of the 2003/04 survey is overdue.
- There is a lack of information on urban gull populations.

Movement/Foraging survey data:

- Post-construction monitoring for gull mortality and non-lethal effects due to wind farms.
- Analysis of colour-ring datasets.
- Use of technology to look at foraging movement at night as well as during the day.

Recommendations:

a) Link future work to ScotMER evidence gap OR.11: Baseline colony population data.

b) Commission research on existing colour-ring datasets currently available in Scotland.

c) Scope potential for volunteers to help monitor inland colonies – initiatives within the SMP potentially could be developed.

d) Undertake further analysis of post-construction monitoring required to help inform future impact assessments (both UK datasets and European datasets).

3. Foraging variability:

- It was clear through the discussions during the workshop that there is a huge amount of variability in gull foraging behaviour, be it diurnally, seasonally, annually, breeding state, colony-specific, regionally, or between individuals.

- Further work on the non-breeding foraging of large gulls has been identified as a knowledge gap. Whether gulls undertake longer migrations (such as individual LBBGUs) or remain in UK waters (more common in HERGUs), there is a need to understand what proportion of gulls could come into contact with wind farms over the non-breeding period.
- There is a particular lack of information on urban gull foraging behaviour over both breeding and non-breeding seasons. In turn, we lack information on apportioning effects to non-SPA populations but also how SPA and non-SPA populations may interact in urban environments.
- Species-specific deficiencies in knowledge are apparent, particularly for great black-backed gulls and common gulls, due to the lack of tracking studies. Non-*Larus* species (little gulls and black-headed gulls) also mentioned as lacking foraging and distribution data.

Recommendation:

a) Conduct a meta-analysis of distributional data (tracking and ringing data) from across many colonies. This would substantially help with seeing if any general foraging patterns emerge. Would also help our understanding of where spatial segregation occurs for gull foraging areas.

b) Apply technology to look at foraging movement at night as well as during the day.

c) Look to commission future research on species with deficiencies, e.g. trial of GBBGU year-round tagging.

d) Many of these gaps in knowledge could feed into ScotMER (e.g. OR 02, OR 03, OR 04, OR 07, OR 08, OR14, OR 16[10]). Ensure the recommendations from this report are included in the next ScotMER review process.

4. Habitat and prey data

- Regional differences in gull diet (e.g. terrestrial-based diet versus marine-based diet, and/or anthropogenic food sources versus 'natural' prey sources), as a result of individual behaviour differences being influenced by different resource landscapes.
- Further understanding required on distribution of foraging habitat inland.

Recommendation:

a) Analyse land-use maps to determine potential gull foraging areas.

b) Conduct a meta-analysis of gull diet from previous studies to help reveal general patterns.

c) Commission research on habitat and prey distribution, ensuring data from recent and current PhD projects on gull diets and foraging is included (e.g. Nina O'Hanlon, Rebecca Lakin, Liam Langley, Anouk Spelt).

5. Guidance document:

- Combined onshore/offshore gull apportioning guidance document for casework.
- Joint (UK) approach to apportioning, if possible.

Recommendation:

a) Write apportioning guidance including onshore and offshore distribution and covering both breeding and non-breeding seasons.

b) When guidance document is being drafted ensure the other SNCBs can comment on it should they wish.

[10] See https://www2.gov.scot/Topics/marine/marineenergy/mre/research/ornithology for link to details on ornithology evidence gaps and Section 2.2.5 in this report for more detail on ScotMER.

c) *Look more closely at how NE have dealt with gull apportioning casework recently*.

6. Public involvement:

- Public perception of some, particularly larger, gull species, is still largely negative in certain areas. This can lead to potential conflict situations and may in some cases lead to more gull control licences being requested in certain areas (which also links to gull population dynamic knowledge gap).
- Citizen science contributions to gull studies.

Recommendation:

a) *Encourage gull researchers to use the Clyde Muirshiel Tag 'n' Track*[11] *work and the Bristol Urban Gull project*[12]*, as an inspiration for engagement of local communities and the public with their work.*

b) *Review where areas of conflicts are arising and why that particular habitat is so attractive for gulls, could help inform our information on gull foraging (links to habitat and prey knowledge gap).*

c) *With other SNCBs be more proactive with press releases when gull research has been commissioned and ensure positive, interesting stories about gulls are put into the media.*

d) *Design a project where citizen science could help gather information on gull relative abundance and foraging behaviour which can in turn help inform guidance and advice.*

[11] Further information see: http://clydemuirshiel.co.uk/things-to-do/widlife/tag-n-track/teamgull/
[12] Further information see: https://twitter.com/urbangulls?lang=en

5. NEXT STEPS

- **Interim guidance.**
  It was suggested that interim guidance on gulls be developed before the full guidance can be put together, which is something SNH will consider. SNCBs should discuss the feasibility of having a joint guidance document across all SNCBs. Furthermore, discussions between terrestrial and marine caseworkers should also take place. Currently, any advice on apportioning for gulls at either an onshore or offshore wind farm site will still be given on a case-by-case basis. In the absence of further information on where the gulls come from, the advice we provide will still be based on a precautionary approach.

- **Literature review of gull foraging behaviour.**
  This was something that was suggested during the workshop and will be considered as a useful next step. This could be ideal as a Masters dissertation which could be published or turned into a report. Potentially could have an SNH graduate placement to work on this (see below). A species account per *Larus* species could summarise what is known on e.g. foraging behaviour between different regions and between nesting habitat types (e.g. inland, coastal, offshore island), prey types consumed within and between colonies etc. This would be a useful starting point for determining whether any general patterns emerge from current literature, and whether apportioning techniques informed by regional differences in gull foraging behaviour, could take place.

- **Graduate placement student**
  Following the workshop, SNH put forward a proposal to have a graduate placement relating to the development of a combined offshore/onshore guidance document, with specific regard to potentially carrying out the much-needed comprehensive literature review. This has been rejected for the 2019/2020 graduate intake, but could be looked at again in the near future.

- **International collaboration**
  SNH is happy to be collaborating with a proposal put together by the University of Amsterdam to look at pooling data sources on gull foraging traits (LBBGU data only so far) in relation to apportioning impacts for wind farms. SNH will provide help with the policy context and impact assessment aspects of the project.

- **Tracking work commissioned**
  The BTO has been commissioned to undertake a large LBBGU tracking project on the Forth Islands SPA (funded by BEIS). SNH has also funded a number of HERGU tags. Fieldwork will be carried out in summer 2019 and 2020. The data retrieved will feed into our understanding of gull foraging behaviour, specifically in the Lothian and Fife region, where several pieces of casework for offshore wind farms have recently taken place.

- **Prioritise list of recommended research and monitoring requirements**
  Ideally this would be carried out through on-going collaboration with attendees at the workshop and includes identifying sources of funding and ways of taking forward recommendations. Collation of identified evidence gaps not currently included in the ScotMER evidence maps would be useful to inform future versions of evidence map.

- **Foraging range update of data**
  The BTO has been commissioned by NIRAS to update Thaxter *et al.* 2012. It is suggested that better differentiation in gull foraging ranges be included within this project, depending on where the data relates to (e.g. more onshore foraging, or more

offshore foraging). This needs to provide two foraging ranges for each gull species; marine foraging ranges as distinct from onshore foraging ranges. Work is being carried out on LBBGU with University of Amsterdam (see International collaboration above) which could also usefully feed into this project should timespans match.

- **Workshop on cumulative impacts**
  It would be good to ensure further thinking of cumulative impacts is considered for gulls. As yet, no funding has been secured to progress a windfarm cumulative effects database but JNCC and the other SNCBs see this as a priority piece of work, not just for gull species. In addition, understanding the cumulative effects of windfarm related mortality in relation to other drivers of population change for gulls (such as loss of food sources, gull management and control measures and persecution etc.) has been identified as one of the key research needs. Work on this could work well as a workshop – possibly JNCC/SNCB led, but also further communication with researchers in academia who are working on population models for gulls.

- **Presentation of work at CWW conference**
  SNH will present the conclusions and recommendations from this workshop at the Conference on Wind Energy and Wildlife impacts (CWW). Natural Power are involved in co-ordinating of the conference. The intention is to raise more awareness of how crucial it is for both onshore and offshore caseworkers to work together and how important collaboration from developers, consultants, policy-makers and researchers is in tackling a complex problem.

6. CONCLUDING REMARKS

The workshop demonstrated that there is huge value in bringing together specialist experts to help inform future policy and advice decisions. More collaborative working would help reduce some of the identified knowledge gaps and help future development. For example: developers and researchers sharing bird survey data; SNCB caseworkers (both within and between organisations) sharing approaches to complex gull casework with one another (both onshore and offshore); and researchers communicating their work to advisory and government bodies such as SNH and Marine Scotland. Government bodies should also communicate what research is required to inform their policy needs with the academic research community. In addition, UK research bodies and advisory agencies can look further afield to learn from European colleagues who may have tackled the same problem, especially given the wealth of research carried out by European researchers.

To tackle such a complex issue as gull foraging and their potential interactions with renewable developments both onshore and offshore, further collaborative thinking and working in this area is essential.

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ANNEX 1: WORKSHOP AGENDA

Time	Name	Institute	Topic
09:00-09:30	Registration, teas and coffees	All delegates	
09:30-09:40	Lucy Quinn/Bob Furness	SNH	Welcome, workshop aims & brief background
Policy context			
09:40-10:00	Helen Wade/ Matt Burnett	SNH	SNH examples of gull assessment casework in Scotland.
10:00-10:20	Alex Banks	Natural England	NE examples of gull assessment casework in England and recent research.
10:20-10:40	Graeme Cook	Natural Power	Gull assessment – A consultant's perspective
10:40-11:00	Tom Evans	MSS	Research frameworks in Scotland. Research from a wider context.
11:00-11:20	TEA BREAK		
UK-based research			
11:20-11:40	Liz Humphreys	BTO	Gull tracking research and wind farms
11:40-12:00	Ruedi Nager	University of Glasgow	Gull foraging and research needs
12:00-12:20	Nina O'Hanlon	ERI	Differences in gull foraging behaviour between coastal and inland foragers
12:20-13:00	LUNCH		
European-based research			
13:00-13:20	Stefan Garthe	Kiel University	Gulls in northern Germany: Population trends, foraging ecology and interactions with wind farms
13:20-13:40	Judy Shamoun-Baranes	UVA	Factors influencing the daily movements of gulls on land and at sea.
13:40-14:00	Rosemarie Kentie	NIOZ	From foraging behaviour to population-level effects: current results and research gaps
Discussion group sessions			
14:00-15:00	Discussion session 1 (3 groups: casework example to work through)		
15:00-15:15	TEA BREAK		
15:15-16:15	Discussion session 2 (3 groups: mind-mapping session)		
16:15-16:40	Group summaries – 5 mins each		
16:40-17:00	Lucy Quinn	SNH	Round-up, next steps, end.

ANNEX 2A: WORKSHOP PARTICIPANTS

This is a list of people who attended the workshop on 31st January 2019, who also had the opportunity to comment on this workshop report.

Name	Role and Institute	Workshop role
Dr Alex Banks	Natural England	
Dr Julie Black	JNCC	
Matt Burnett	Renewable energy casework advisor, SNH	
Rob Catalano	APEM	
Graeme Cook	Natural Power	
Dr Tom Evans	Marine Scotland Science	
Simon Foster	SNH	
Prof. Bob Furness	SNH Board	Chairperson, morning
Prof. Stefan Garthe	FTZ, Christian-Albrechts-University of Kiel	
Dr Liz Humphreys	BTO	Facilitator Group 1
Dr Rosemarie Kentie	NIOZ	
Liam Langley	University of Exeter	
Dr George Lees	SNH	Scribe Group 2
Dr Aly McCluskie	Senior policy advisor, RSPB	
Dr Ruedi Nager	University of Glasgow	Facilitator Group 2
Dr Nina O'Hanlon	ERI, University of the Highlands and Islands	Scribe Group 1
Emma Philip	SNH	Facilitator Group 3
Dr Lucy Quinn	Policy and advice officer - Marine ornithology, SNH	Chairperson, afternoon
Dr Alex Robbins	Policy and advice officer - Marine ornithology, SNH	
Dr Judy Shamoun-Baranes	University of Amsterdam	
Dr Helen Wade	Policy and advice officer - Marine ornithology, SNH	Scribe Group 3

ANNEX 2B: WORKSHOP REPORT – ADDITIONAL REVIEWERS

This is a list of people who were unable to attend the workshop but who commented on this workshop report.

Name	Institute
Dr Chris Thaxter	BTO
Dr Aonghais Cook	BTO
Dr Niall Burton	BTO
Dr Glen Tyler	SNH
Erica Knott	SNH

ANNEX 3A: DISCUSSION SESSION 1: CASEWORK INFORMATION

	Information
Herring gull colonies	'Urban' gull colony of rooftop nesters, 'Inland' gull colony near landfill, 2 coastal SPAs and 1 island SPA, shown on map.
Distances	Provided on map. If you think additional ones are required, use an estimated distance.
Herring gull mean maximum foraging range	61.1km (Thaxter *et al.* 2012)
SPA 1	220 pairs, sea area = 0.6
SPA 2	140 pairs, sea area = 0.5
SPA 3	60 pairs, sea area = 0.7
Inland population	10 pairs
Rooftop 'urban' population	30 pairs
Influx discount	An influx discount is a value that can be applied to take into consideration that not all wintering gulls will be from focal populations. For the purposes of this exercise, wintering herring gulls in this region (north-east) = 30% discount (Coulson *et al.* 1984).
Wind farm survey data from developer (includes wind farm area and buffer). Note the values are considerably simplified as the casework is purely illustrative.	Mean count for monthly breeding period surveys, across 2 years: 100 adults HERGUs recorded, 50 sub-adult or immature HERGUs. Mean count for monthly non-breeding period surveys, across 2 years: 100 adults HERGUs recorded, 50 sub-adult or immature HERGUs. Sabbaticals can be ignored for the purposes of this exercise, for simplicity.
Apportioning sheet	Excel sheet for apportioning calculation provided on laptop. We acknowledge other apportioning tools are available; this is just an example of what we present within our current guidance.
Mortality estimate for offshore wind farm (from CRM)	10 in breeding period 15 in non-breeding period All collisions assumed to be for adult birds for simplicity for this exercise.
Mortality estimate for onshore wind farm (from CRM)	12 in breeding period 18 in non-breeding period All collisions assumed to be for adult birds for simplicity for this exercise.
Assumption	All gulls, whether adult or subadult, or from any of the colonies, are all assumed to be equally susceptible to collision, i.e. avoidance is the same in all individuals.
Age structure of population	*Assume all colonies have the same age structure of 0.4:0.6 adult:immature. (note: we are concentrating on only adults for this example so this is not needed for working through this example. Provided here in case of discussion of age groups).*

ANNEX 3B: DISCUSSION SESSION 1: CASEWORK GROUP DISCUSSIONS

Scenario 1: Breeding period/offshore wind farm

Scenario 1 'breeding/offshore': There is a proposed offshore wind farm. Based on the following information, what approach would the group take in assessing the connectivity and in apportioning potential effects to the SPA populations? How would the group tackle a cumulative effect with the onshore development? This group should focus on the breeding season assessment for herring gulls, which are a qualifying feature of all the SPAs.

General Thoughts:
We need to incorporate empirical and colony-specific data into apportioning as correction factors or to validate our theoretical input data and model approaches.

1. *Establish which SPAs and non-SPAs show connectivity to the proposed offshore wind farm and onshore wind farm. Give brief reasons as to why and note down any which you would need further information on.*

- Consideration of mean maximum foraging range (mmfr):
  - It's not enough to use a single figure – variability needs to be included.
  - Need to use regional specific values.
  - Helps to scope in potential sites using mmfr.

- When reviewing mmfr, when should we stop?
  - Not interested in rare long trips in terms of risk of impact (because they don't happen very often).
  - Need to consider regional contexts.
  - Is mmfr more stable year-to-year but more variable between colonies? – need to explore this.

- Need to include onshore wind farms:
  - It would be helpful to know flight routes.
  - Need information on proportions of birds from colonies that forage inshore or offshore.
  - Current recording methods don't account for night time flights.
  - Visual surveys could be used to identify flightlines to/from places of interest.

2. *Assign proportions of birds recorded from survey data to colonies identified with connectivity, providing an explanation of why/how the group decided on apportioning.*

- Limitations of current apportioning methods:
  - Focus is on the nearest colony.
  - Need to bear in mind colony size – and base tagging ratios on colony size and proximity to the wind farm/place of interest. This will enable targeted survey effort.

- Connectivity is equivalent to weighting – we could incorporate into existing apportioning models the proportion of birds using sites based on empirical data as a correction factor.

- Colony-level monitoring depends on the surrounding resource landscape – and focus of questions. Could collect:
  - Diet data, flight lines if possible, tracking to look at connectivity (including consideration of spatial coverage of tagging).

- Tracking data from the site of interest (e.g. wind farm) rather than an SPA – perhaps using GSM tags – to assess connectivity directly with the wind farm. This could be more directly beneficial to developers.

- Discussion suggested colour ringing is of limited use for offshore wind farms – no resighting capabilities.

- Alternatives to the existing approaches:
  - Should we use site-based counts of juveniles etc. or just use stable-age models to calculate age class population values? To bear in mind that some juveniles we see in the colony may be from Scandinavia rather than UK SPA birds.
  - Should we remove sabbaticals as they do contribute to the SPA breeding population? They are also often in the colony during the breeding season.
  - Colour ringing could be used to identify the % of birds that come back to the colony prior to breeding.

3. *Work out possible number of collisions that would be attributed to SPA 1 for adult birds. Actual numbers are not as important as the approach you used to get there.*

- We need empirical information (e.g. tracking) to inform the split of birds attributed to each wind farm – and the resulting collision impacts.

- Should repeat visual observations for old/already operational sites – bird behaviour may have changed – potentially because of wind farm presence/landfill closures/openings.

- Target species during onshore wind farm surveys do not usually/have not usually included gulls. This should be done to future proof data collection and ensure if it's required, the data is available (e.g. for retrospective assessments).

4. *How would you approach a cumulative assessment between onshore/offshore wind for SPA 1?*

- We need additive cumulative impact assessment across both onshore and offshore wind farms for gulls. We also need to consider old/historical sites but these could be an issue if gull data wasn't previously collected.

Scenario 2: Non-breeding period/offshore wind farm

Scenario 2 'non-breeding/offshore': There is a proposed offshore wind farm. Based on the following information, what approach would the group take in assessing the connectivity and in apportioning potential effects to the SPA populations? How would the group tackle a cumulative effect with the onshore development? This group should focus on the non-breeding season assessment for herring gulls, which are a qualifying feature of all the SPAs.

General Thoughts:

- Different SPAs and non-designated colonies could be exhibiting different population trends which could, consequently, affect foraging ranges (populations in decline may forage further); may need to factor this in, in future approaches
- Do we need a meta-analysis of reports to see if there is anything in common we can extract on *Larus* gull behaviour and foraging?
- Absolutely need a better idea (i.e. more information) on winter foraging areas, ranges and roosts for *Larus* spp. And, if feasible, establish their connectivity or otherwise with BS SPA populations.

- Was noted that winter roosts of gull spp. could vary substantially over the 25 year life cycle of a typical OWF (i.e. they may be less faithful to winter roosts than, say, to breeding colonies).
- Question: are non-breeding birds which visit an SPA in winter protected? And if an SPA bird moves one season out of the SPA to a rooftop to breed, is it still protected?

1. *Establish which SPAs and non-SPAs show connectivity to the proposed offshore wind farm and onshore wind farm. Give brief reasons as to why and note down any which you would need further information on.*
    - All SPAs are likely to have connectivity in the NBS due to potential movements of all birds in the mapped scenario through the OWF area
    - Also all non-designated colonies; basically need to add in all the inland birds to the SPA populations, apply the influx discount and treat that as the whole population.
    - Could use the BDMPS report but, in practice, given the apparent variability in gull behaviour and movements discussed today, that report may not represent the specific behaviour of birds at this location.

2. *Assign proportions of birds recorded from survey data to colonies identified with connectivity, providing an explanation of why/how the group decided on apportioning.*
    - Given the high variability we've discussed today, any formulaic approach to apportioning (whether SNH or NE or MS approach) could be risky;
    - Conversely, given this high variability is there a danger in extrapolating from field data which could, in practice, be highly mis-representative of the whole population? I.e. given such inherent variability is reliance on a formulaic approach to apportioning actually the preferred way forward? Something that needs considered as part of the future combined offshore/onshore guidance document.

'Solution' is probably to seek to build uncertainty and variability (stochasticity) into the apportioning process and derive probabilistic outputs, much as has been done of late in CRM; that being the case, would need to move away from Excel to 'R' or similar.

3. *Work out possible number of collisions that would be attributed to SPA 1 for adult birds. Actual numbers are not as important as the approach you used to get there.*
    - In BS gulls will have distinct foraging areas / ranges allowing potential mortality to be assigned to specific colonies. In NBS foraging area will be far more diffuse and less tied to a specific colony or colonies. Preferred approach may be to calculate two extremes: reality will lie somewhere in between:
        1. Apportion all mortalities to the nearest SPA (1) and apply the influx discount. This is our worst case scenario.
        2. Split the mortalities proportionately (based on our knowledge of populations in the BS) between all the SPAs and the non-designated colonies inland, and apply the influx discount. NB because the populations in the NBS are not tied to a breeding colony we should not factor in distance between the OWF and the colonies (the population is fluid / mobile, not tied to specific locations). This is the minimal impact which may be realised with a specific SPA.

4. *How would you approach a cumulative assessment between onshore/offshore wind for SPA 1?*
   Not discussed during discussion group session due to time constraint.

Scenario 3: Breeding period/onshore wind farm

Scenario 3 'breeding/onshore': There is a proposed onshore wind farm. Based on the following information, what approach would the group take in assessing the connectivity and in apportioning potential effects to the SPA populations? How would the group tackle a cumulative effect with the offshore development? This group should focus on the breeding season assessment for herring gulls, which are a qualifying feature of all the SPAs.

1. *Establish which SPAs and non-SPAs show connectivity to the proposed offshore wind farm and onshore wind farm. Give brief reasons as to why and note down any which you would need further information on.*

The group considered the foraging range provided with Thaxter *et al.* 2012, and establishing connectivity between the three SPAs with breeding Herring Gulls and concluded that the proposed onshore wind farm is within the foraging range of all three SPA colonies, and the two inland colonies. If gulls from these colonies are foraging on the nearby landfill site then there could be connectivity to all three SPA colonies - especially as the landfill is a hotspot, which might be equally as attractive to / used by the furthest colony as the nearest colony.

- Foraging hotspots may be equally attractive to gulls despite distance from colony being more for one colony than another.

The proposed wind farm site may not be within the flight path of the two inland colonies as they do not look to pass that way to access the landfill. However, the nearest inland colony might be foraging in the proposed wind farm vicinity to access other resources, for example agricultural habitat. Also if freshwater nearby – could be cleaning/loafing after foraging.

- Context of the surrounding habitat is important as to whether or not gulls might be passing through an onshore wind farm.

2. *Assign proportions of birds recorded from survey data to colonies identified with connectivity, providing an explanation of why/how the group decided on apportioning.*

We considered the worst case scenario first that all colonies would be affected - and we couldn't rule out any that would be unlikely to be potentially affected.

- One point was whether we could combine the data from everyone working with gulls / tracking gulls to get a range of trip statistics / metrics i.e. proportion of individuals / tracks foraging on and offshore to help apportion where we don't have colony specific data.
- Also terrestrial and marine foraging ranges etc. A min and max range could be used instead of 100% of individuals foraging both on and offshore? This could somehow also be used to understand certainty or highlight the range of uncertainty. Then we can work to reduce this uncertainty and it may help to inform correction factors.
- Building uncertainty into metrics would require funding but could be used in a similar way to Collison Risk Models.

We also considered the gulls' behaviour that might increase or decrease the risk.

- Individuals commuting to the landfill might be at higher risk than those foraging in agricultural/grassland habitats in the vicinity of the proposed site - i.e which are feeding on the ground rather than flying at a height that may collide with the blades.

- Do gulls from one colony leap frog over the foraging ranges of gulls from other neighbouring colonies? i.e. if each colony has a mutually exclusive foraging area to reduce competition?
- Having data on flightlines would be really useful to link individuals to potential colonies.
- For the established offshore wind farm, is post-construction flight line data available? This could be used to determine which colonies the gulls near the wind farm are from to help work out the proportion feeding offshore versus inshore?

3. *Work out possible number of collisions that would be attributed to SPA 1 for adult birds. Actual numbers are not as important as the approach you used to get there.*

One point was knowing whether gulls offshore are flying or whether they are on the water to determine potential risk from the offshore wind farm.

- Behaviour at sea an important thing to take account of.

4. *How would you approach a cumulative assessment between onshore/offshore wind for SPA 1?*

Not discussed during discussion group session.

ANNEX 3C: DISCUSSION SESSION 2: NOTES FROM FLIPCHARTS

The main points from the discussion session 2 are captured in section 3 of this report. Notes taken from the flipcharts on identifying knowledge gaps and possible research to fill the gaps are reproduced below.

Monitoring & Survey:
Knowledge gaps:

- Up to date information on gull population trends/colony sizes is crucial, especially for SPA populations but also for urban and inland gull colonies.
- Quantify numbers of non-breeding birds at the colony – does this change over time?
- Continue protected area monitoring to provide current population estimates – and demographic rates.
- Metapopulations and links to habitat mapping - identification of source and sink colonies and possible drivers.
- New technologies for establishing population estimates.
- Broader regions of assessment required - esp. for non-breeding birds (e.g. North Sea region).
- National census of urban and inland gull populations.
- Continue winter gull surveys (WINGS) on 10 yearly cycle (currently overdue).

Points made on possible research to fill gaps:

- Develop SMP database (central repository) further to make it easier to search for colony sizes.
- Current population estimates – long term commitment is required.
- More data (camera based) on avoidance - empirical data, relevant to gulls.
- Where people record gulls WeBS counts could provide useful information on important freshwater used by bathing and loafing birds, especially in the non-breeding season, which might help determine flightlines / commuting routes for onshore wind farms.
- Uncertainty in at sea-survey data (behavioural variation under different conditions).

Foraging characteristics:
Knowledge gaps:

- Having a better understanding of what is driving inter-colony variation. Should think about how much we can use this to determine what is happening at less well-known sites. Understanding more about inter-colony interactions and whether it differs between the seasons.
- Foraging strategies and changes over time.
- More information required on the non-breeding foraging in gulls (areas they go to, how far away from their breeding population SPA, what other-non breeders come across from Scandinavia, etc.).
- Behaviour – how to get a representative sample of behaviour (numbers of individuals, colonies, regions, etc.). Think about if power analysis could be used, or expert knowledge.
- Predictor of broad foraging strategies/behaviours.
- Relating diet to breeding success at pair level over time.
- Foraging ranges – needs to be updated and take into account potential colony-specific and regional variations (as well as seasonal variations etc.).

- Flight behaviour- spatial and scale, and flight speed.

Possible research to fill gaps:
Tracking
- Tracking from wind farm sites (e.g. offshore).
- Tracking non-breeding birds at higher resolution data (and juvenile/immature birds) – e.g. UVA-BiTS increased resolution in wind farm.
- Longer-term tracking data of individuals – tag effects (long term).

Technology and Advancement
- Improved means of attaching and detaching tags.
- Developing biometrics and stable isotope methods for identifying origins of winter birds.
- PIT tag tracking of birds using network of receivers (e.g. on Wind farm sites). (MOTUS system). Develop technology for radar pick up.
- Non-breeding season movements (non-remote downloading tags).

Analysis/Modelling
- Population relevance of migratory patterns – where do 'our' birds go in winter for consideration of cumulative effects.
- More robust, evidence-based correction factors – could develop Bayesian framework approach? Generic model but incorporating empirical data.
- Capture uncertainty and variability.
- Shiny app (non-excel) apportioning tool (& other tools available).
- Relate diet data variation to habitat mapping.
- Understand how changes in resource landscape affects behaviour.
- Meta-analysis of: colonies regarding foraging; diet preferences; non-breeding data exists on diet: need to analyse this.
- Identification of regional trends in foraging behaviour
- An analysis of colour-ringing data could provide useful information on the movements of juvenile and immature birds.

Species deficiencies:
Knowledge gaps:
- Species deficiencies – GBBGUs, COMGU (only a few studies on foraging range). Non-*Larus* species, little gull and black-headed gulls for data in the non-breeding period, also mentioned.
- Little gull as not having extensive information on foraging information available (or national population estimate).
- Empirical data to support sabbatical correction factor for species – is this stable in time and between colonies? Frequency and drivers for sabbaticals and where do they go?
- Survival rates for different age classes.
- Influx discount data on all gull species (include updates for HERGUs). Influx discount will vary depending on region.

Possible research to fill gaps:
- Review of existing research and source material to establish what we have (literature review), MSc project or a graduate placement project could be ideal for this.

- Ensure that species with deficiencies are prioritised for further work.
- Data required from a better geographic spread and representative range for each species.
- Overdue winter gull survey – could try to push for another winter gull survey to take place.
- Better understanding of winter ranges and roosts.
- Foraging range information/foraging distribution:
  - Wakefield *et al.* 2017 type data maps for gulls and then apportioning tool.
  - Development of appropriate 'foraging range' buffers to ascertain connectivity (could be colony specific, for onshore and offshore).
  - What's driving variability – species specific, between and among individuals – and between colonies.

Factors affecting gull populations:

Knowledge gaps:

- Effects to impacts – does it matter at a population level? – displacement, collision, carrier.
- Long term consequences of wind farms e.g. prey.
- Better understanding of drivers for carrying capacity, drivers for declines.
- Comparative/relative impacts of different pressures e.g. wind farms versus landfill closure, discard ban, gull controlling etc.
- Gull control:
  - Demographic impacts of gull control.
  - Mitigation of wind farm impacts offset by reduction of gulls due to gull control etc.
  - Better understanding of the effects of gull controls on gull populations.
  - How to change public perception of gulls in cities as being 'pest species', e.g. see Tag 'n' Track project as an example[13] – engaging people with positive stories and information about gulls.

Possible research to fill gaps:

- PhD work (Liam Langley) already looking at one of the potential drivers of change: changes in land-use practice. Other PhDs currently taking place looking at factors affecting gull populations (e.g. Dutch work).

Data Sharing:

Knowledge gaps:

- Data sharing agreements between countries – more communication required and knowledge of differences/similarities in approaches, implications for EIA.
- Cross colony analysis of ecological traits – not just UK, but International collaboration– can inform variation between colonies etc. information for policy.

Possible research to fill gaps:

- Ensuring data sharing across:
  - Developments (e.g. German database of all development data - given at time of application to federal agencies) – including being available in visible/easy access format.
  - Agencies (e.g. between SNCBs)
  - Also data sharing between onshore and offshore caseworker.
- Shared platform for diet data.
- Citizen science project encouraging reporting of colour-ringed gulls – fostering interest in gulls as well as providing data on foraging range/locations.

[13] http://clydemuirshiel.co.uk/tag/tag-n-track/