International Workshop:

Improving our knowledge on bird migration over the sea

Hamburg, 28th and 29th August 2017

Dear colleagues,

We welcome you cordially to our international workshop "Improving our knowledge on bird migration over the sea" in the lively city of Hamburg!

This workshop is organised by the Institute of Avian Research "Vogelwarte Helgoland" in cooperation with the Research and Technology Centre (FTZ) of the University of Kiel and is friendly hosted by the Thünen Institute of Sea Fisheries in Hamburg. The frame of this workshop is the "BIRDMOVE" project, which is financed by the German Federal Agency for Nature Conservation (BfN). BIRDMOVE deals with the potential effects of the fast-developing offshore wind industry on migrating birds. This project explicitly investigates movements of birds along the coast and over the sea and their reactions to offshore wind farms in taking advantage of recently developed tracking technologies. The scope of this symposium is to compile and to discuss the current knowledge on bird migration over the sea together with our invited international scientific experts. We designed it as a lunch-to-lunch scientific workshop including eleven expert talks and allowing enough time for vivid discussions on the current offshore situation.

We are very much looking forward to interesting talks and discussions in the stimulating environment of the "Hamburger Fischmarkt" at the Elbe River!

Ommo Hüppop

Vera Brust

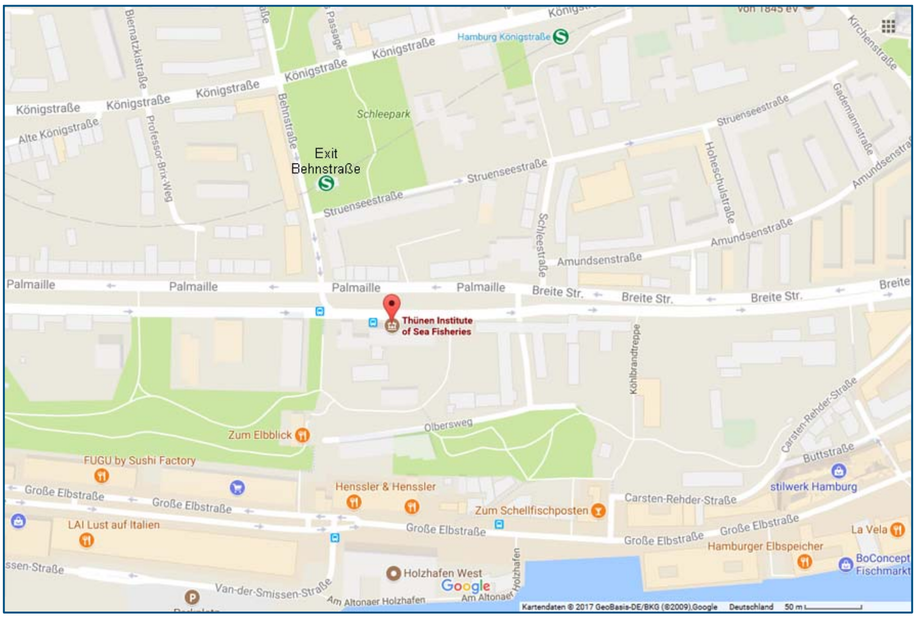
Bianca Michalik

Location:

Thünen Institute of Sea Fisheries

Palmaille 9

D-22767 Hamburg-Altona



How to get there:

By car:

- A 7 exit "Othmarschen", drive towards "Zentrum", at Behringstraße turn right at the church on to the Hohenzollernring, turn left at the end on to the Elbchaussee, which then becomes Palmaille

By train:

- From Hamburg Main Station:
  take S1 (direction Wedel) or S3 (direction Pinneberg) to station "Königstraße"
  exit via Behnstraße, upstairs turn left, walk about 100 m to Palmaille
- From Hamburg-Altona:
  take S1 (direction Poppenbüttel) or S3 (direction Neugraben) to station "Königstraße" (1 stop)

By plane:

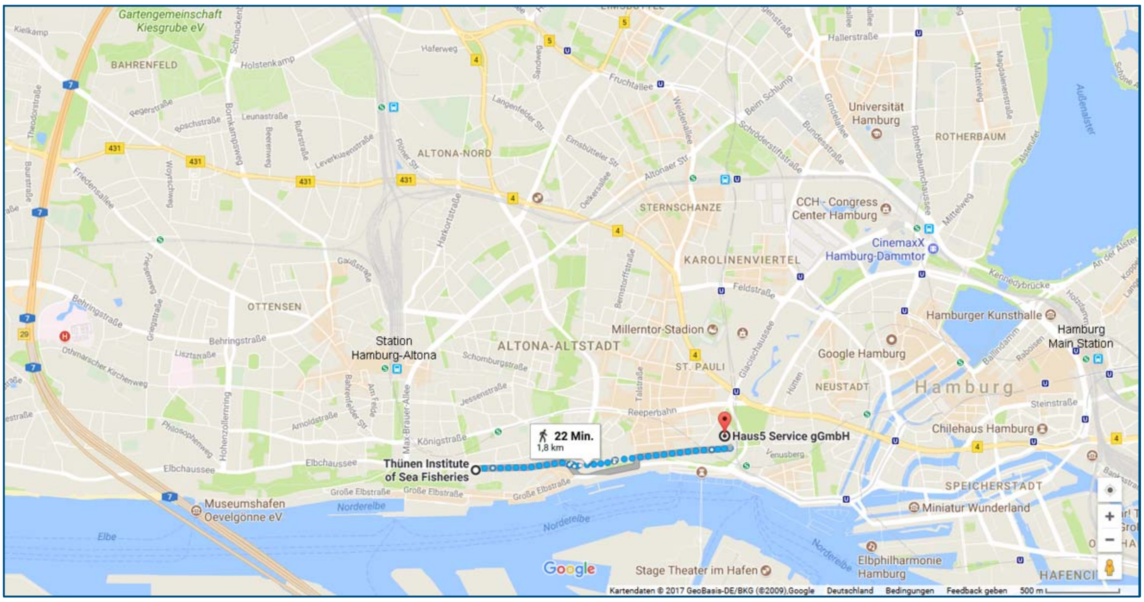
- take S1 (direction Blankenese/Wedel) to station "Königstraße" (ca. 35 min)

Social Dinner:

"Haus 5"

Seewartenstraße 10

D-20459 Hamburg



Mon 28th August 2017

13:00	Registration	
14:00	Welcome and introduction	Stefan Garthe (FTZ, U Kiel, Germany)
14:10	*Current situation of offshore development in Germany*	Thomas Merck (BfN, Germany)
14:40	*What we (don't) know about offshore bird migration*	Ommo Hüppop (IfV, Germany)
15:10	*Migration patterns of songbirds over the North Sea - Flight heights and density patterns*	Karen L. Krijgsveld (Royal Netherlands Air Force) & Ruben C. Fijn (BuWa, The Netherlands)
15:40	*Criteria for the assessment of mortality in wild birds connected with human projects and impacts*	Volker Dierschke (Gavia EcoResearch, Germany) & Dirk Bernotat (BfN, Germany)
16:10	coffee break (*30 min*)	
16:40	*Seabird GPS tracking*	Stefan Garthe & Philipp Schwemmer (FTZ, U Kiel, Germany)
17:10	*ENRAM - Remote sensing of animal migration in Europe*	Judy Shamoun-Baranes (U Amsterdam, The Netherlands)
17:40	*The ICARUS Project - New perspectives for animal tracking*	Bernd Vorneweg (MPI for Ornithology, Germany)
18:30	Social Dinner at "Haus 5"	

Tue 29th August 2017

09:00	*Offshore monitoring of migrating birds*	Ralf Aumüller & Markus Molis (Avitec Research, Germany)
09:30	*Automated radiotelemetry in Europe - Animal tracking across borders*	Sissel Sjöberg (U Copenhagen, Denmark)
10:00	*Migratory decisions of passerines at the remote island of Helgoland*	Heiko Schmaljohann (IfV, Germany)
10:30	coffee break (*30 min*)	
11:00	*BIRDMOVE - Automated radiotelemetry across the German Bight*	Vera Brust (IfV, Germany)
11:30	Closing remarks	Ommo Hüppop (IfV, Germany)

Current situation of offshore development in Germany

Thomas Merck (Bundesamt für Naturschutz, Vilm/Rügen, Germany)

In 2000, the German "Renewable Energy Sources Act" (EEG) entered into force aiming at increasing the share of renewable energy sources. *Inter alia*, it defines the tariff paid for electricity gained offshore. According the "Marine Facilities Ordinance" an approval had to be granted unless the project poses amongst others a threat to shipping traffic or to the marine environment, including bird migration. In the first years this led to a high number of applications and approvals of offshore wind.

Following a revision of the EEG in 2004, no subsidies are paid for electricity from projects within designated Marine Protected Areas (MPA). In 2009, the "Regional Planning Act" (ROV) excludes offshore wind farms from MPAs in general. The request of the Federal Agency for Nature Conservation to restrict offshore wind farms to areas outside known migration routes was not reflected in the ROV. In the same year the Federal Ministry for the Environment decided that no (further) approvals should be granted in a definite wintering area of red-throated divers and black-throated divers aiming at protecting these bird species from being displaced.

Even though several offshore windfarms have already been permitted in the early 2000's the first project became operational only in 2009. In 2011, the Federal Maritime and Hydrographic Agency was given the task of elaborating an annual offshore grid plan for the German EEZ guiding the further development. As one consequence, projects far offshore are not pursued further. In 2012, the legal frame work changed to a 'plan approval procedure' and the applicant is not any more eligible for the approval even if he meets all the required conditions. Finally, since 2017 a tendering procedure entered into force and the further development will follow a central plan aiming at providing an installed capacity of 6.5 GW by 2020 and 15 GW by 2030.

To date, there are 16 operational wind farms with almost 1,000 turbines and four projects under construction in the German waters of which 17 are located in the North Sea. The installed electrical power adds up to more than 5,300 MW. About eight additional wind farms with an installed capacity of 2,250 MW are expected to be constructed until 2020 followed by 3,100 MW and 3,500 – 4,500 MW until 2025 and 2030 respectively.

What we (don't) know about offshore bird migration

Ommo Hüppop (Institute of Avian Research "Vogelwarte Helgoland", Wilhelmshaven, Germany)

Migration is a widespread phenomenon in many branches of the animal kingdom. It can be obligate, facultative, partial, sometimes varying between different populations and even individuals within a species. Migration allows taking advantage of temporally predictable foraging and breeding conditions in different areas that cannot be used simultaneously. A complex combination of internal physiological rhythms and external cues influence decisions to migrate at a given time and location.

Worldwide, every day and night there are birds on the move. Some 50 billion birds annually change between their breeding, moulting and wintering areas. Depending on species, season, location, weather and distances to be covered, migration intensity, direction, flight speed and altitude vary considerably, sometimes even within a few hours.

While waterbirds - namely marine ones - avoid crossing large land masses, land birds are reluctant to fly larger distances over sea. Nevertheless, crossing these ecological barriers rather than circumventing them can reduce flight costs and time considerably, especially when flights are assisted by tailwinds. Thus, despite the risks associated with flights over water, not only waterbirds move far away from land when on migration. The "champions" fly nonstop nine days more than 11,000 km over the open ocean! Many diurnal species become more or less nocturnal during their migrations, roughly two thirds of the European bird species.

Onshore, birds are known to collide with wind turbines, but – depending on species – in numbers that seemingly do not threat populations. Offshore, the situation might be different. But our knowledge is very limited, since carcass collection at sea is not feasible and reliable methods to quantify bird strikes still need to be developed. Fatality numbers might be higher offshore than onshore. Over land, birds can interrupt their flight when they get drifted by unexpected winds or lose orientation in deteriorating visibility. Offshore "landing" would be fatal. Instead birds reduce flight altitude and during darkness they are attracted by (illuminated) structures where they might seek rescue.

Normally, birds are able to perceive wind turbines and other offshore structures. Radar studies have shown that at least flying ducks, geese and swans normally avoid wind farms. However, when they fly at low altitudes (e.g. under head winds) the resulting detours could increase flight costs considerably, especially, if birds cannot detect sufficiently broad gaps between wind farms.

Migration patterns of songbirds over the North Sea – Flight heights and density patterns

Karen Krijgsveld (Royal Netherlands Air Force, The Hague, The Netherlands)
and Ruben Fijn (Bureau Waardenburg, Culemborg, The Netherlands)

As part of a long-term research project aimed at gaining insight in the effects of offshore wind farms on birds, we have measured flight activity of birds over the North Sea over a period of 10 – 15 years, using automated bird radar. This has provided us not only with data on flight directions, but also with data on the quantity and flight heights of birds crossing the sea, not only for local seabirds but for migrating songbirds as well. The length of the study period has allowed us to determine the occurrence of strong peaks in bird migration at low altitudes over sea. This information is a crucial factor in quantifying the number of birds that can potentially collide with offshore wind turbines.

Here, we focus on the numbers and flight altitudes of migrating birds throughout the year, and relate these patterns to the flight directions of these birds. We then calculate how many migrating birds may fly through a wind farm area during nights of peak migration at low altitudes. From this, we can estimate the number of birds that can potentially collide with the turbines. Similarly, we can estimate the number of birds that are saved when the turbines are shut down during these events; a mitigation measure that is enforced in the currently commissioned round of offshore wind farms in the Netherlands.

We discuss how these flight patterns reflect birds migrating to and from various destinations and origins, and explain the variation in flight altitudes. For this purpose, we have related the patterns observed at low flight heights to large-scale patterns measured at higher flight heights, by comparing the data to those from the radar of the Royal Netherlands Air Force. With this radar we measure bird concentrations at altitudes between ca. 100 m and 2,400 m above sea level measured at two different elevations (100 – 1,100 m and 1,100 – 2,400 m), which provides us with information on migration patterns at higher altitudes.

The combined data provides insight in the effects of offshore wind farms on migrating birds, and therewith show which mitigation measures may be most effective in limiting collision rates.

Criteria for the assessment of mortality in wild birds connected with human projects and impacts

Volker Dierschke (Gavia EcoResearch, Winsen/Luhe, Germany)
and Dirk Bernotat (Bundesamt für Naturschutz, Leipzig, Germany)

Based on population models it is possible to determine how sensitive a population is to mortality, i.e. the loss of individuals. Owing to the lack of specific population models and species-specific data this sensitivity is unknown for many populations of free-ranging animals. However, such information is urgently needed when the influence of additive anthropogenic mortality on population growth has to be assessed, for example in the frame of Appropriate Assessments according to the EU Habitats Directive. In order to overcome the gap of knowledge in many animal species, an index based on parameters reflecting the population biology and parameters describing the conservation status of species was created.

In the **Population Biology Sensitivity Index (PSI)**, the parameters (natural) mortality rate, longevity, age of first reproduction, potential reproductive rate, actual reproductive rate, national population size and national population trend are accumulated. For most parameters, measured values were transferred into a scoring system reflecting the sequence from high vulnerability towards additional mortality (class 1) to low vulnerability (class 9). The national population trend was considered by additions to or reductions from the average of the other parameters. Generally, PSI is ranking species from K- to r-specialists and shall express how difficult or easy it is for a species to replace lost individuals.

An **Index of Conservational Value (NWI)** was created from the parameters status on the National Red List, abundance in Germany, population condition (according to the Natura 2000 system) and national responsibility for the species. On a national level, both population condition and national responsibility have so far not been defined for birds. Therefore, these parameters were substituted by the proportion of federal states in which a species is threatened (according to regional Red Lists) and by the conservation status in a global context (SPEC).

To get a species-specific assessment based on both indices (PSI and NWI), they were aggregated in a matrix resulting in an **Index of Sensitivity to Mortality (MGI)**. This index allows deriving the relevance of the loss of an individual from the population with respect to conservational issues as well as for decisions in environmental planning and assessments. This approach enables to detect for which of those species (being rare, threatened and sensitive) already the loss of few individuals has to be regarded as critical concerning nature conservation and relevant concerning planning. On the other hand, the index of sensitivity to mortality helps to identify, among the abundant, ubiquitary and "robust" species, those which do not require more detailed investigation regarding a project-caused mortality risk in the frame of planning and permission, at least when only a few individuals are concerned.

The Index of Sensitivity to Mortality can and shall not replace the assessment of mortality in each individual case, but the differentiated classifications should help to objectify the assessments of mortality risks. With the help of our species-specific approach, it shall be ensured that, where a strict protection is required for nature conservation, this can also be justified fully and consistently. On the other hand, infrastructure planning should not be provided with unnecessary restrictions where this is not necessary for nature conservation. Thus, the aim is to contribute to objectivity and transparency of impact assessments.

Seabird GPS tracking

Stefan Garthe and Philipp Schwemmer
(Research and Technology Centre (FTZ), University of Kiel, Germany)

While recently several studies of offshore wind farms (OWFs) on local seabirds (breeding, resting, wintering) have been published, the potential effects of OWFs on migrating seabirds are very poorly known. This knowledge gap can only be reduced by recording individual movements and activity patterns of seabirds. Therefore we have equipped different seabird species with GPS data loggers. The devices were either attached to the feathers using adhesive tape (which enables to record data until the device was shed with the moulting feathers) or using a backpack system (which enables long-term data recording). The solar-powered GPS data loggers recorded geographical position, time of day, date, velocity and sometimes flight heights. Data transfer was secured in most cases by a GSM connection, i.e. that recorded data were downloaded via mobile phone networks, enabling a synoptic tracking of the birds. We have selected a set of species which were already identified as potentially threatened by OWFs and which at the same time had sufficiently high body mass to allow for the equipment of powerful GPS devices.

In contrast to Herring Gulls, which focused on the mainland or the Wadden Sea area during migration, Lesser Black-backed Gulls showed certain overlaps with OWFs during autumn migration. Great Black-backed Gulls mainly occurred close to the coast and made use of the intertidal gullies and tidal flats of the Wadden Sea most of the year. Only few individuals crossed the open North Sea during migration. Eurasian Curlews caught in the German Wadden Sea migrated over the Baltic Sea to their breeding grounds and chose similar routes on their way back. Most individuals migrated along the coast lines but several birds also crossed the open Baltic Sea and showed a certain overlap with OWFs. A similar migration pattern was found for Brent Geese, although this species showed a much more concentrated migration pattern using a corridor over the Baltic Sea south of Sweden and through the Gulf of Finland. Common Eiders caught near the island of Fehmarn in the Baltic Sea used mainly coastal waters around the island, but few individuals performed longer trips to the mainland coasts of Germany and Denmark.

The first results of the project show only moderate overlap of bird migration with offshore wind farms in German waters. As many tagged individuals intensively used international waters during their migration it will be essential to interpret the results also against the background of marine spatial planning in other countries.

ENRAM – Remote sensing of aerial migration in Europe

Judy Shamoun-Baranes (University of Amsterdam, The Netherlands)

Aerial migration occurs annually on a massive scale, more often than not, unobserved by the human eye. Among birds alone, it is estimated that 2.1 billion passerines and near passerines migrate across Europe annually. The ability to monitor and forecast mass movements of migrants could help address a broad range of scientific and societal challenges. As human activities increasingly encroach on the aerial environment the need for basic information on migratory movements is becoming more urgent. Not only is there an increasing demand for near real-time information but also a need for long term data for a more historic perspective and to understand potential changes in movements patterns, distributions and abundance of migrants. One of the few technologies that can be used to systematically monitor the multitudes of animals travelling across continents through the aerosphere is operational weather radar. National weather radar systems are organised into continental networks and individual radars are already being used to study animal migration.

In the European Network for the Radar surveillance of Animal Movement (ENRAM) ecologists, meteorologists, engineers and computer scientists are working together to create a paradigm shift in how existing earth observation systems are used, so that they can contribute to a much broader range of applications than currently realised. Several examples from this interdisciplinary community will show how weather radar is being used to study aerial migration as well as to understand and mitigate human-wildlife conflicts and novel visualisations developed to support data exploration and integration across multiple sensors will be shown. The use of operational weather radars may provide unique opportunities to help mitigate potential conflicts between offshore wind energy and aerial wildlife but it also comes with many challenges. In order to turn this hidden potential into a reality, a roadmap has been envisioned to address some key challenges and a concerted action is needed among scientists and policy makers.

The ICARUS Project – New perspectives for animal tracking

Bernd Vorneweg (Max Planck Institute for Ornithology, Radolfzell, Germany)

ICARUS, short for "International Cooperation for Animal Research Using Space", is a global collaboration of animal scientists to establish a satellite based infrastructure for earth observation of all kinds of migratory animals.

Many billion songbirds migrate every year between continents. Similarly, many bat species and countless large insects migrate long distances, potentially also between continents. Scientists are so far unable to follow individual small animal during their long-distance migrations. Knowledge about individual decisions is essential for an ecological and evolutionary understanding of dispersal and migration.

ICARUS will help to solve two major enigmas in biology: we need to understand the ontogeny of behavioural and movement traits of animals in the wild, and the selection acting on individuals in the wild (i.e. where, why and when do individuals die). ICARUS will also provide a seeing-eye dog for humankind. We will use the evolved senses of animals for remote sensing

The ICARUS small animal tracking system will enable researchers to answer some "grand challenges in environmental sciences", such as:

- Spread of infectious diseases (via birds, bats, rodents or insects)
- Relationship between biological diversity and ecosystem functioning
- Follow and predict bird presence, to enhance safety of aviation
- Identify stop-over and wintering sites for key endangered species
- Movement patterns of animals that provide ecosystem services
- Effects of land-use and climate change on migration patterns
- Invasiveness of species
- Migration routes and patterns
- Orientation and navigation over large scales
- Life history connectedness
- Mortality, extinction, natal dispersal, metapopulation dynamics or seed dispersal.

Small solar powered logger tags (< 5 g) get 12 GPS points per day, as well as 3D-acceleration, 3D-magnetometer and temperature data. The GPS data will be transmitted to the International Space Station (ISS), where the data of all tags are collected and then sent back to earth. Additional data will be written into the tag's memory for later readout with handhelds or portable base stations.

All these information shall be transmitted to the global data base "Movebank" for further evaluation.

With all these information's scientists are able to observe small animals over long distances and long time periods and to establish a conjunction between the decision of the animals and their environmental conditions.

Offshore monitoring of migrating birds

Ralf Aumüller, Markus Molis, Christiane Weiner and Reinhold Hill
(Avitec Research, Osterholz-Scharmbeck, Germany)

The development of renewable energy has intensively advanced in Germany since the political decision for a policy change in energy generation ("Energiewende") has been made. Offshore wind farms represent an essential element on the way to accomplish this change. As these facilities may, however, affect survivorship of migratory birds and habitat quality for seabirds, extensive research and monitoring programs were launched in Germany. We primarily show results from the analyses of acoustic long-term data taken from two sites (FINO 1 and FINO 3) within the German Bight. These records of bird calls allow an assessment of the spatial distribution of bird species that utter flight calls across the southern part of the North Sea as well as temporal dynamics at different scales in bird migration with respect to the construction and extension of offshore wind farms. We present changes of approach frequency and intensity of migratory birds to FINO 1 and FINO 3 (I) prior to and after near-by construction of (II) a single and (III) multiple wind farms. Furthermore, we evaluate wind farm impact on the diversity and species composition of migratory birds. We provide evidence on the magnitude and direction of the effects that artificial light sources may have for migratory birds in offshore environments and how this might affect the interpretation of data on approach frequency and intensity for different groups and species of birds. Finally, we assessed whether the observed effects of wind farm construction were confounded by weather conditions (air humidity, direction and speed of wind).

Automated radiotelemetry in Europe – Animal tracking across borders

Sissel Sjöberg (University of Copenhagen, Denmark)

Studies at stopover sites along the different migration routes have given us a fairly good understanding about how intrinsic and extrinsic factors modulate the endogenously controlled migration program in birds. However, recent radio-tracking studies have demonstrated that birds leaving a "stopover site" do not necessarily resume migration, but that they could also leave in search for a more favourable stopover site or possibly to explore the current wind condition for future departure decisions. Determining when a bird actually resumes migration, and whether the findings of a current site can be generalised for the entire migration route, are challenges for future stopover ecology research.

The spatial range of tags and the number of animals that can be tracked using manual tracking devices has traditionally limited avian research using radiotelemetry. The recent development of automated radiotelemetry now allows simultaneous and continual tracking of multiple individuals at the scale of the entire receiver array. More and more research groups are starting and planning projects using automated radiotelemetry in Europe. With coordination and cross-boundary cooperation many of the challenges of operating over many nations can be addressed, and we can work towards a network of receiver coverage across the flyway. This opens up for new collaborations to study migratory and stopover behaviour, routes and other aspects of movement ecology across a wide range of species at different spatial scales. Here, we will introduce the collaboration on automated radiotelemetry in Europe and highlight its potential for bird migration studies across borders.

Migratory decisions of passerines at the remote island of Helgoland

Heiko Schmaljohann (Institute of Avian Research "Vogelwarte Helgoland", Wilhelmshaven, Germany)

Migratory birds react to the seasonal change of their food availability by travelling between their breeding areas and wintering grounds. The vast majority of them are songbirds of which most migrate exclusively during the night. Their migration is further characterised by a sequence of fuel accumulation at the departure or stopover sites, and migratory flights to the next stopover or destination site. As first-year birds are not guided by adults or conspecifics, they entirely rely on an innate migration program providing information on how to physiologically prepare for the journey and how long to travel in which direction. Further the genetically determined reaction norm regulates how migrants respond to variation in environmental cues encountered *en route*. To understand bird migration, we consequently need to jointly study how intrinsic (fuel load, migration distance) and extrinsic factors (wind, ecological barrier) affect the individual decision-making processes. One crucial decision on every evening during migration is whether to stay or to resume migration from the current site. In case of the latter, other decision-making processes on actual departure timing within the night and departure direction follow. To study how intrinsic and extrinsic factors influence these decision-making processes, an integrated individual-based approach is required that combines laboratory and field studies. A long-distance insectivorous songbird migrant, the Northern Wheatear (*Oenanthe oenanthe*), serves here as the model species. During migration, two subspecies co-occur in Western Europe. *O. o. oenanthe* breeds in Europe but not Iceland. *O. o. leucorhoa* breeds in Iceland, Greenland, and eastern Canada. Both subspecies winter sympatrically in western Africa. The main ecological differences between subspecies are their breeding ranges and their migratory challenges. In contrast to *oenanthe* Northern Wheatears, *leucorhoa* birds cross the North Atlantic, a severe ecological barrier for a land bird, to their Arctic breeding areas. By temporarily caging wild Northern Wheatears on Helgoland, a small island in the North Sea, we corrected for environmental factors enabling to study how an endogenous time program is involved in the regulation of the departure decisions. By radio-tracking them, we further investigated how intrinsic and extrinsic factors jointly affected a bird’s departure decision from day-to-day and within the night. These studies demonstrated that the response to a certain condition depended on the specific characteristic of another intrinsic or extrinsic factor. This highlights the importance of interpreting departure decisions in relation to the currently encountered conditions and the nature of the upcoming flight.

BIRDMOVE – Automated radiotelemetry across the German Bight

Vera Brust, Bianca Michalik and Ommo Hüppop
(Institute of Avian Research "Vogelwarte Helgoland", Wilhelmshaven, Germany)

The German Bight of the North Sea is regularly crossed by migrating land birds on their way from wintering and stopover sites to their breeding sites and vice versa. Due to a long history of research at the coast and on islands, general itineraries of species, as well as their migration periods, are well known in this area. These data however also suggest that individual flight paths are fairly flexible and that some birds prefer the detour along the coast while others take the direct route across the sea. Recoveries and sightings of ringed birds as well as radar studies also revealed that reverse migration appears more regularly than one would expect. To date, it is still widely unclear how common individual deviations from the main itineraries within species occur and which intrinsic or extrinsic factors cause individual birds to fly a specific route.

In the BIRDMOVE project, we set up a network of automated radio telemetry receiving stations covering the coastline of the German Bight. During spring migration, 25 Northern Wheatears (*Oenanthe oenanthe*) were radio tagged at the coast of Lower Saxony. Receiver stations recorded fly-bys of over 70% of tagged birds, several birds recorded multiple times at different sites in Lower Saxony as well as in Schleswig-Holstein. Birds that passed the detection ranges of several antennas exclusively did so at night and within just a few hours. These findings and two additional stopovers registered at islands suggest that the tagged birds did not follow the coast line but crossed the open water during their spring migration.

Bundesamt
für Naturschutz