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

- Since 1999: systematic colour-ringing of Lesser black-backed gulls in Zeebrugge (B) by Eric Stienen (INBO) and Harry Vercruysse
- 2011: Davy Bosman (PhD), Luc Lens (UGent) join

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

Bosman 2016
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:
  - VLIZ
  - LIFEWATCH

- 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**

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

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

Kavelaars et al. in prep.
Why does a generalist species that is known to be able to exploit novel (anthropogenic) resources not adjust to its new environment?
Gulls adjust to human-linked food resources – but lack an alternative on short time scales (weekends)

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?

Specialists

![Graph showing marine foraging activity for specialists between 15 Jun and 1 Aug.]

Generalists

![Graph showing marine foraging activity for generalists between 15 Jun and 1 Aug.]

Individualized ecological niches
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
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)

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 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?
Bird migration

Why migrate?

![Graphs showing cumulative distance and daily effort vs. total migration distance.]

- **Cumulative distance (km)**
  - X-axis: Total migration distance (km)
  - Y-axis: Cumulative distance (km)

- **Daily effort (km)**
  - X-axis: Total migration distance (km)
  - Y-axis: Daily effort (km)
Why migrate?

Habitat use (%)

West Europe  Iberia  North Africa  West Africa

- Urban
- Landfills
- Marine
- Grassland
- Farmland
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 – when identifying behaviours
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