Next Generation Animal Tracking
- deciphering the ecological code

Wendt Müller, Jan Baert, Luc Lens

Where it all began, a brief overview of the past
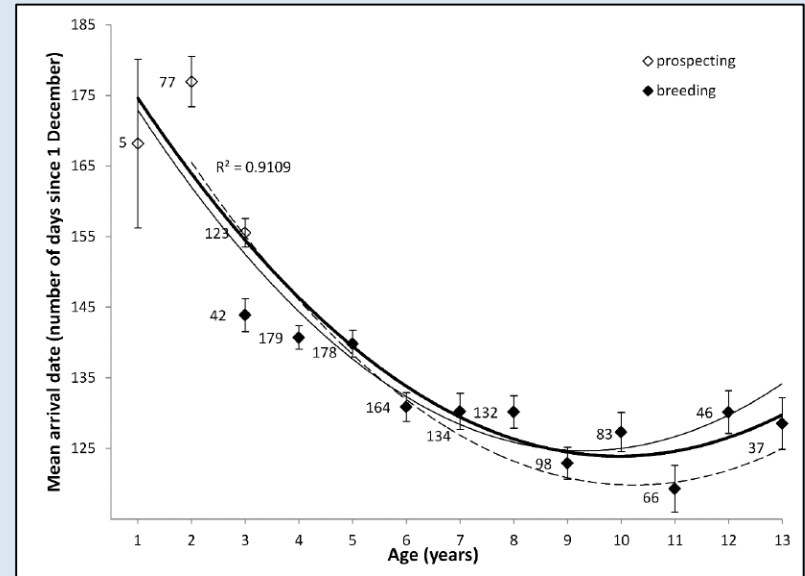
The Lesser black-backed gull project: the very beginning

RESEARCH INSTITUTE NATURE AND FOREST

Parameters of interest:
First-year survival, recruitment, migration…

Bosman 2016

- Since 1999: systematic colour-ringing of Lesser black-backed gulls in Zeebrugge (B) by Eric Stienen (INBO) and Harry Vercruijsse

- 2011: Davy Bosman (PhD), Luc Lens (UGent) join

The Lesser black-backed gull project: the very beginning

The evidence of a decline in reproductive performance stimulated the start of a new joint project:

Born to ageing parents - integrating pre- and postnatal parental effects (FWO funded project)

Do parental capacities to successfully raise offspring decline with age?

UvA BiTS GPS trackers

The Lesser black-backed gull project: the very beginning

- Substantial boost thanks to the support from:

- Running since may 2013
  - >15 billion records
  - >150 individuals
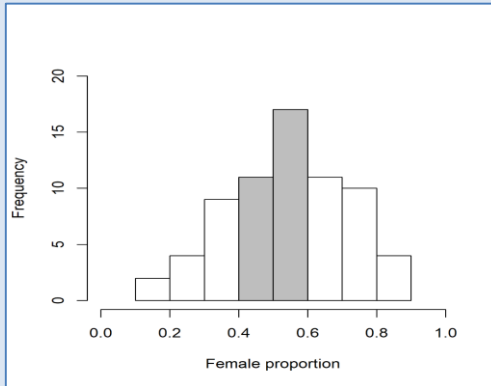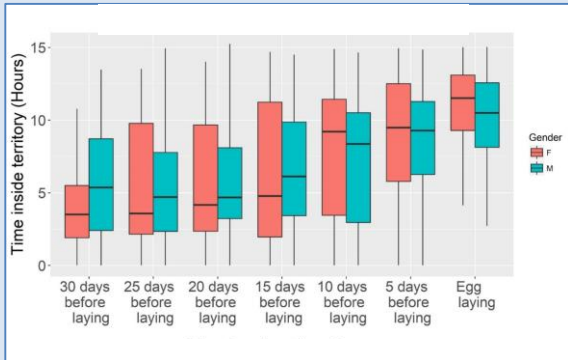 - 4 Institutions
  - 5 joined PhDs/Postdocs

Do parental capacities to successfully raise offspring decline with age?
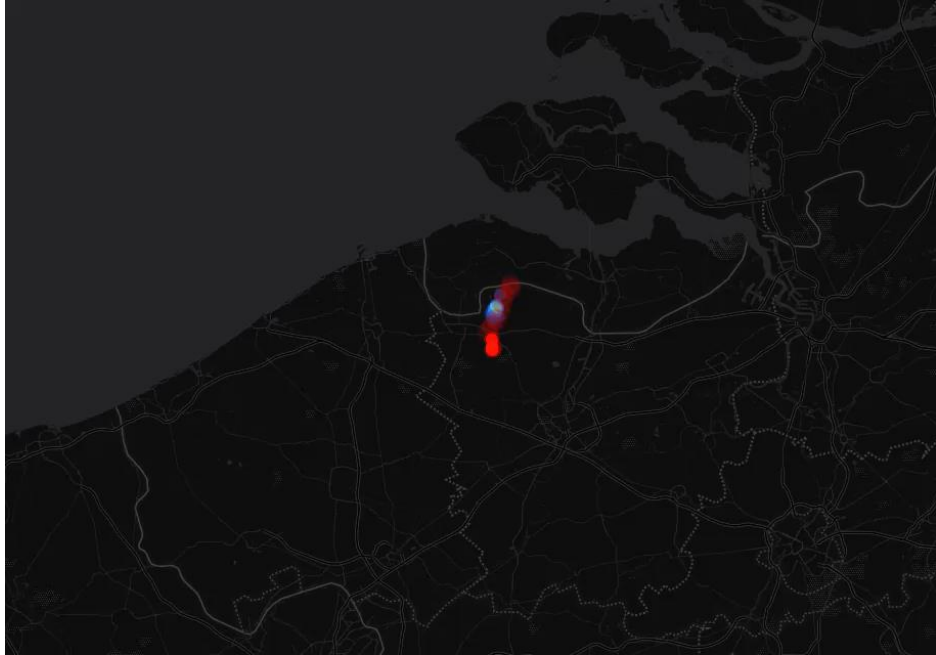

UvA BiTS GPS trackers

(The coordination of) **Parental care**

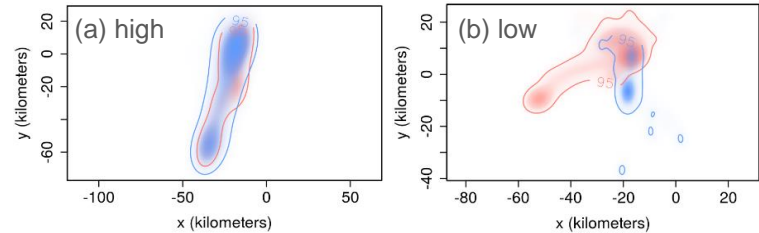- how to achieve the optimal division of parental tasks

(The coordination of) **Parental care**

- how to coordinate in space and time?
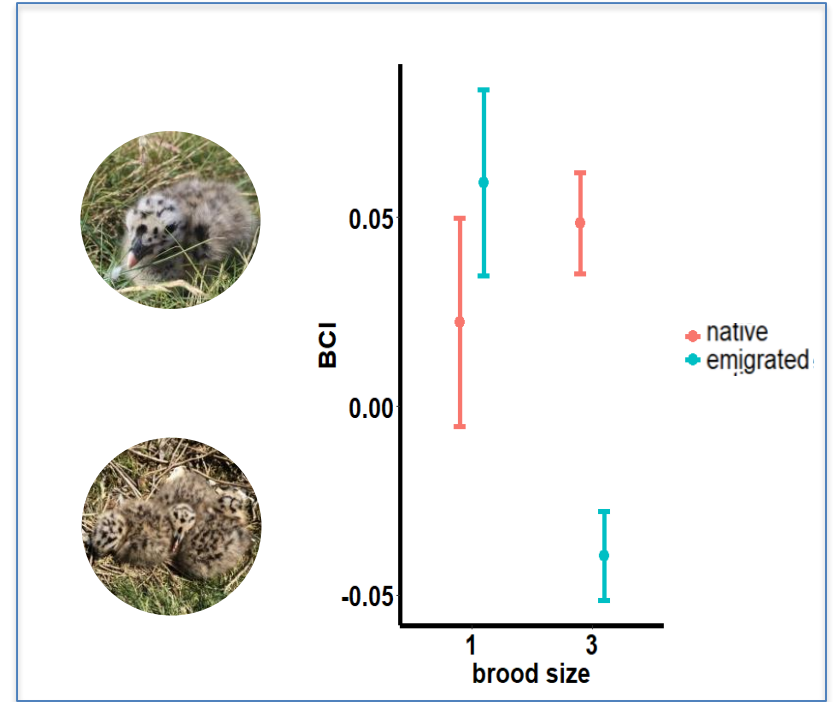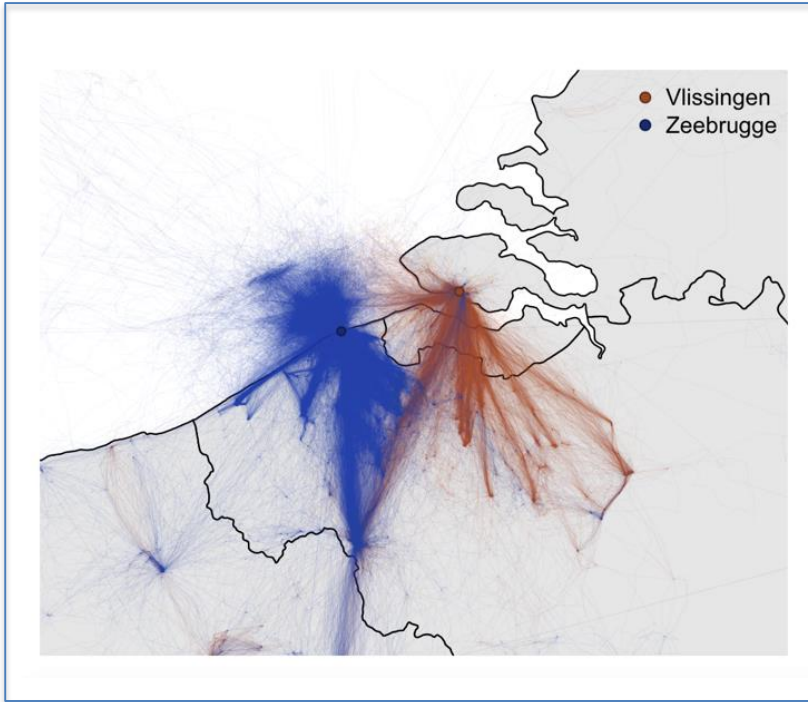

Similarity in Space Use

(a) high

(b) low

Mean home-range overlap = 0.562

Individuals are more similar to their partner than to other individuals

# (The coordination of) **Parental care**

- in times of anthropogenic change: consequences of a forced emigration

Kavelaars et al. in prep.

Gulls do not adjust their foraging behaviour after emigration – and pay a reproductive cost

Why does a generalist species that is known to be able to exploit novel (anthropogenic) resources not adjust to its new environment?

Parental Care
(Kavelaars/Salas)
PhDs

Foraging
(Santos/Sotillo/Heylen)
PhDs
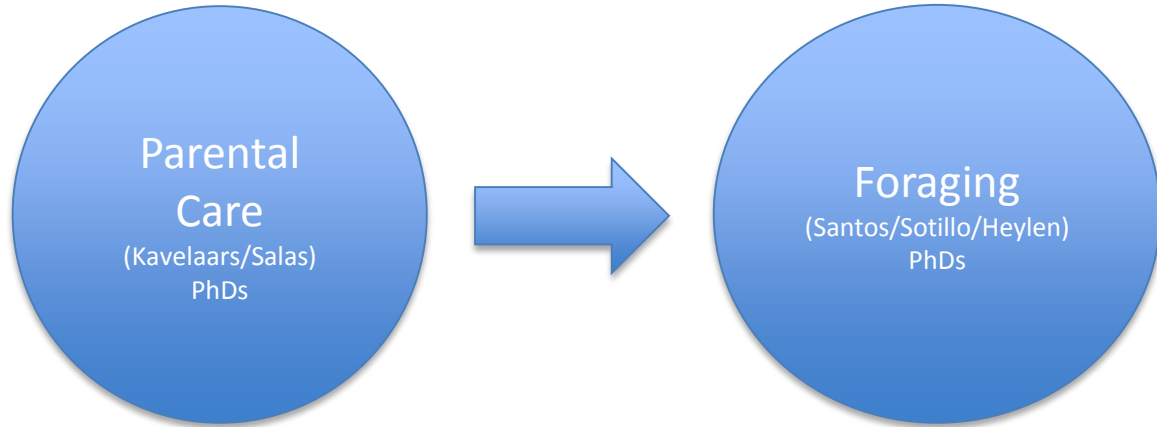
Gulls adjust to human-linked food resources – but lack an alternative on short time scales (=weekends)

Gulls Turn Cannibal on Sundays
Camphuysen & Gronert 2010

Sotillo et al. in prep.
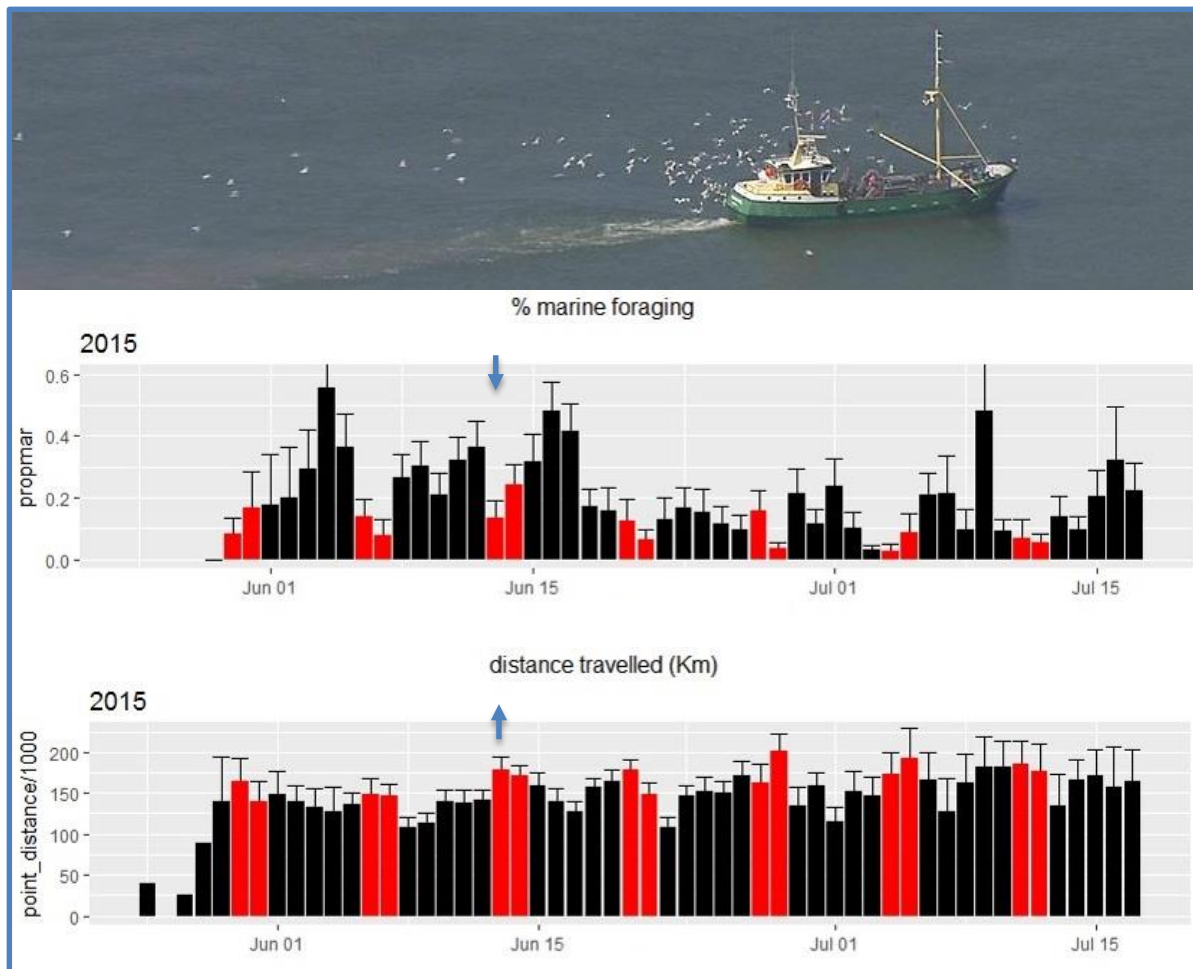
Individualized ecological niches

How do individuals interact with their environment, and how does that lead to variation in the realized ecological niche?
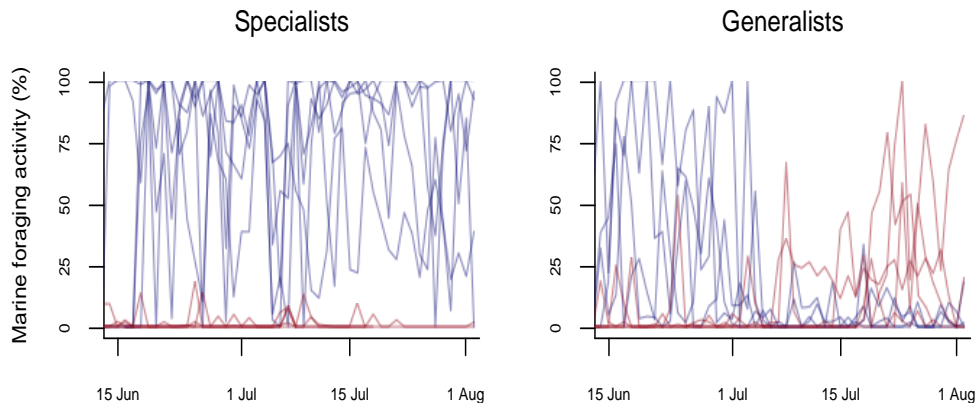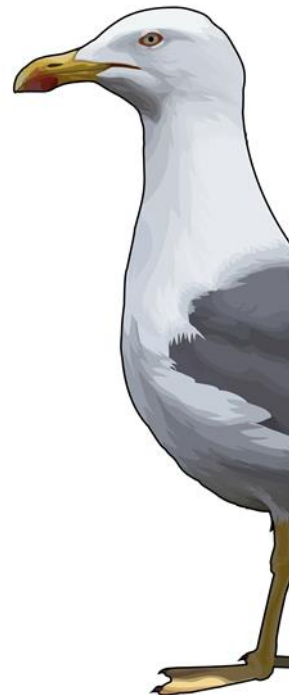
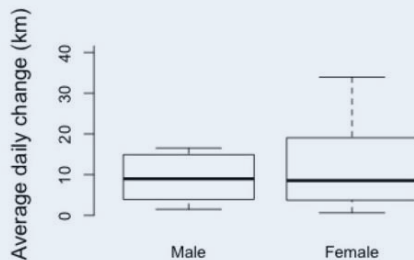# Individualized ecological niches

Individuals differ

- – The concept of individualization was initially highlighted in behavioural biology (animal personalities, behavioural reaction norms)
- – Foraging specialization: Among-individual differences in niche use and width of their ecological niche/individual niches
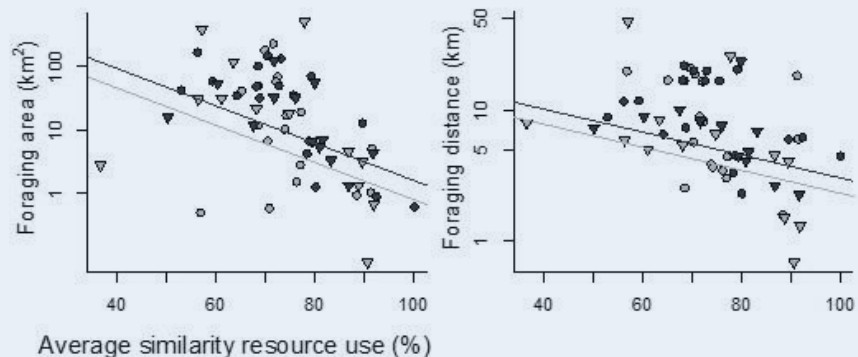
The adaptive significance of foraging specialization likely depends on

- – How specialization improves foraging efficiency and spatial knowledge
- – The predictability of a food resource (environment)
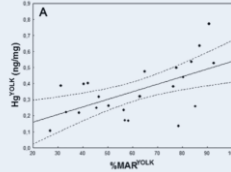
Individualized ecological niches


Consistency in foraging behavior

Resource specialization reduces the size of the foraging area and lowers the daily foraging effort
(males: circle, females: triangle; dotted line: during incubation, solid line: during chick rearing)

Higher reproductive success

Van den Bosch et al. 2019

Individualized ecological niches

But see...

- Toxicological consequences of different diets
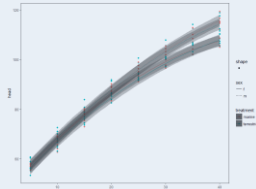
- Consequences of different diets for chick growth

- Foraging efficiency
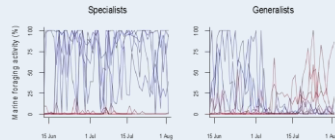
- Foraging specialisation

Individualized ecological niches

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- The concept of individualization was initially highlighted in behavioural biology (animal personalities, behavioural reaction norms)
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The adaptive significance of foraging specialization likely depends on
- How specialization improves foraging efficiency and spatial knowledge
- The predictability of a food resource (environment)

Detailed, high resolution data are required to study the processes leading to individualized niches along with their ecological and evolutionary consequences

The individual

Intrinsic capacities and state

Genetic and phenotypic information

Behavioural types: Individuals differ in their behaviour over time and across contexts (*animal personalities or behavioural types*) - and therewith potentially also in their response to (changes in) their environment.
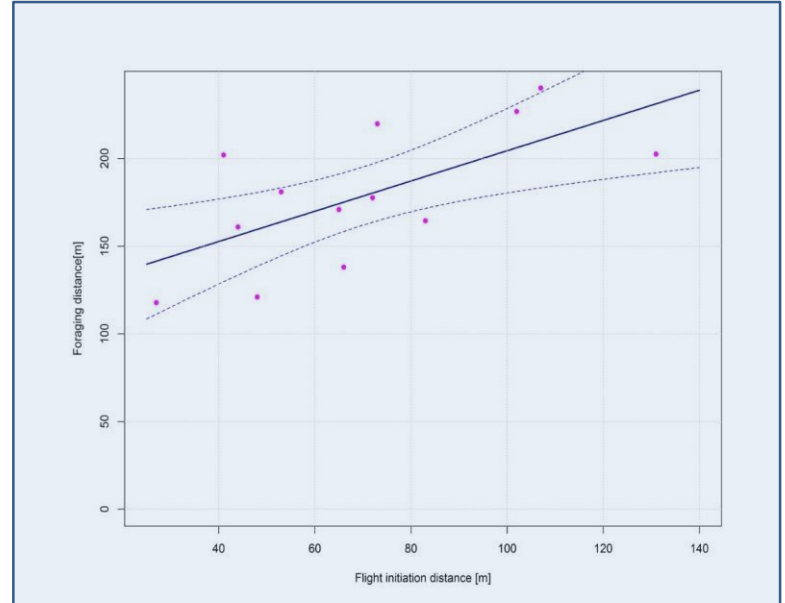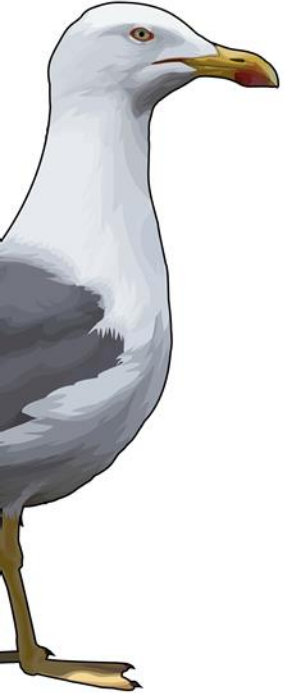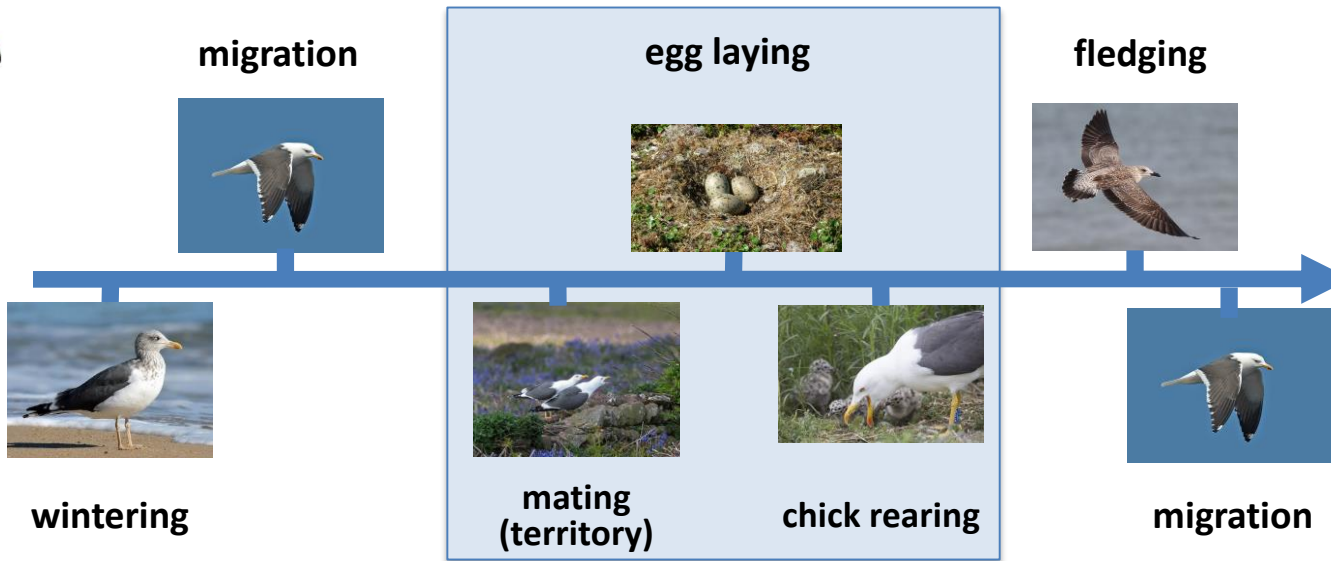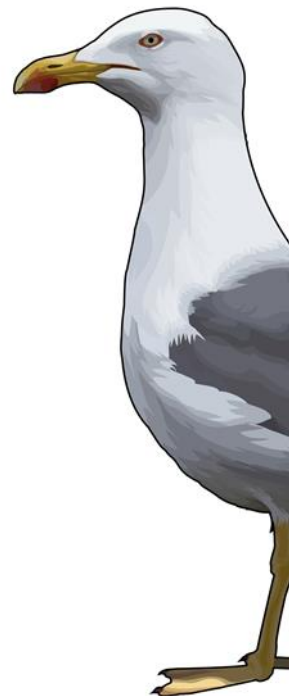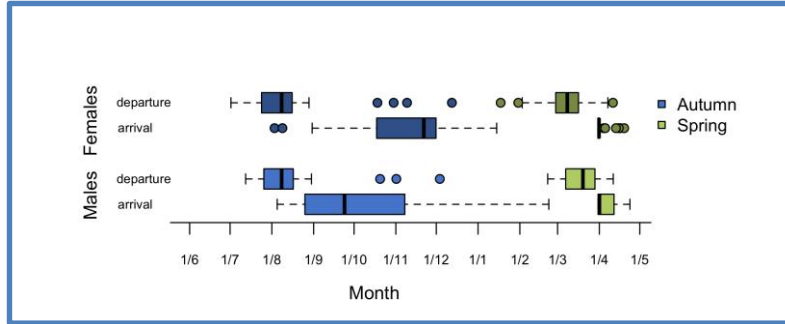
shyness, sociability, aggression, activity and exploration

Behavioural types

(a)

Start distance
AD — Shows alert behavior
FID — Flees (rapid walk or flight)

(b)

100 cm
200 cm
100 cm
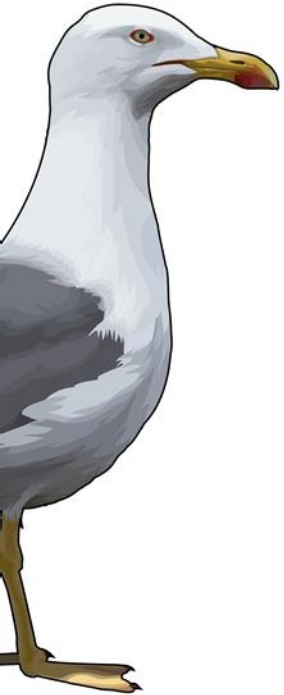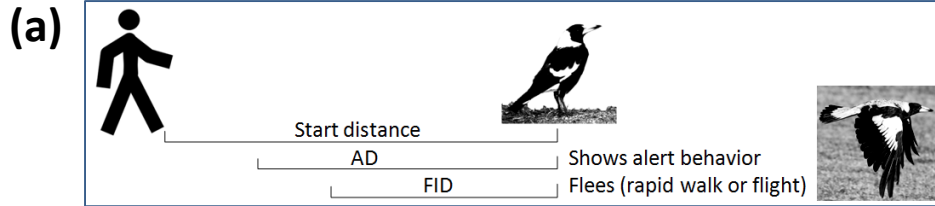
(c) Behaviour can be inferred from tracking data

Foraging distance [m]

Flight initiation distance [m]

Behavioural types and foraging specialization: conceptually similar and functionally entwined

Toscano et al. (2016)

The individual

Intrinsic capacities and state

Genetic and phenotypic information

Behavioural types
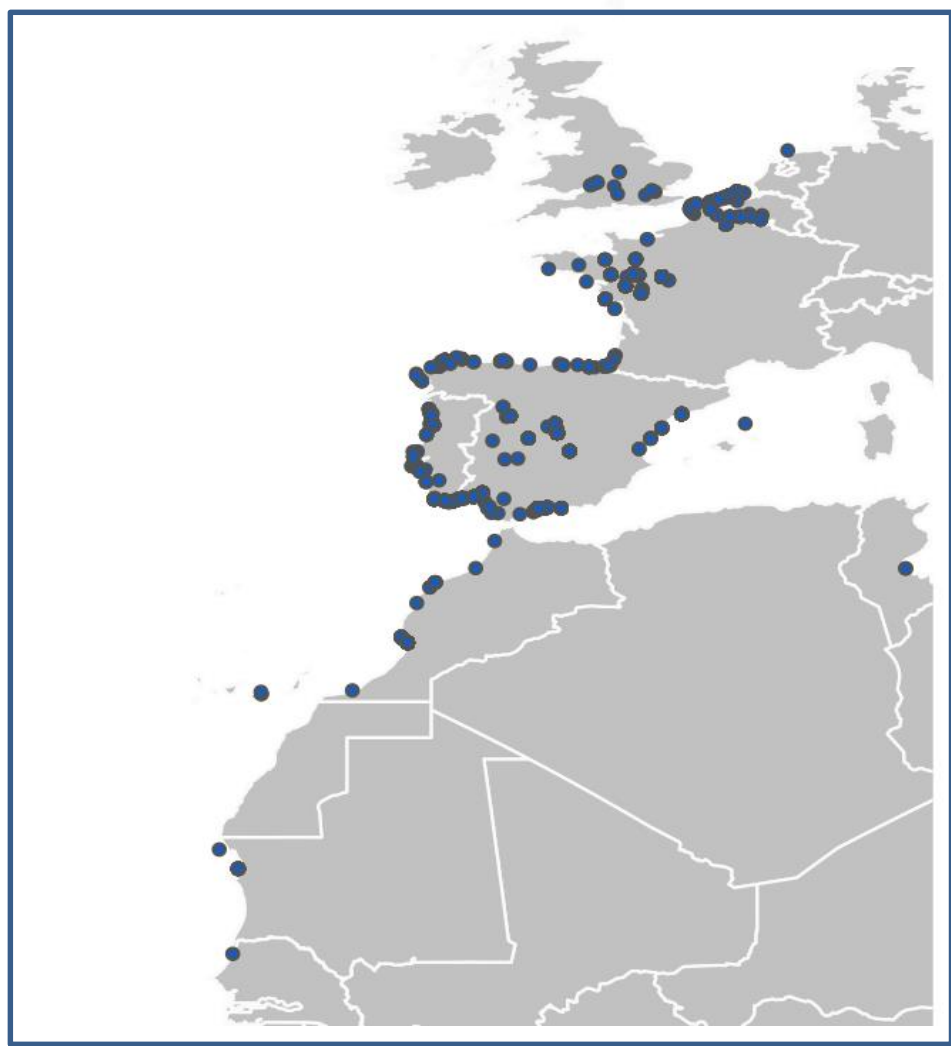
Affecting life-history decisions
throughout the annual cycle?

migration

egg laying

fledging

wintering

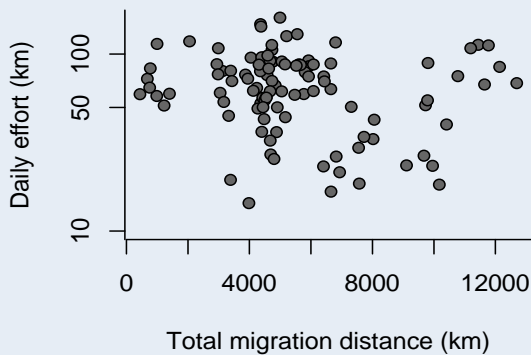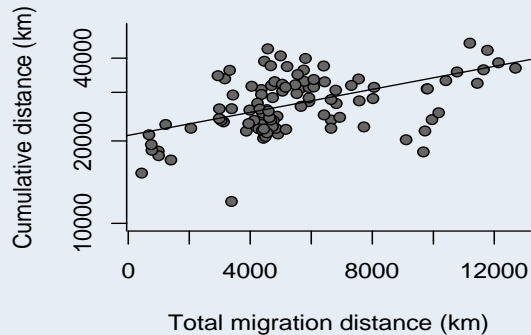mating (territory)

chick rearing
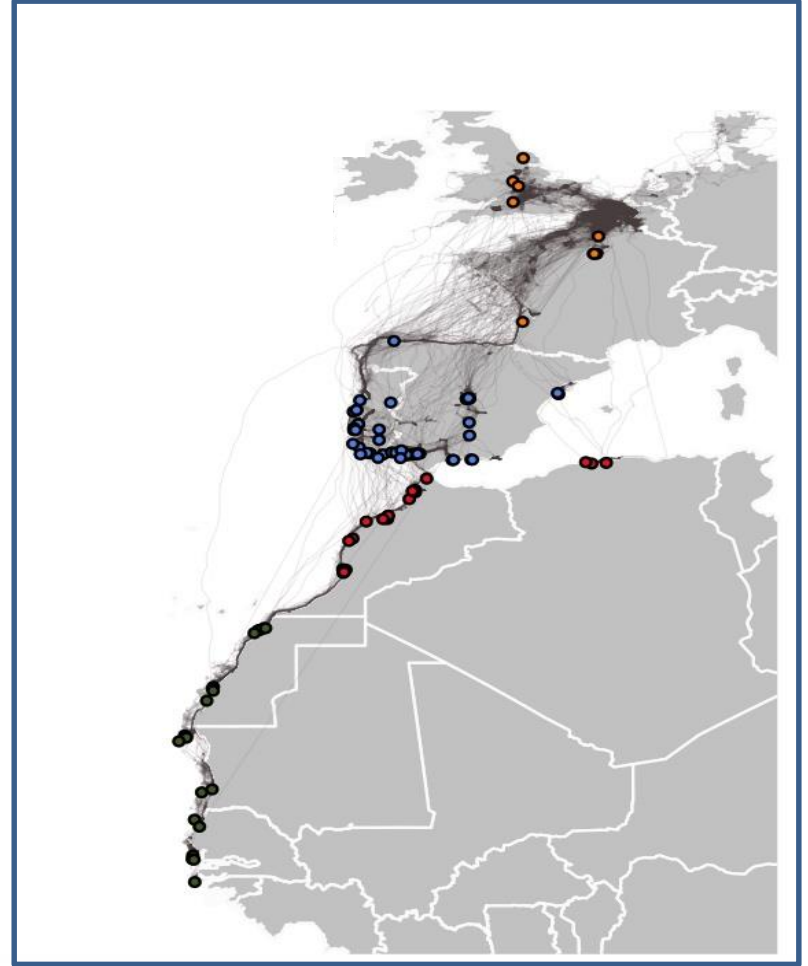
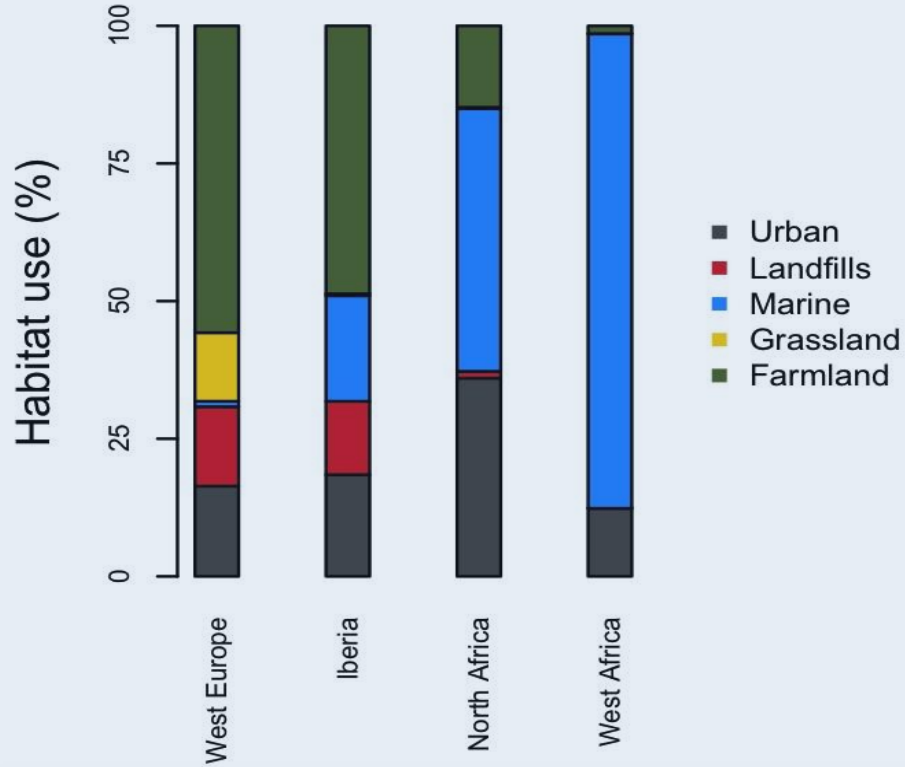migration

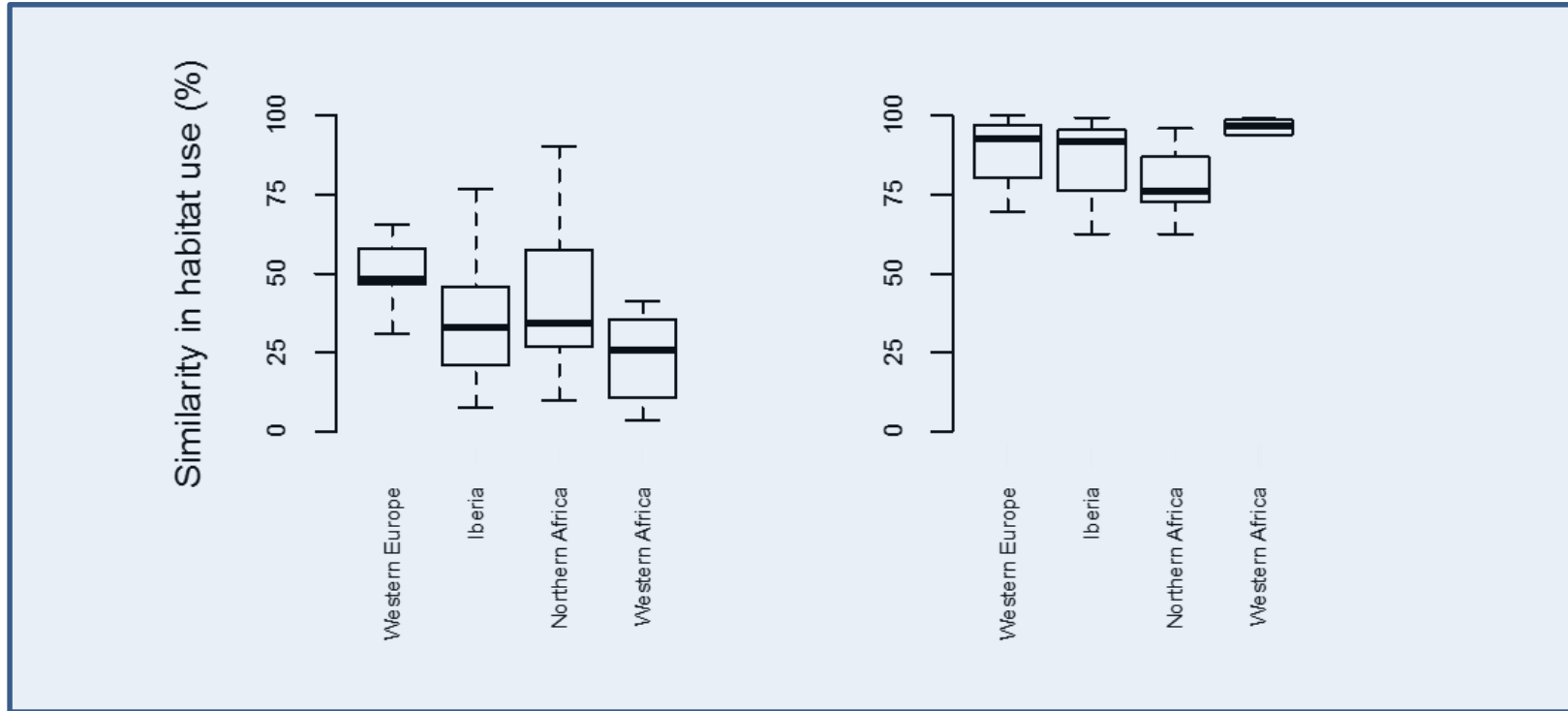Life History context: Towards individual fitness landscapes?

Bird migration

Bosman *et al.* 2012, *Ibis,* Shamoun-Baranes *et al.* 2017, *Journal of Avian Biology,* Baert *et al.* 2018, *Scientific Reports*
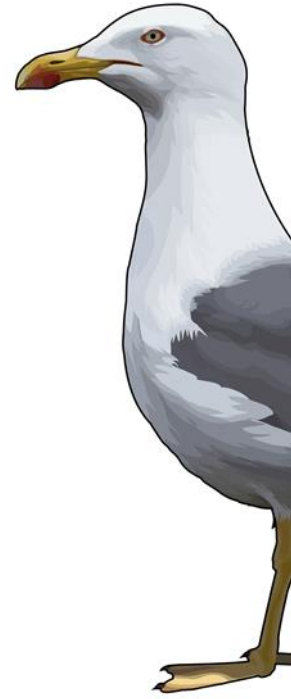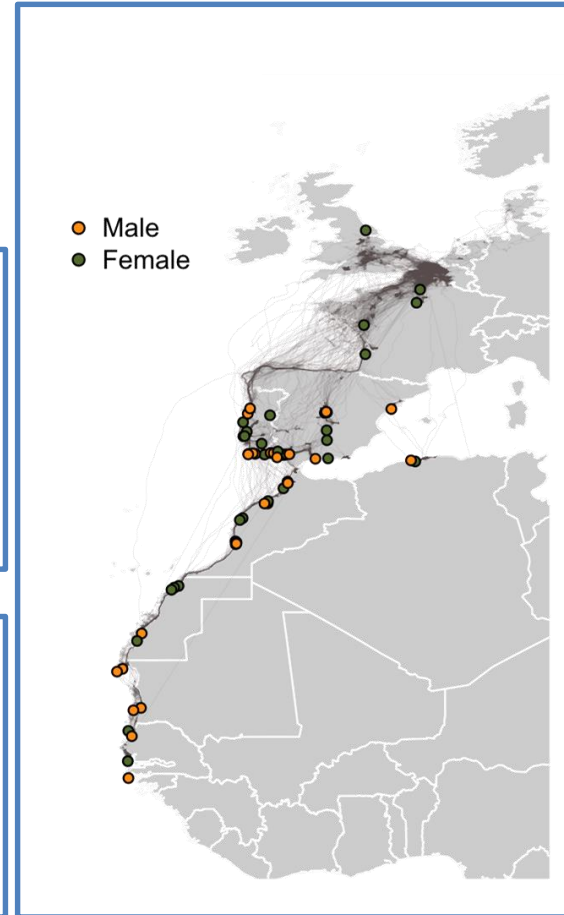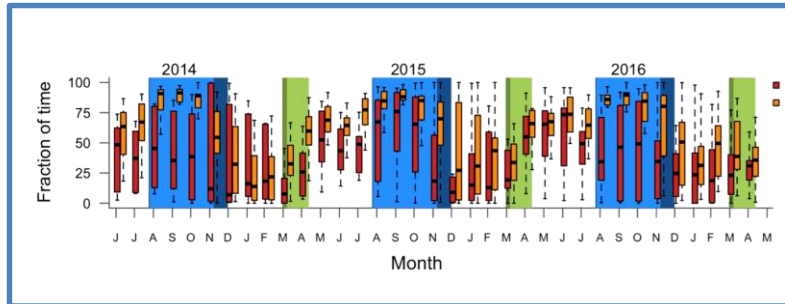
Why migrate?

Why migrate?

Migrating in function of their ecological niche?

No evidence – the causes and consequences of individual variation in migratory behaviour remain elusive – to be continued
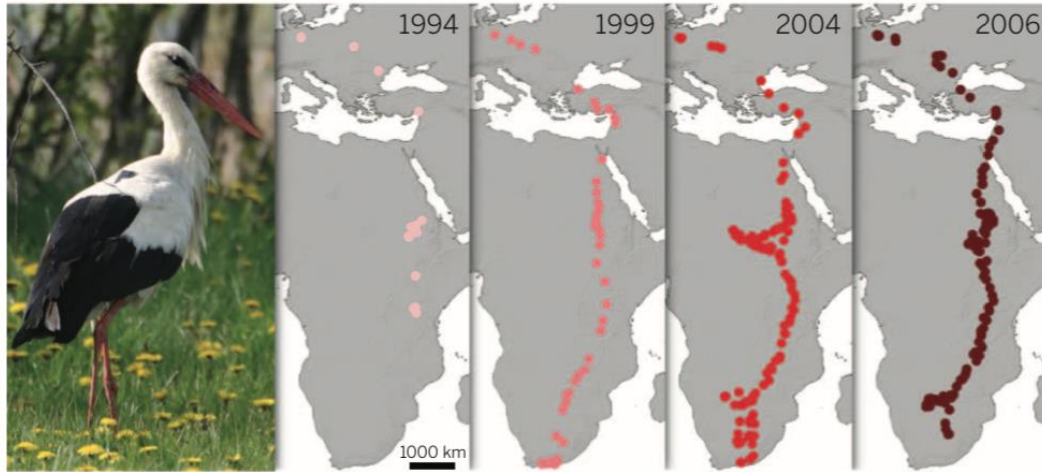
Current challenges

Recording the unobservable

Kays et al. 2015

National Geographic Society

High-resolution monitoring of animals and their environment


Kays *et al.* 2015
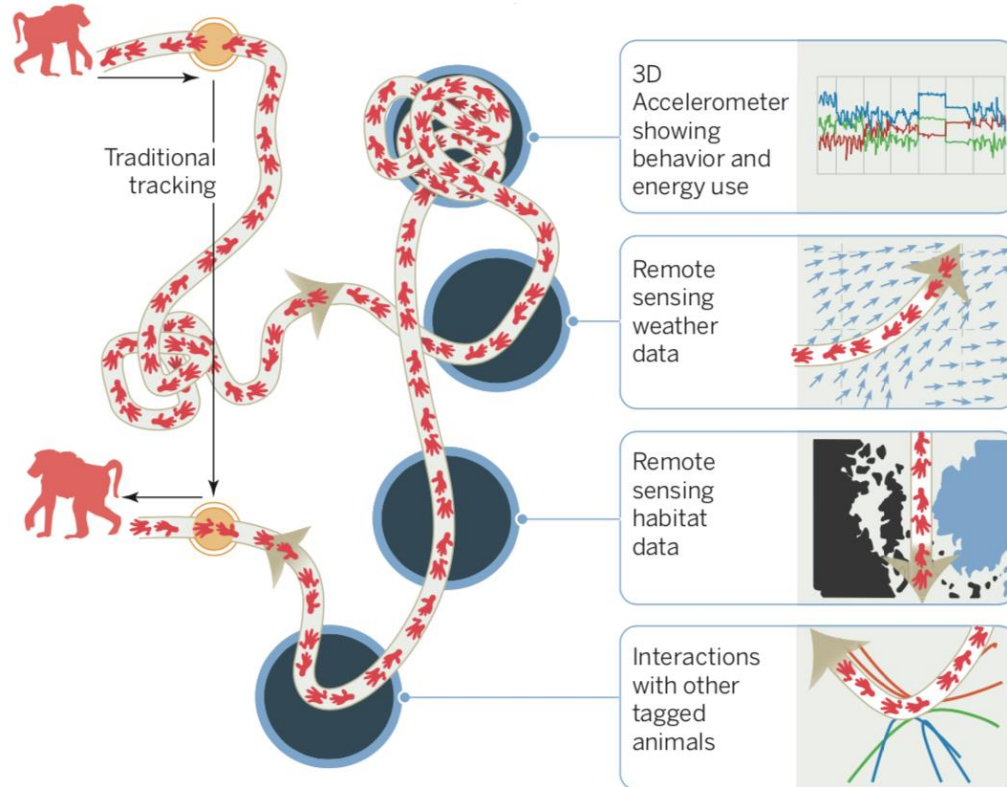
Unprecedented opportunities

- High resolution time series
    e.g. individual decisions, learning behaviour and cognition…

- Affordable devices
    e.g. group dynamics, social interactions, intraspecific variation …

- Mapping of the abiotic environment
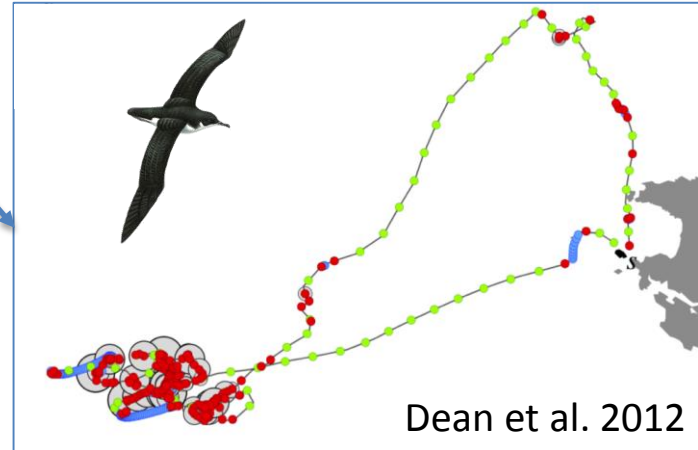   e.g. energy landscapes, resource selection, responses to
    environmental changes …

Methodological challenges

- Efficient processing of big data

- Annotating data from animal-borne and remote sensors

- Analysing spatiotemporal patterns

Methodological challenges –
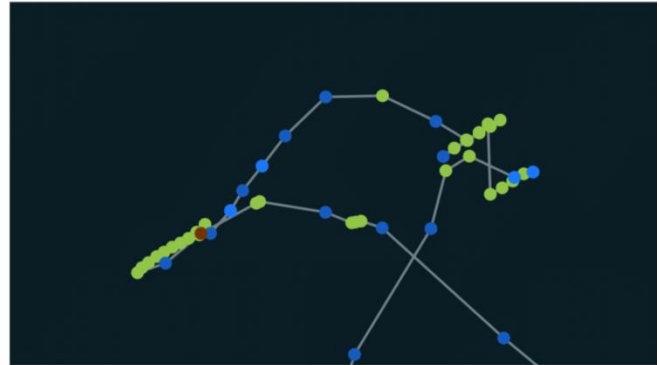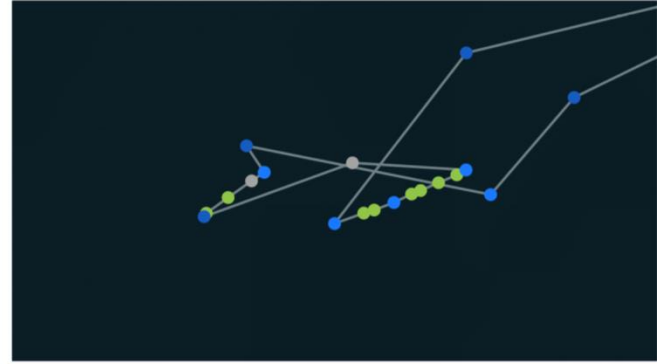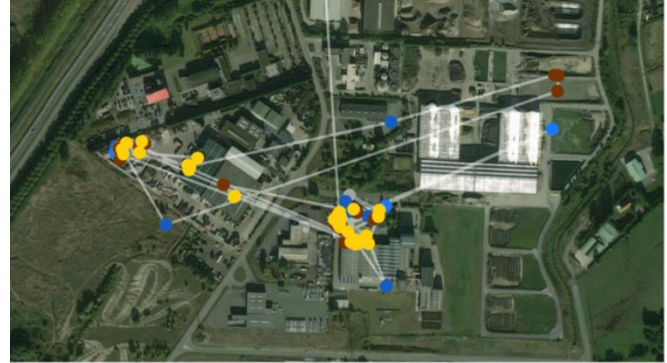## when identifying behaviours
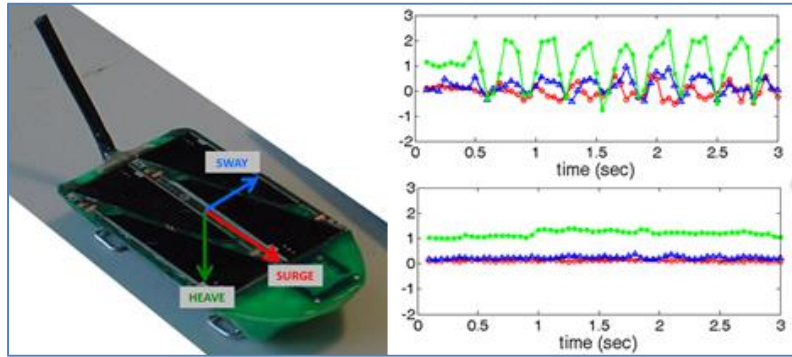
Bouten et al. 2013

Dean et al. 2012

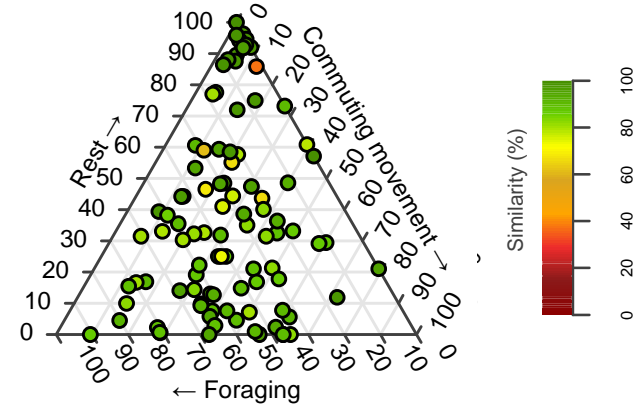# Methodological challenges –
when identifying behaviours
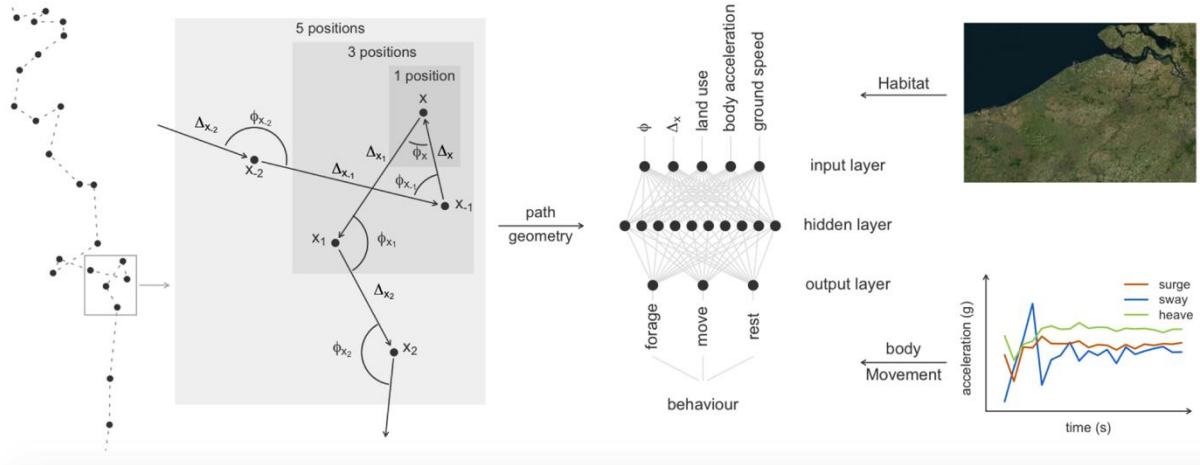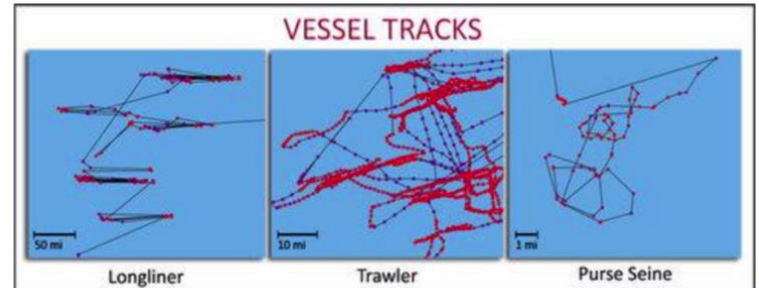
Methodological challenges –
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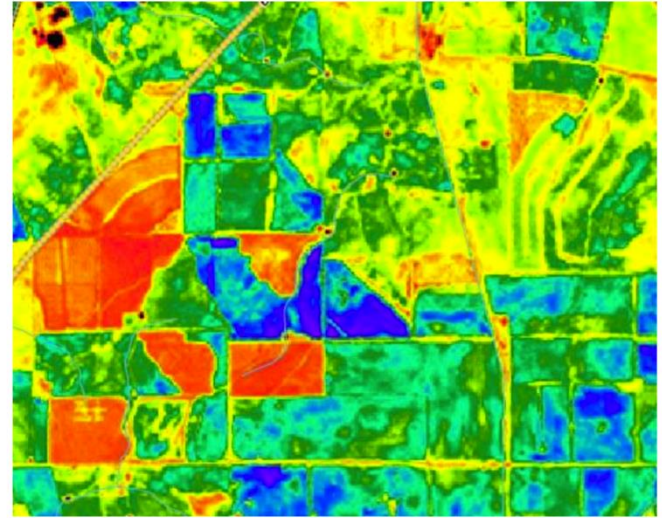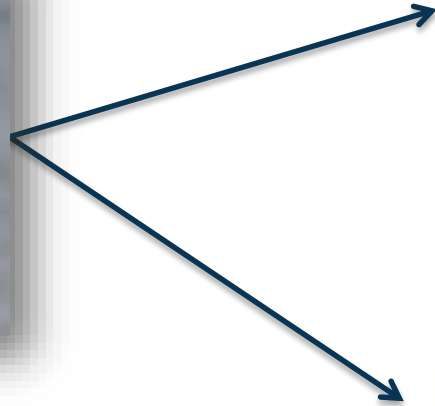

?

Methodological challenges –

when identifying behaviours

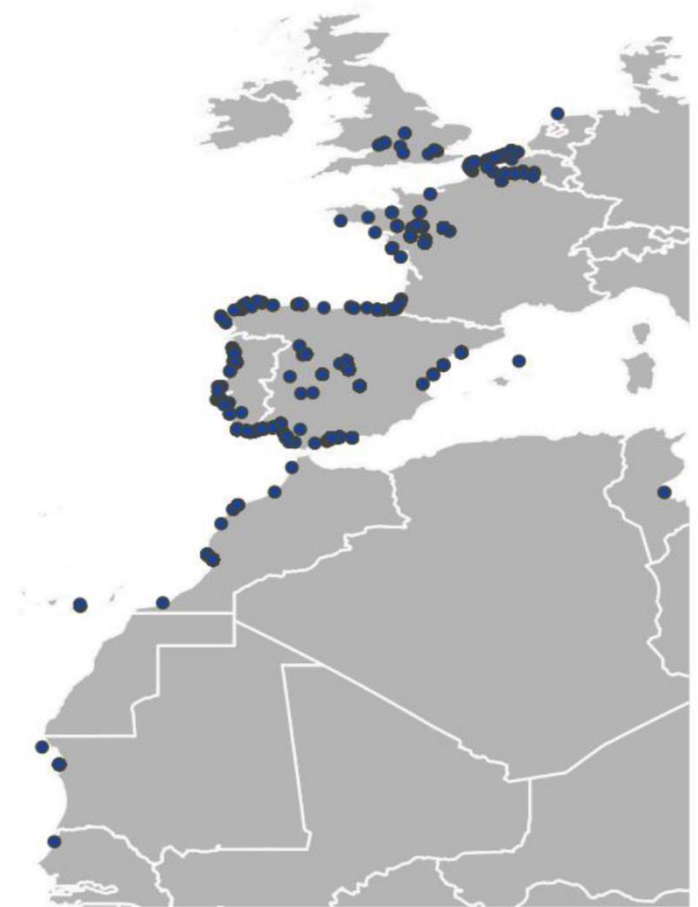

Baert *et al.* under revision

Methodological challenges –
to identify the cues underlying behaviour

Methodological challenges –
to identify the cues underlying migratory behaviour

Next generation animal tracking

Deciphering the ecological code:

- Tackle **methodological challenges** – processing of **big data**

- To understand the cues individuals use to take decisions - by **combining data streams**

- Understanding how individuals cope with environmental challenges - **individual responses to external cues**

Next Generation Animal Tracking