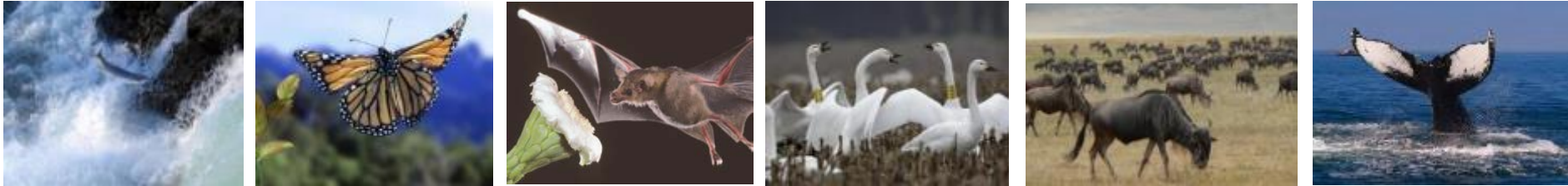


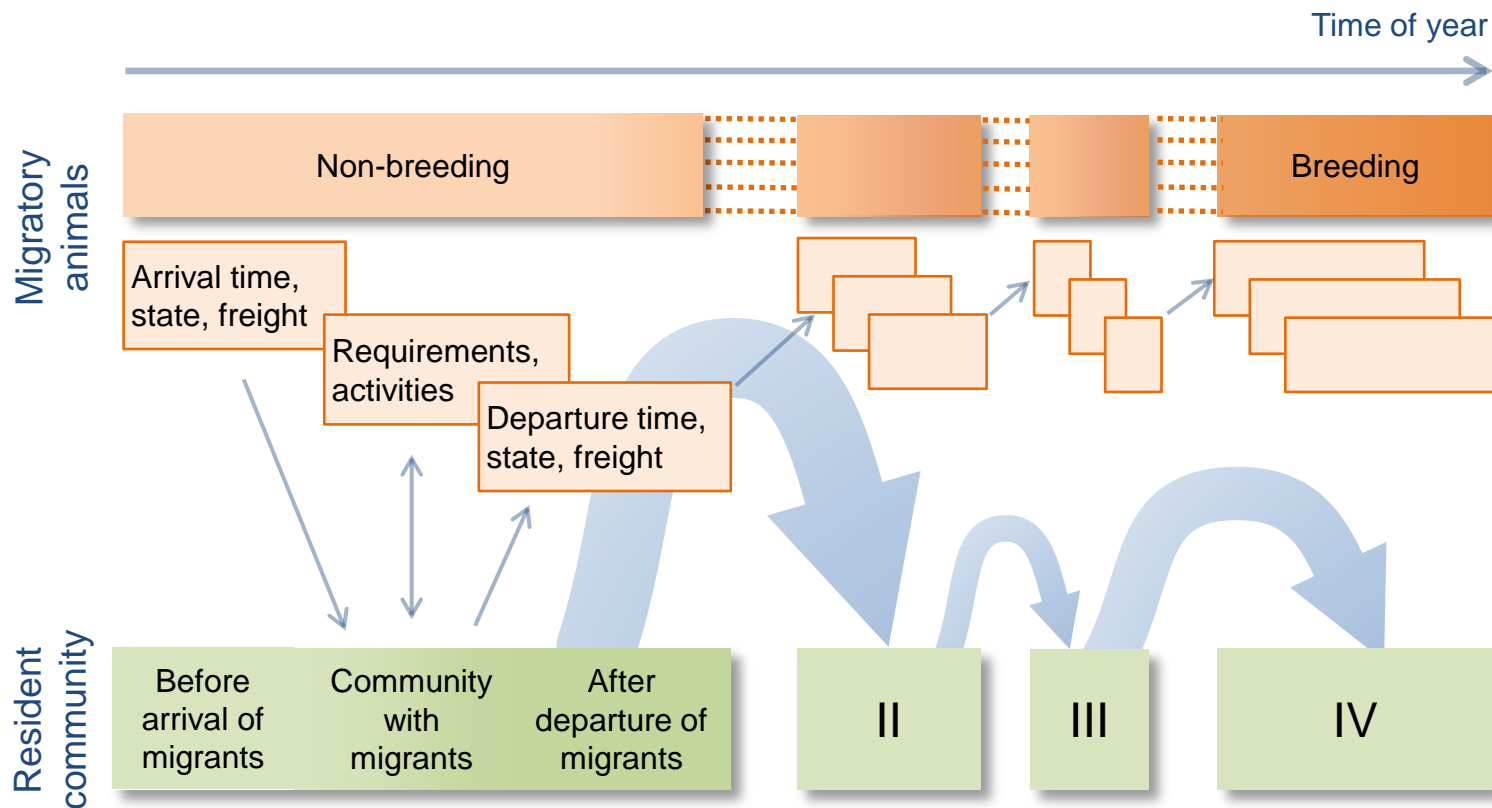
Grand challenges in animal movement research

Where are we and where are we headed?

Silke Bauer and Nir Sapir



Migrants link communities





Migrant services and disservices

- **Pollination and seed dispersal**
 - Birds disperse plant seeds & invertebrates
 - Many organisms, including fruit-plants depend on bat-pollination
 - Contribution to genetic exchange, biodiversity,

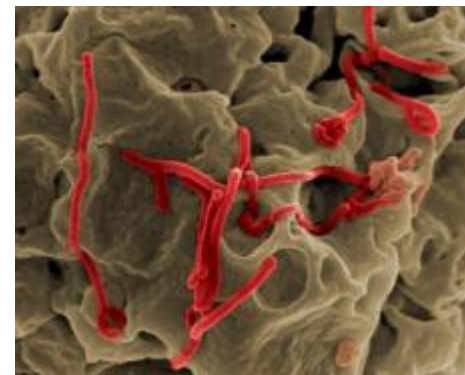
- **Pest control**
 - Bat consumption of insect pests
 - Economical benefits: crop damage avoided & reduced need of pesticides





Ecosystem services and disservices

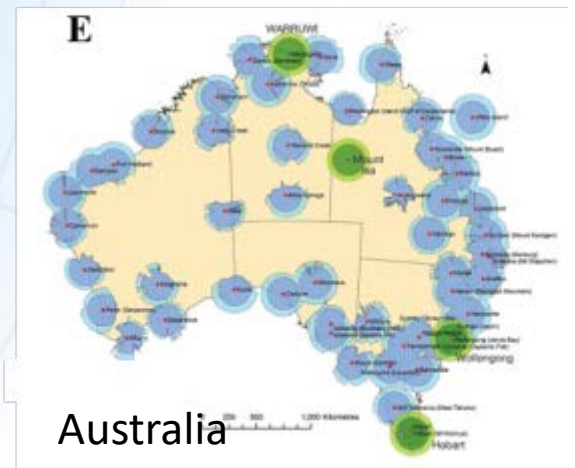
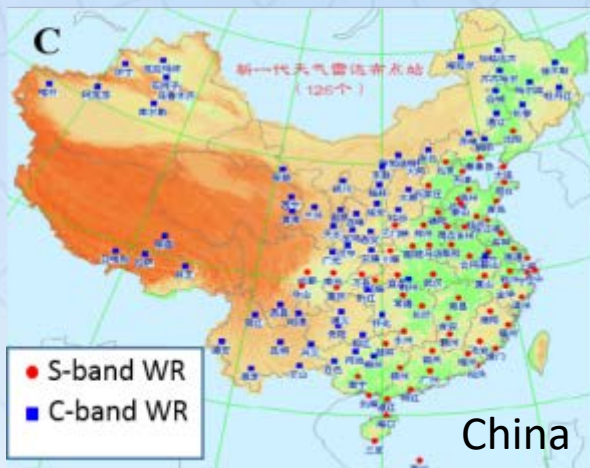
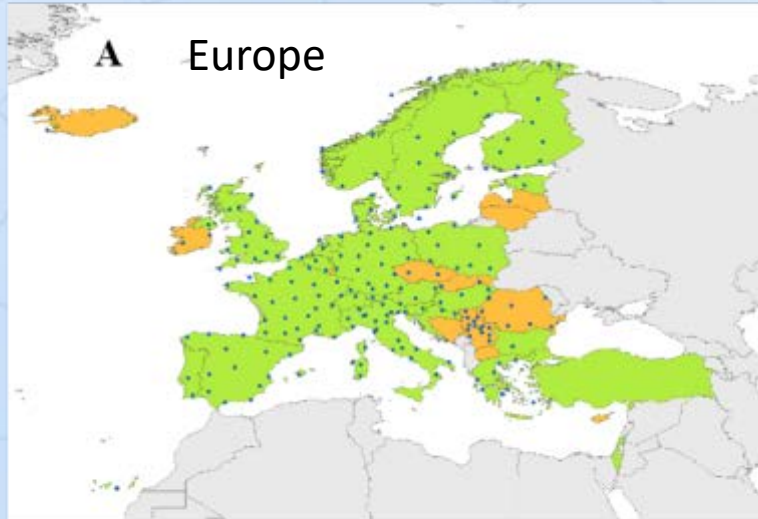
- Spread of parasites
 - Mig. birds & bats harbour many parasites, also with zoonotic potential: Ebola, AviFlu, hendra, SARS, etc.
 - Role of migrants in long-distance transport debated
 - Insects spread crop pathogens
- Agricultural damage
 - Insects consume crops
- Collisions with man-made structures
 - Aircraft-safety
 - Wind turbines
 - Buildings, power lines, etc.



Relevance for human health, agriculture, economy



Continent-wide networks of weather radars

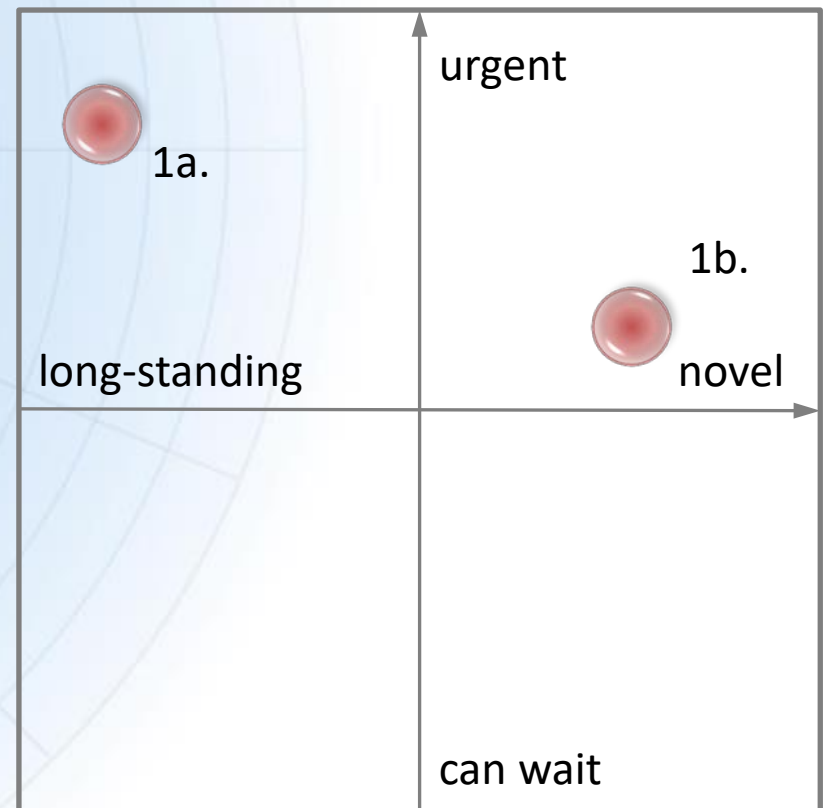


Identifying grand challenges

- Approach:
 - Brainstorm, questionnaire to researchers worldwide
 - Selection of highest-ranked questions
 - Grouping into major themes
- Various ways of categorizing questions, e.g.
 - Novelty: Long-standing - novel
 - Level: Fundamental - applied
 - Urgency of answer: urgent – can-wait
 - Target audience: researchers, policy makers, farmers, funders, etc.

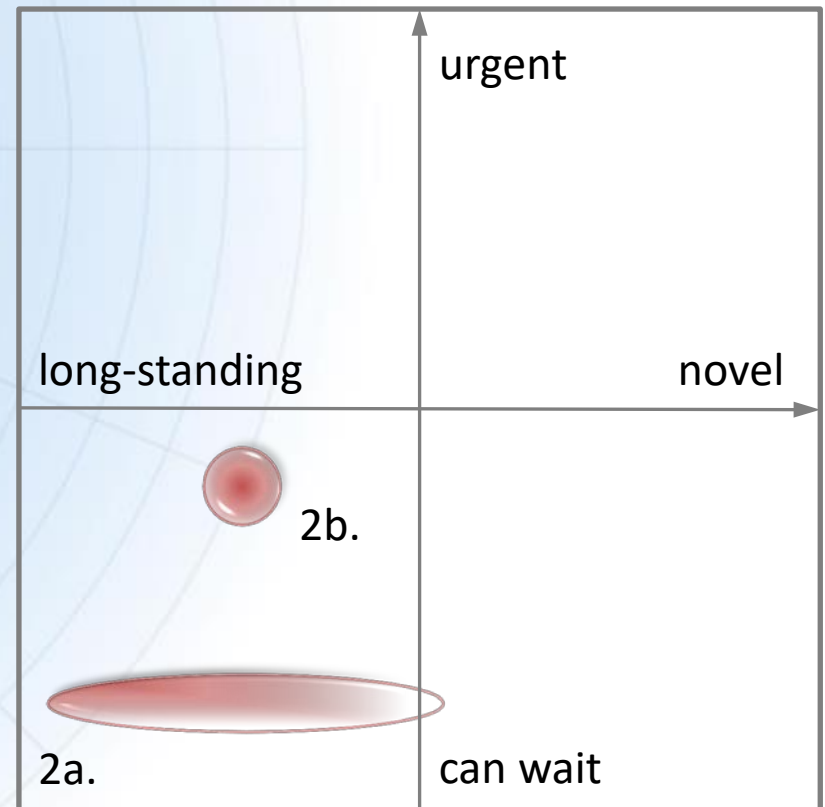
1. Description of migration

- a. Identification of migration corridors, important stopover sites and wintering regions -> migration maps
- b. Quantification of biomass & numbers



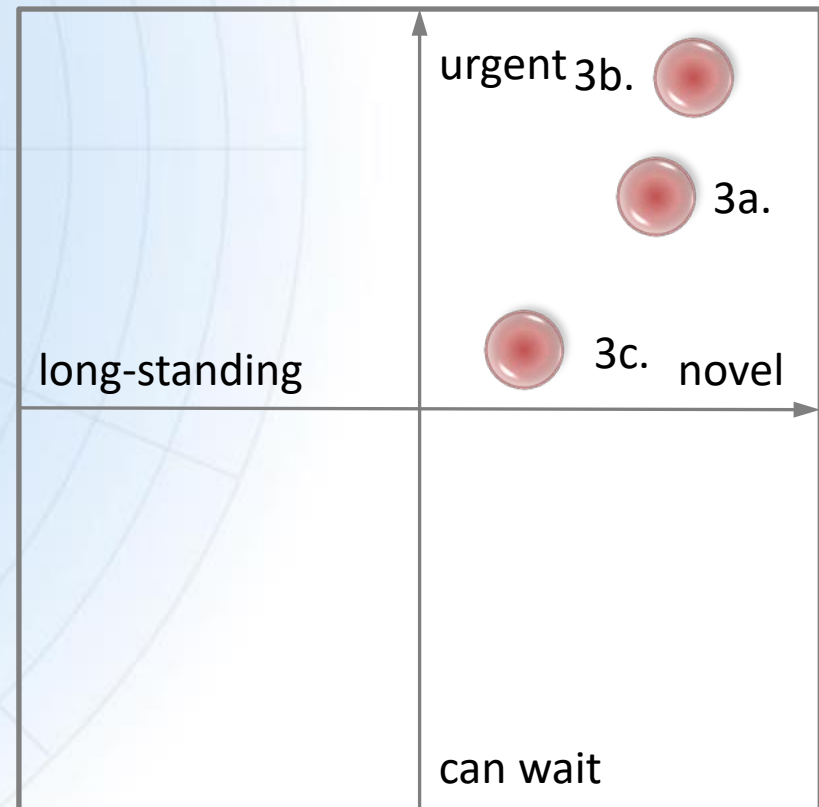
2. Mechanisms of movement

- a. Cross-taxon comparison of navigation and orientation strategies, cues, response to ecological barriers
- b. Influence of weather on migration, survival and population dynamics



3. Services and disservices

- a. Effect of transfer of biomass, nutrients, pathogens and genetic material on ecosystem processes?
- b. Early warning systems for invasion of migratory pests of crops, livestock and human health
- c. Migration forecasts

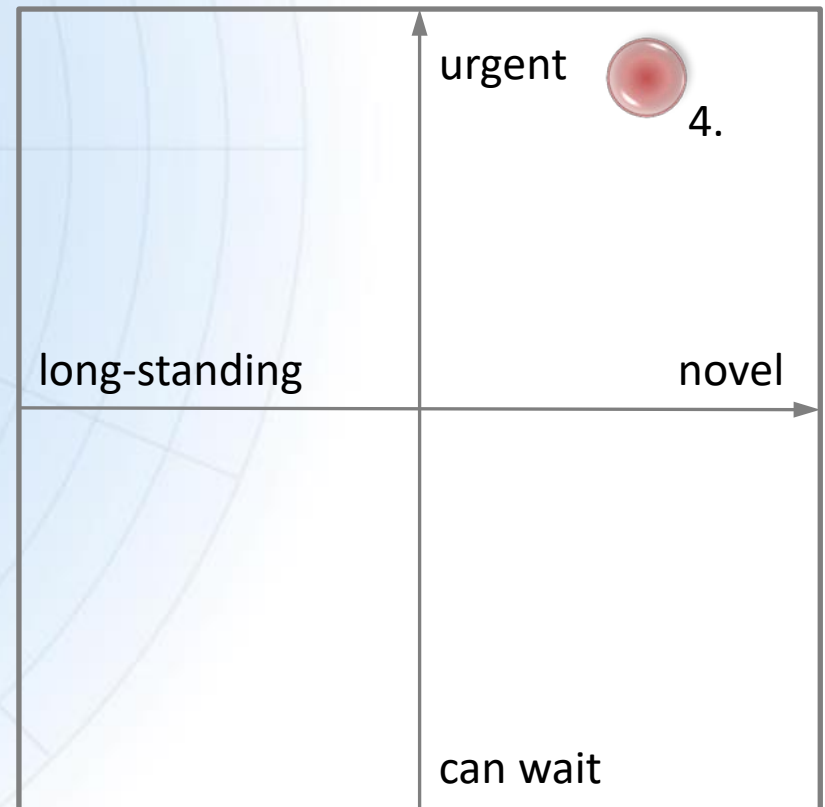


4. Human influences

What is the effect of ...

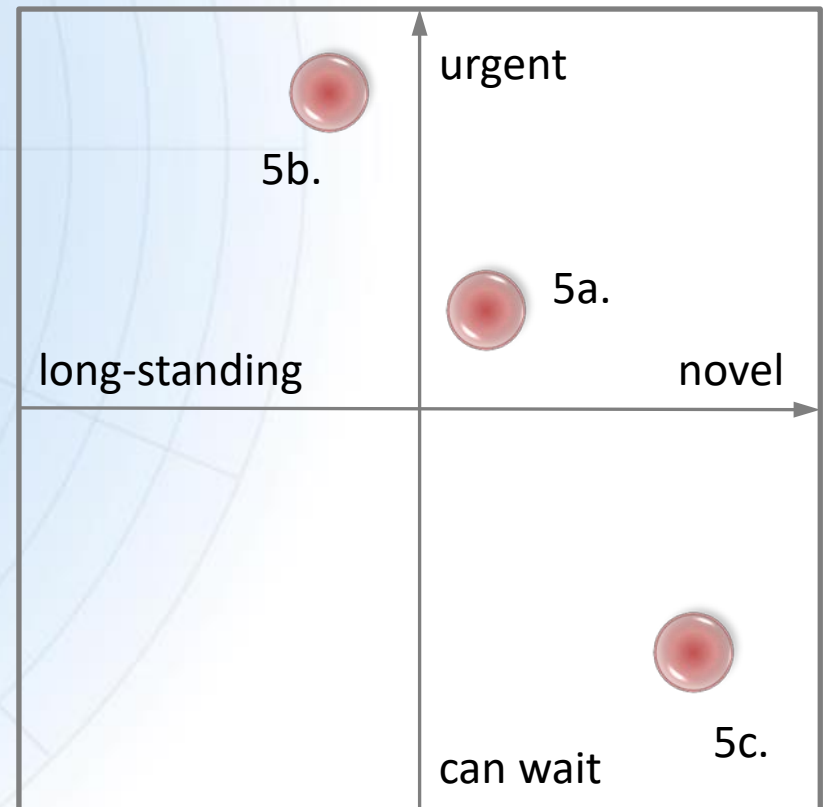
- a. climate change on phenology of migration?
- b. anthropogenic light and noise on migration?
- c. man-made structures on migration routes and flight behaviours?

How can we effectively conserve migrants and migrations (not mentioned)?



5. Technical challenges

- a. Improve classification and identification capabilities of radars for a better taxonomic resolution
- b. Radar data management: (long-term) storage and access, visualization (not mentioned)
- c. Integrate radar data with other data



- Where are we in providing answers to these questions, what have we achieved within ENRAM?

J Comp Physiol A (2017) 203:509–529
DOI 10.1007/s00359-017-1181-9



From Agricultural Benefits to Aviation Safety: Realizing the Potential of Continent-Wide Radar Networks

SILKE BAUER, JASON W. CHAPMAN, DON R. REYNOLDS, JOSÉ A. ALVES, ADRIAAN M. DOKTER, MYLES M. H. MENZ, NIR SAPIR, MICHAL CIACH, LARS B. PETTERSSON, JEFFREY F. KELLY, HIDDE LEIJNSE, AND JUDY SHAMOUN-BARANES

BioScience •

REVIEW

Atmospheric conditions create freeways, detours and tailbacks for migrating birds

Judy Shamoun-Baranes¹ • Felix Liechti² • Wouter M. G. Vansteelandt^{1,3}

MIGRATION

Mass seasonal bioflows of high-flying insect migrants

Gao Hu,^{1,2,3*} Ka S. Lim,² Nir Horvitz,⁴ Suzanne J. Clark,² Don R. Reynolds,⁵ Nir Sapir,⁶ Jason W. Chapman^{2,3*}

Current Biology
Magazine

Correspondence

Detection of flow direction in high-flying insect and songbird migrants

Jason W. Chapman^{1,2,†,*}, Cecilia Nilsson^{3,†}, Ka S. Lim¹, Johan Bäckman³, Don R. Reynolds^{1,4}, Thomas Alerstam³, and Andy M. Reynolds¹

RESEARCH ARTICLE

Innovative Visualizations Shed Light on Avian Nocturnal Migration



Judy Shamoun-Baranes^{1†*}, Andrew Farnsworth^{2†}, Bart Aelterman³, Jose A. Alves^{4,5}, Kevin Azijn³, Garrett Bernstein⁶, Sérgio Branco⁷, Peter Desmet³, Adriaan M. Dokter¹, Kyle Horton⁴, Steve Kelling², Jeffrey F. Kelly³, Hidde Leijnse⁹, Jingjing Rong¹⁰, Daniel Sheldon^{9,10}, Wouter Van den Broeck¹¹, Jan Klaas Van Den Meersche¹², Benjamin Mark Van Doren², Hans van Gasteren¹

USING HIGH-RESOLUTION GPS TRACKING DATA OF BIRD FLIGHT FOR METEOROLOGICAL OBSERVATIONS

BY JILLE TREP, GIL BOHNER, JUDY SHAMOUN-BARANES, OLIVER DURIEZ, RENATO PRATA DE MORAES FRASSON, AND WILLEM BOUTEN

23 DECEMBER 2016 • VOL 354 ISSUE 6319
DOI 10.1126/science.1251111

sciencemag.org SCIENCE
Avian Research

RESEARCH

Open Access



Migration of the Western Marsh Harrier to the African wintering quarters along the Central Mediterranean flyway: a 5-year study

Nicolantonio Agostini^{1*}, Michele Panuccio^{1,2}, Alberto Pastorino¹, Nir Sapir³ and Giacomo Dell’Omo²

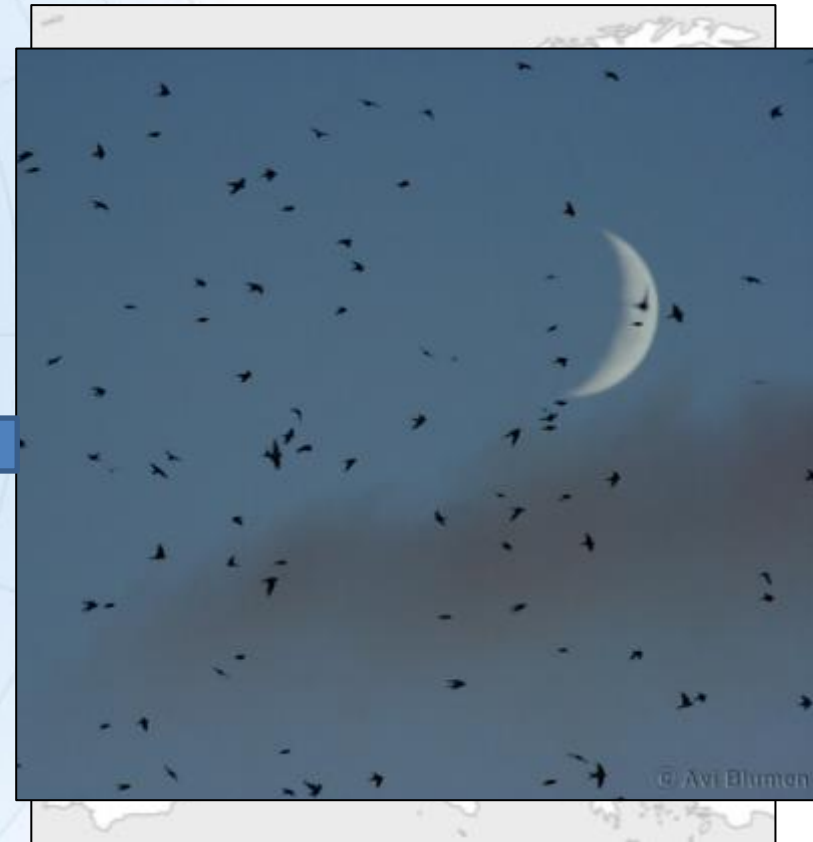
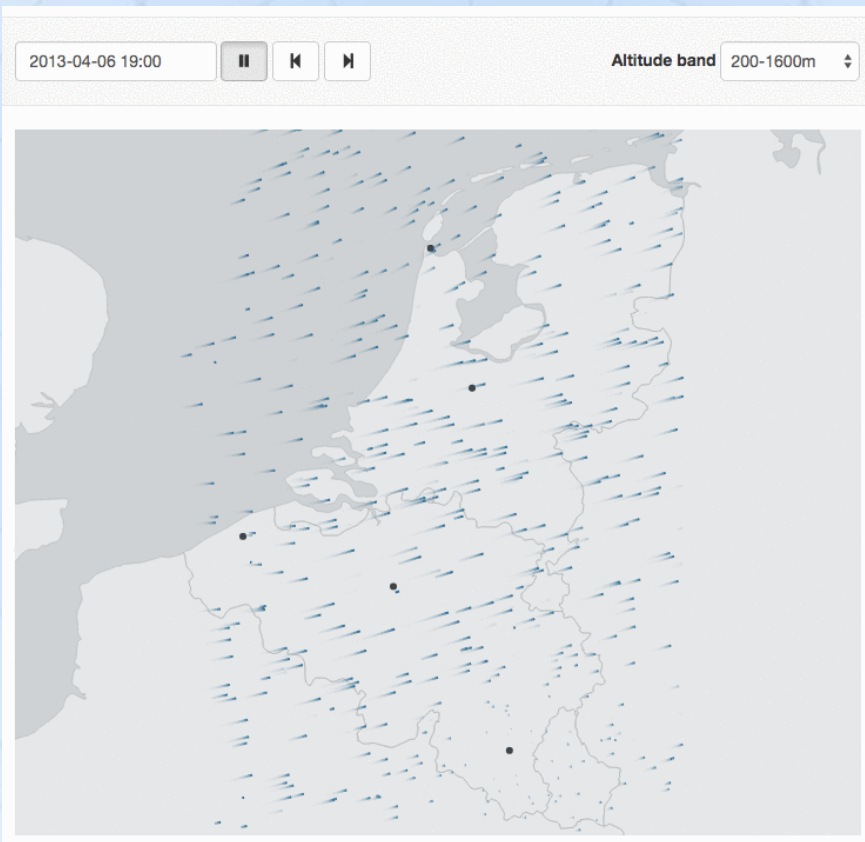
Relationship between the Intensity of Nocturnal Migration Measured by Radar and the Anthropogenic Mortality of Birds

Boyan Michev^{1*}, Pavel Zehindjiev¹, Martin P. Marinov¹ & Felix Liechti²

ACTA ZOOLOGICA BULGARICA
Acta zool. bulg., 69 (2), 2017: 229-237

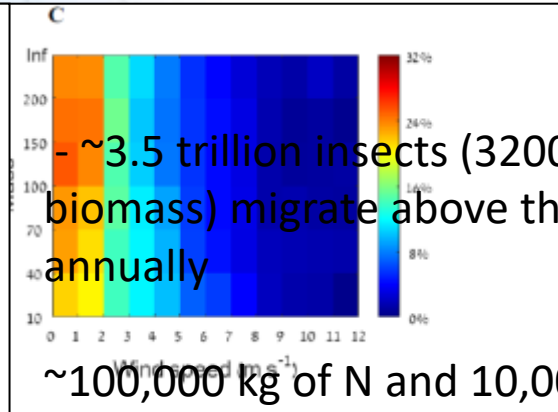
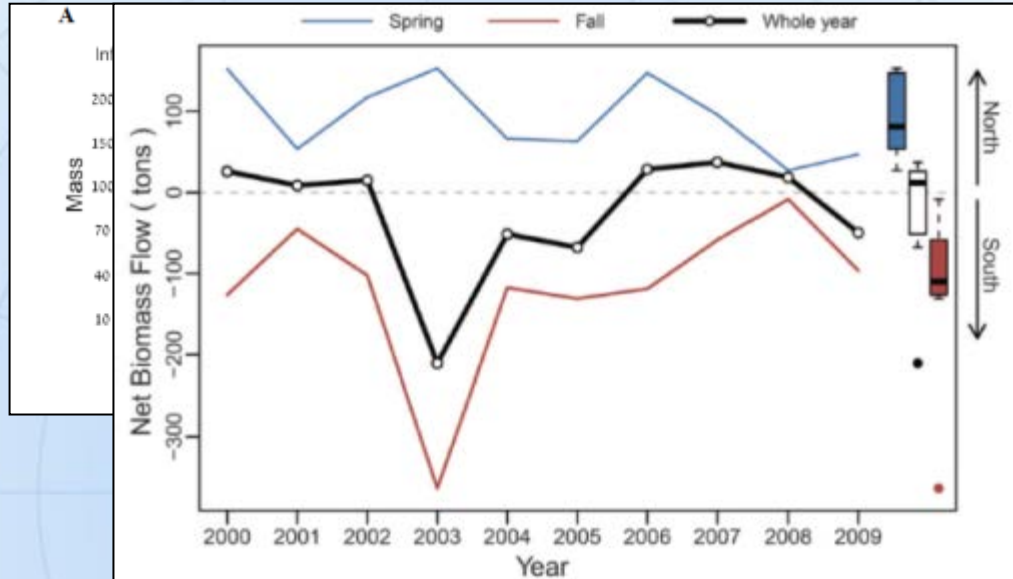
1. Description of migration

- a. Migration corridors, stopover sites, wintering regions -> migration maps
- b. Quantification of biomass & numbers

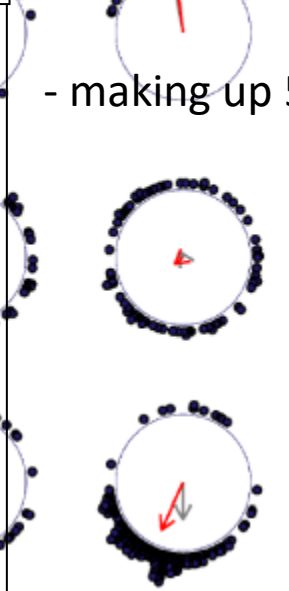
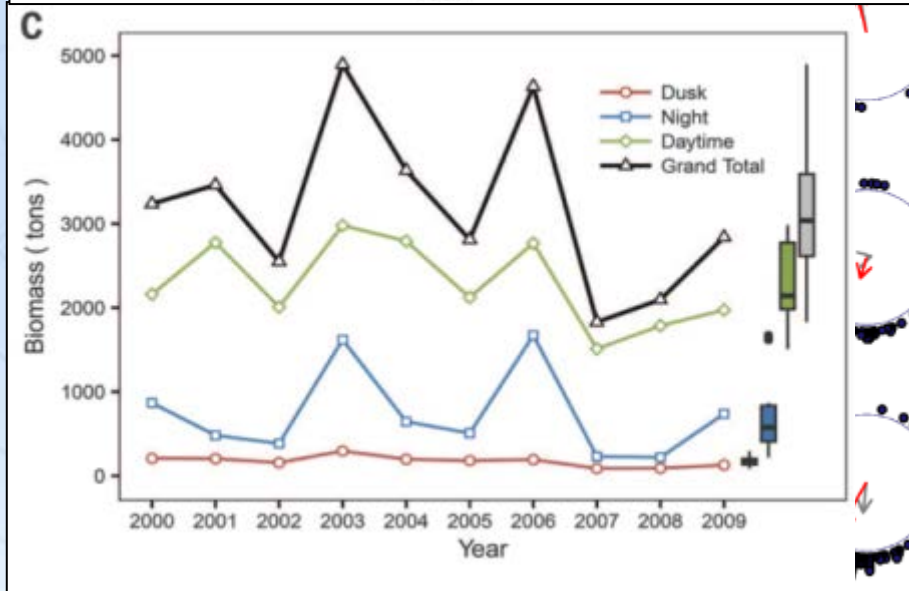


© Avi Bluman

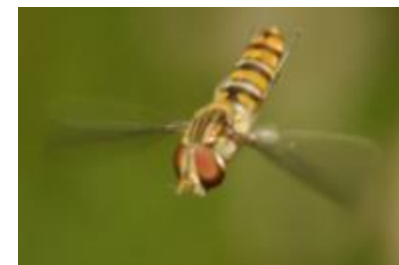
Mass migration, response to environmental conditions and possible consequences



~100,000 kg of N and 10,000 kg of P, representing 0.2% of the surface deposits of N and 0.6 to 4.7% of P from the atmosphere.

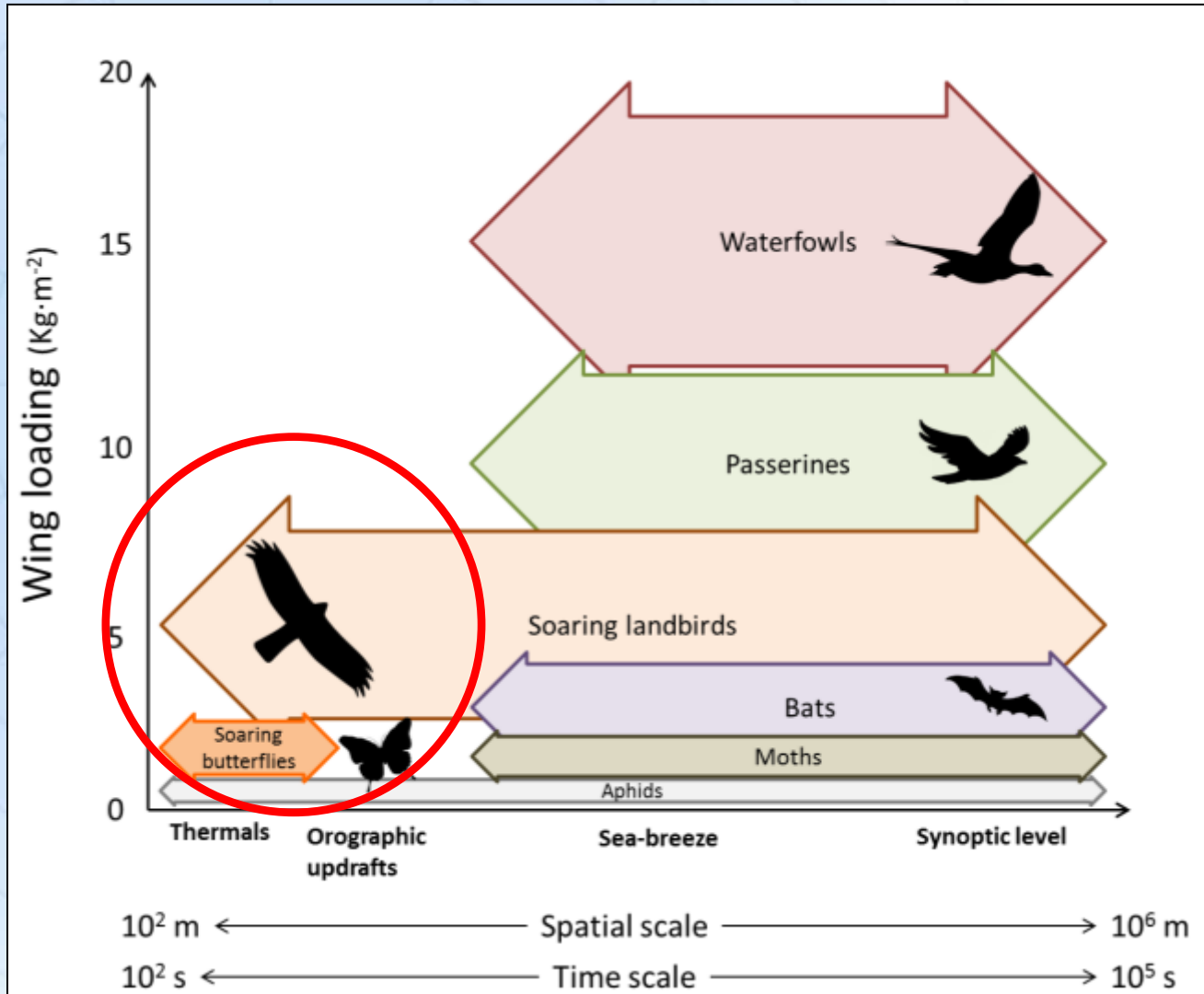


- making up 5.78×10^{12} Joules of energy.



2. Mechanisms of movement

- a. Navigation and orientation strategies, cues, ecological barriers
- b. Influence of weather on migration, survival and population dynamics



Weather is not enough for predicting migration

SCIENTIFIC REPORTS

OPEN

Nocturnally migrating songbirds drift when they can and compensate when they must

Kyle G. Horton^{1,2,3}, Benjamin M. Van Doren⁴, Phillip M. Stepanian^{3,5}, Wesley M. Hochachka⁶, Andrew Farnsworth⁵ & Jeffrey F. Kelly^{1,2}

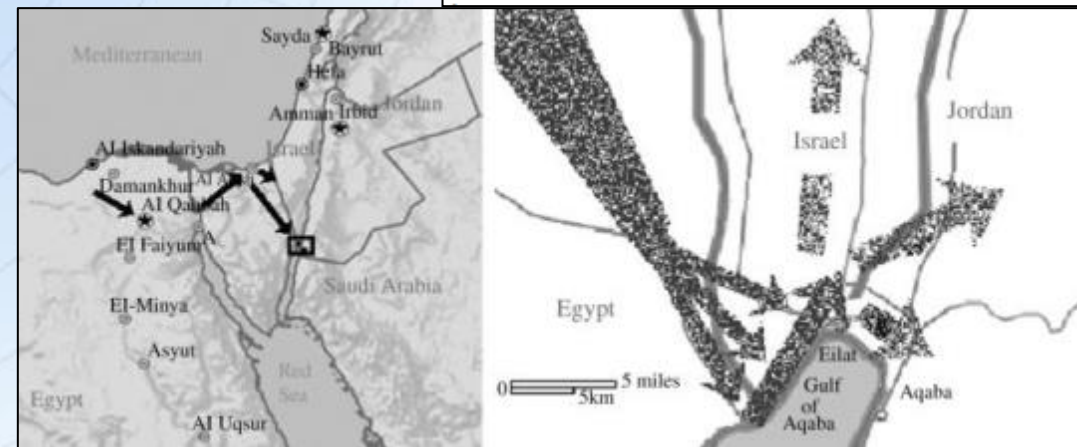
Received: 16 September 2015
Accepted: 20 January 2016

biology
letters
Biol. Lett. (2005) 1, 472–475
doi:10.1098/rsbl.2005.0334
Published online 11 July 2005

Migrating locusts can detect polarized reflections to avoid flying over the sea
N. Shashar^{1,2,*}, S. Sabbah^{1,2} and N. Aharoni¹



Becciu et al. submitted



Atmospheric condition

Behavioral response

Geographic feature



Atmospheric condition

Behavioral response

Geographic feature

Temperature

Wind

Condition dependent avoidance

Compensation for drift towards sea

Large water bodies

Atmospheric condition

Behavioral response

Geographic feature

Fog and low clouds

Avoidance, changes in flight attributes

Topography

Temperature

Exploit thermal updrafts

Exploit orographic updrafts

Wind

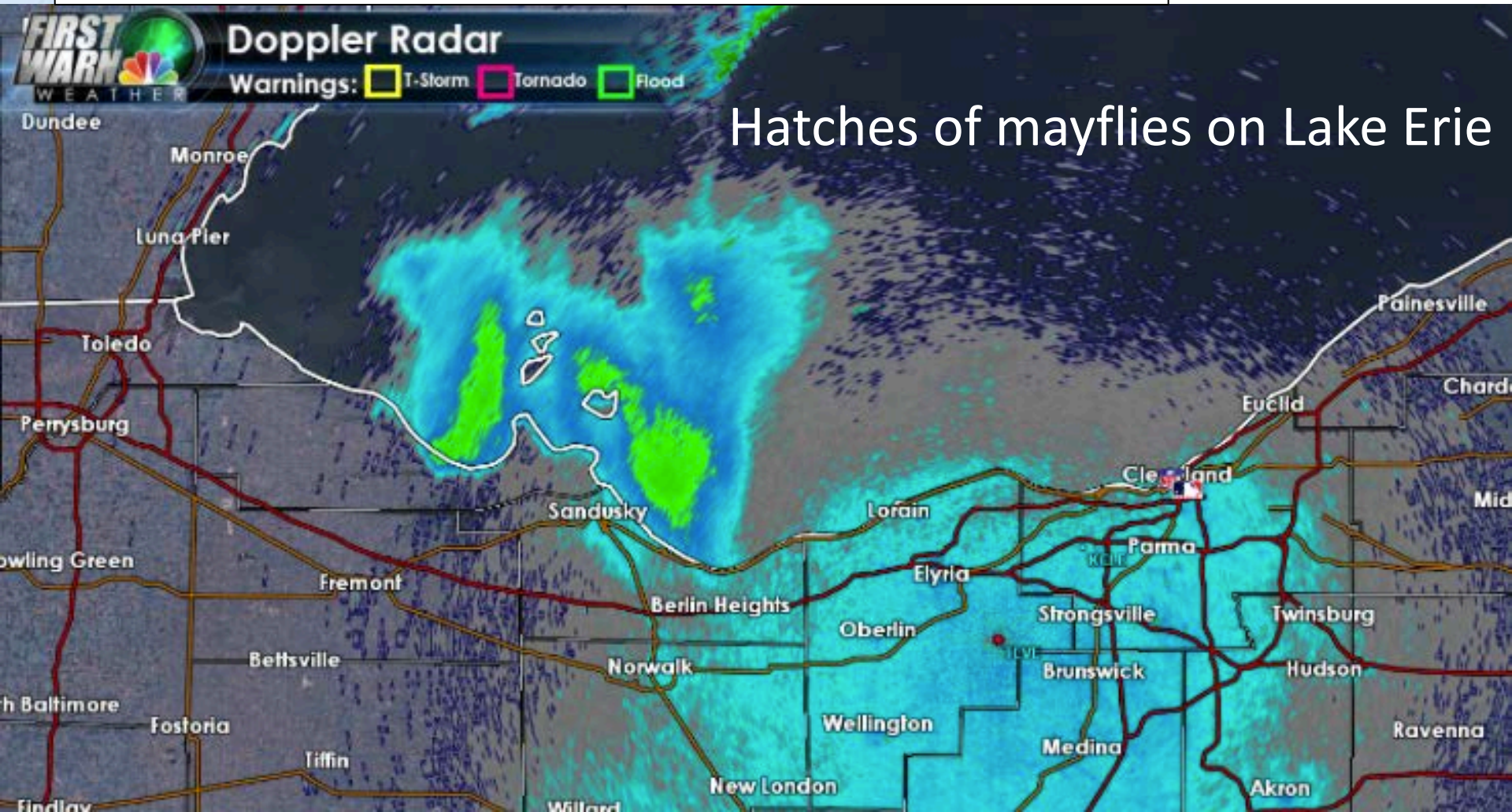
Condition dependent avoidance

Large water bodies

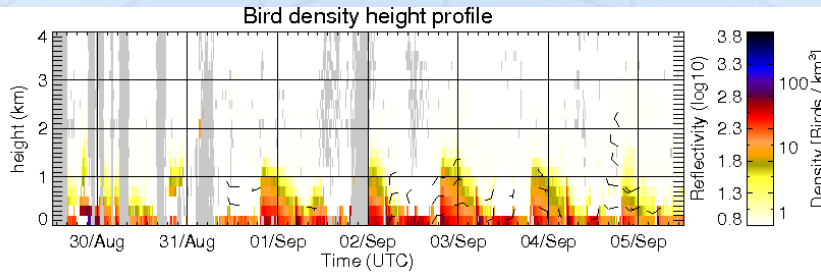
Compensation for drift towards sea

3. Services & disservices – use & avoidance

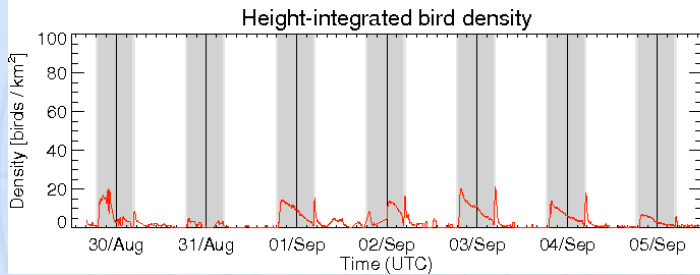
Inferring ecosystem health from radar detected mass insect hatches



3. Services & disservices – use & avoidance

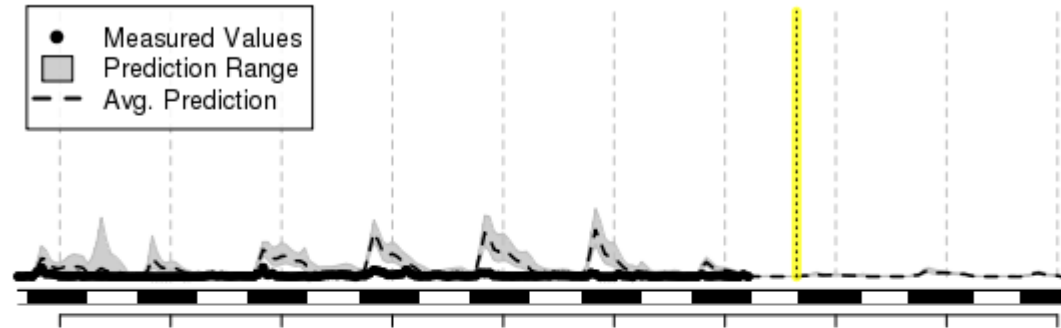


Bird migration consequences for flight safety



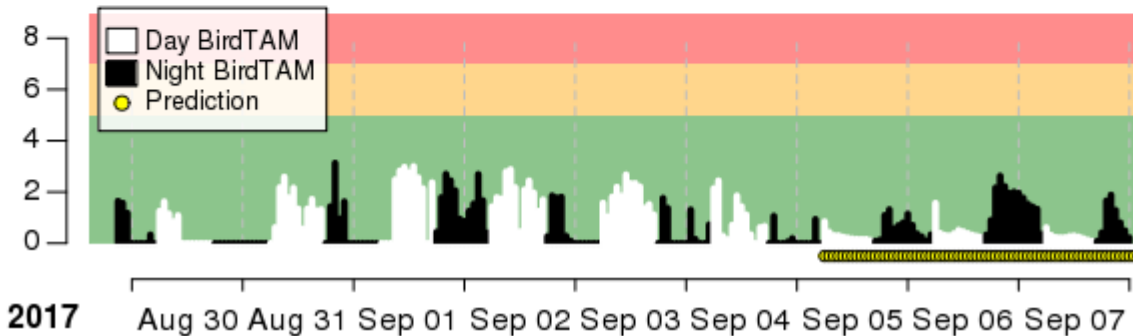
Hourly predicted and measured migration intensity

- Measured Values
- Prediction Range
- - Avg. Prediction



Hourly BirdTAM Intensity

- Day BirdTAM
- Night BirdTAM
- Prediction



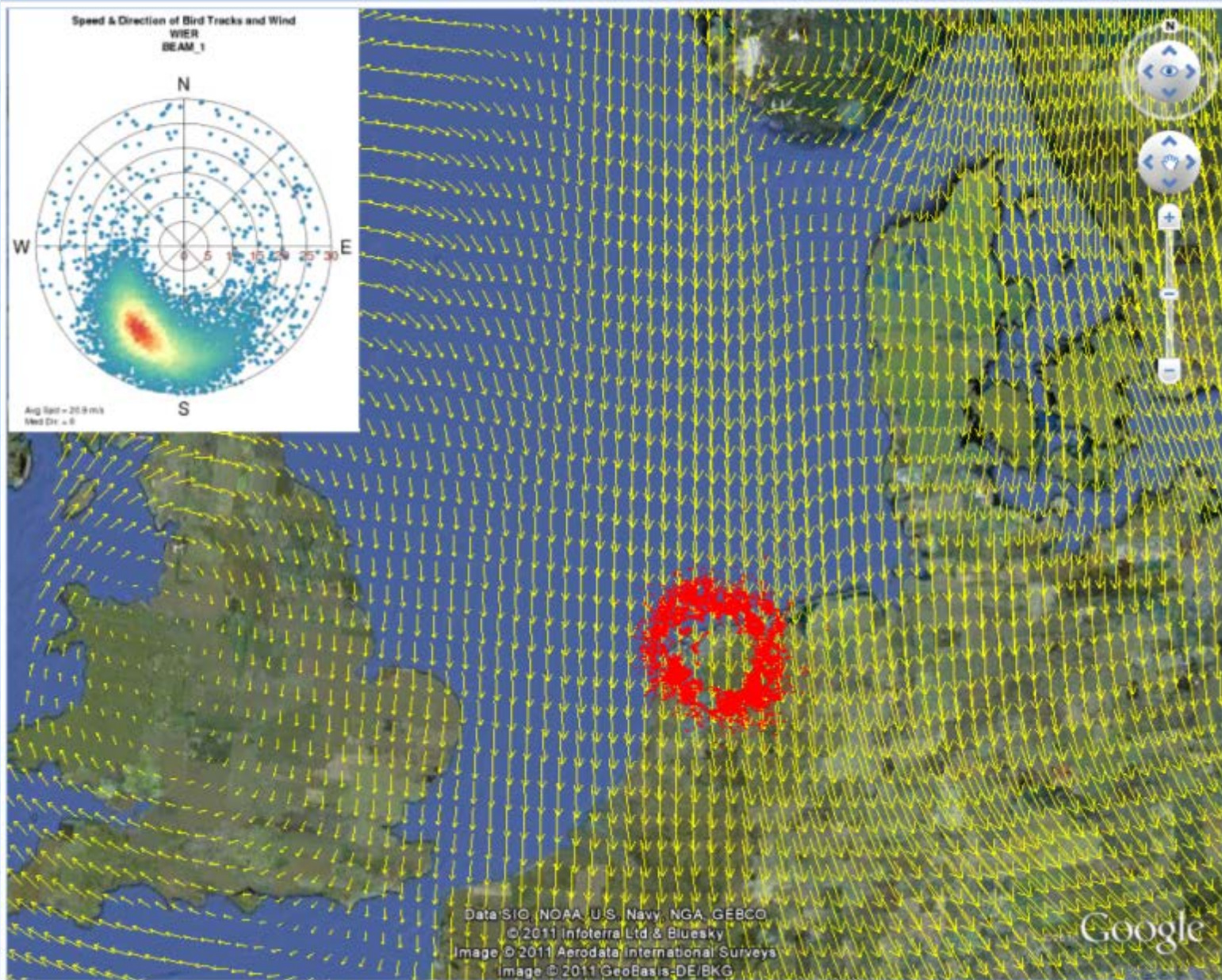
the flysafe
bird avoidance model service centre

Van Gasteren et al.

2017

Aug 30 Aug 31 Sep 01 Sep 02 Sep 03 Sep 04 Sep 05 Sep 06 Sep 07

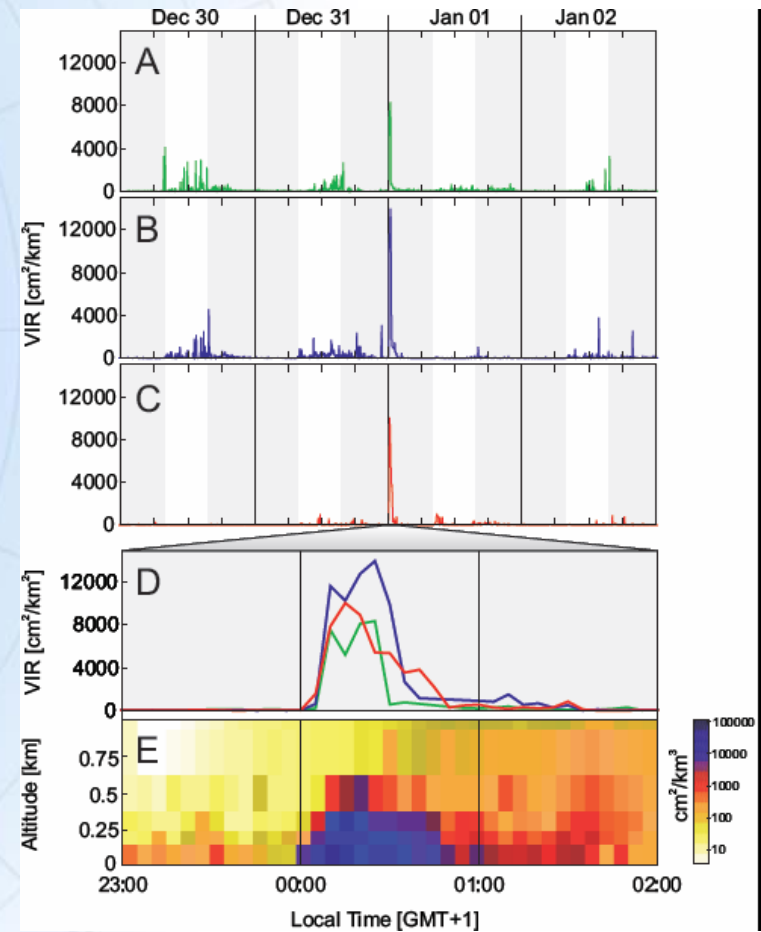
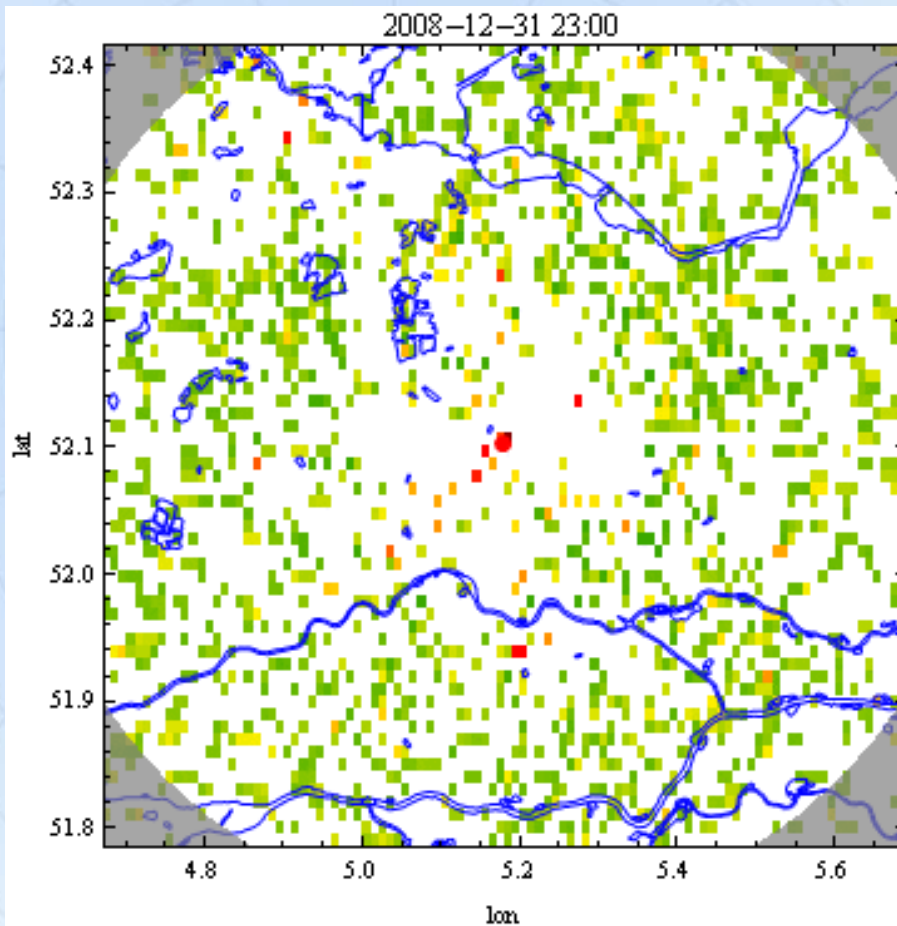
Spatially explicit migration modeling



Shamoun-
Baranes et al.

4. Human influences

- a. Effects of climate change, anthropogenic light & noise, man-made structures
- b. Conservation of migrants and migrations

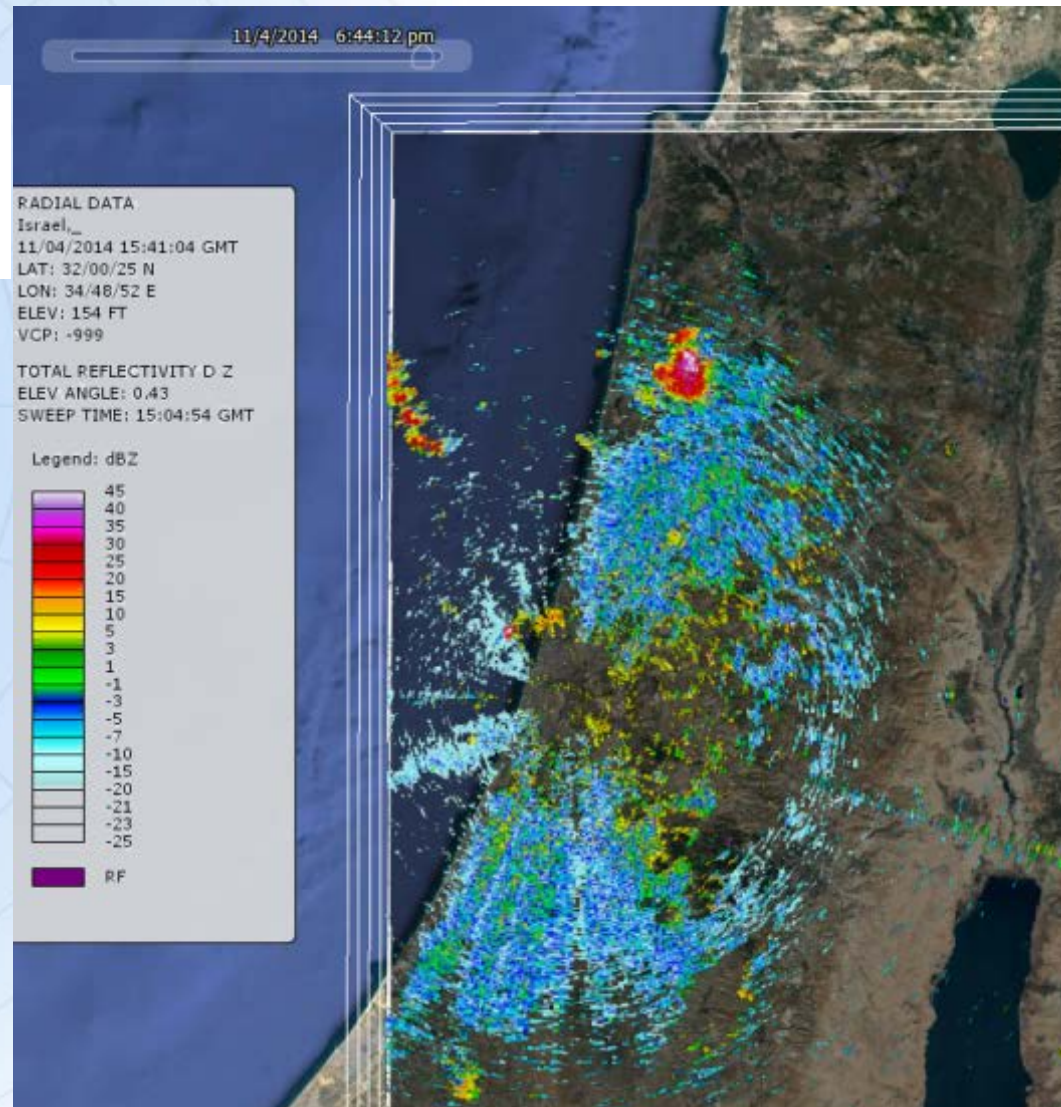
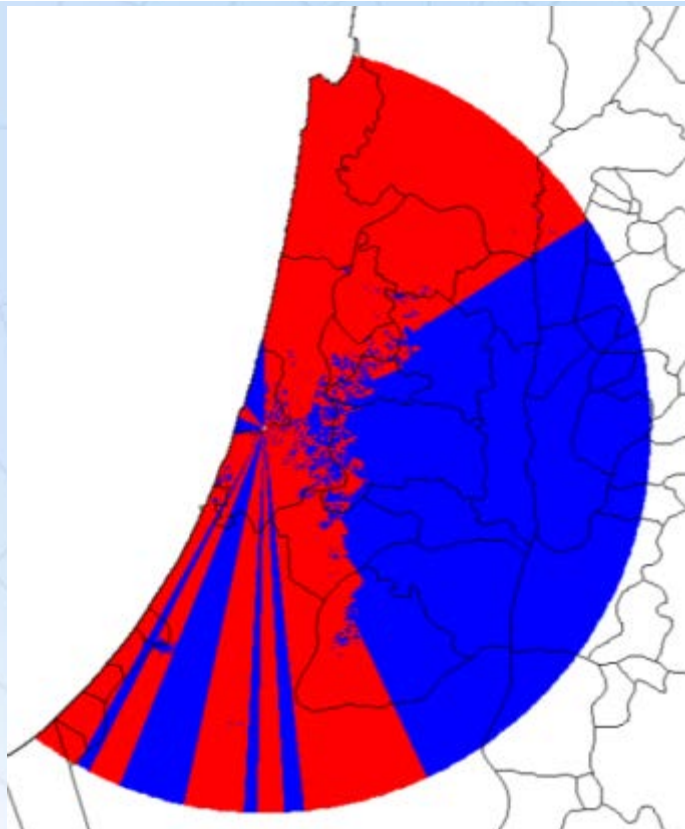


4. Human influences

- a. Effects of climate change, anthropogenic light & noise, man-made structures
- b. Conservation of migrants and migrations**

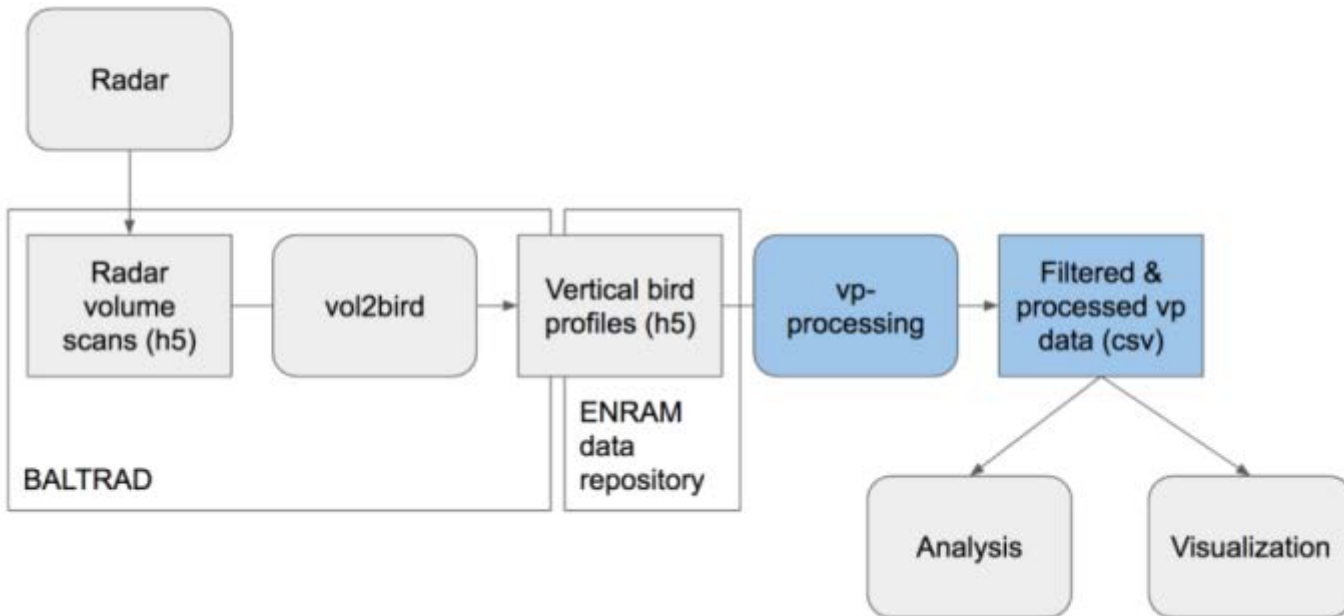
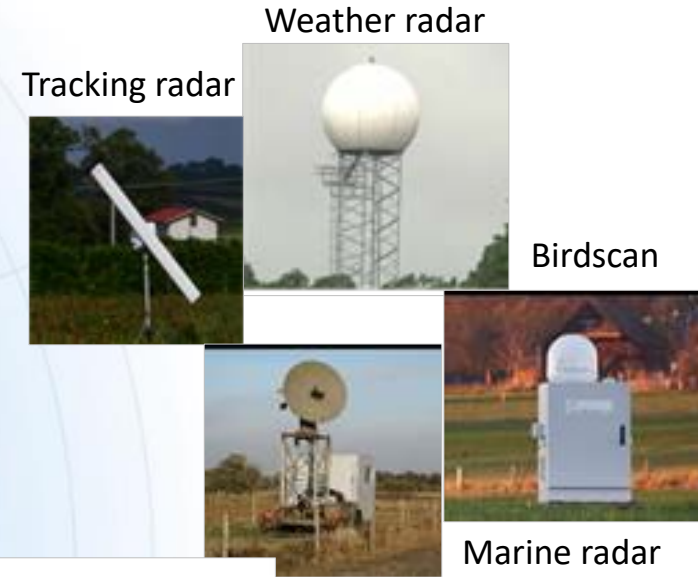
Conservation of migrants

Stopover habitat suitability studied using takeoff densities from low level radar scans



5. Technical challenges

- a. Improve classification and identification
- b. Radar data management, visualization
- c. Integration with individual movement data



Nilsson et al. submitted

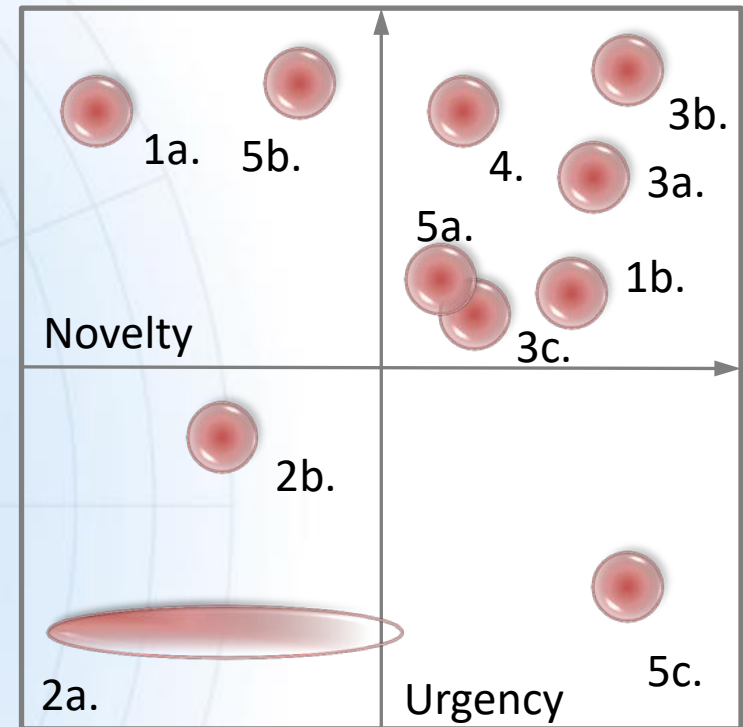
Perspectives

1. Radar data collection, exchange, infrastructure
 2. From radar data to biological information
- Data management / technical aspects / algorithms etc.
 - Points made in previous talks, Table1 in BioScience paper
 - Standard monitoring operational at small to large spatial and temporal scales

Perspectives

3. Answering important/urgent ecological questions

- Answers to questions also as comparisons
 - Across taxa – birds, insects, bats
 - Across geographic regions, e.g. North-America, Asia, Europe



- Response to changes at different time & spatial scales (e.g. climate change vs extreme weather events)
- Identify ecosystem-level consequences of movements (e.g., nutrients, biomass, parasites)

Perspectives

3. Answering important/urgent ecological questions

- Modelling: conceptual & simulation – develop theory behind mass movements
- Integration
 - Movement ecology across different taxa
 - Radar data with other data (citizen science, individual-based tracking, ringing, physiological, etc.)
 - Different disciplines: Biologists, meteorologists, physicist, IT, signal processing, etc.
 - Application fields
- Deliver products for various stakeholders
 - wind turbine facilities,
 - aircraft collision warnings,
 - conservation of important sites/area,
 - pest insect warnings

Visions

- Link continental networks
- Produce similar figure for
 - Various migrants
 - Continent-wide
 - Global

Thank you

