Seminars in Zoophysiology at Aarhus University

Using hidden Markov models to learn about long-term diving behaviour in Weddell seals

Theoni Photopoulo

Sea Mammal Research Unit, St Andrews, Scotland

Hidden Markov models (HMM) are now commonly used for modelling time series of animal locations or other movement data. They are proving to be an extremely useful tool for understanding the evolution of various movement metrics through time. HMMs are discrete time models made up of two stochastic processes: one which we observe through the data and one that we do not observe and want to make inferences about. When applied to movement data, the "hidden" process we want to make inferences about is the underlying, unobserved distribution of movement modes (states) and most likely state at each observation. I will present an application of a HMM to diving data from an Antarctic resident species, the Weddell seal. I have developed a model for movement that includes three dive variables, namely dive depth, duration and hunting time. Importantly the model includes not only dives, but also haulout and surface behaviour to present a more complete picture of animal behaviour. As air-breathing divers, seal visit the surface to rest and breathe but forage at depth. The Weddell Sea is an extremely important area oceanographically, since it is the site of the coldest water formation on the Antarctic continental shelf. This cold dense water sinks and contributes to global ocean circulation. The water column in the southern Weddell Sea is therefore highly stratified and I explore the influence of two oceanographic variables (temperature and salinity at the maximum dive depth) on the probability of switching between states. One of the strengths of HMMs is that they offer a core framework that is relatively easy to adapt and extend. An exciting recent extension of HMMs is that they can be used to make inferences about behaviour over longer time scales, not only dive-by-dive. I will present the idea of using this extension to infer longer term states for seals over a biologically relevant time scale of days or weeks.

Thursday June 20th 2019 at 13.00

Seminar room at Zoophys, Build 1131

Seminars in Zoophysiology at Aarhus University

Linking movement processes to population dynamics: the use of energetics as the common currency in animal ecology

Marianna Chimienti

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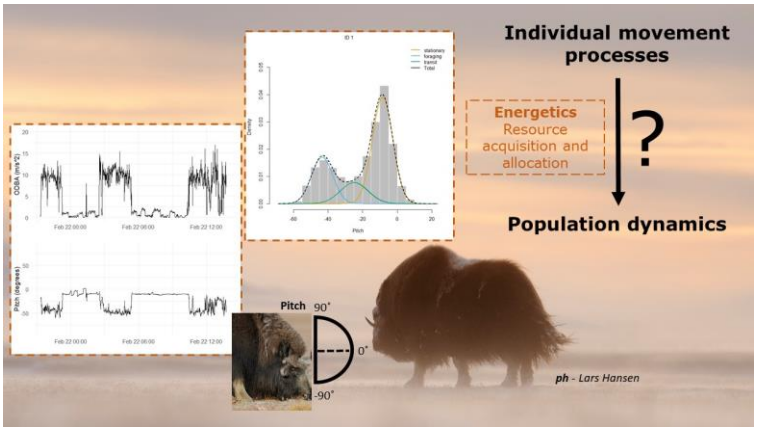
Ecologists are now able to remotely collect extremely detailed and high-resolution data on movements and physical states of free-ranging animals as well as the environmental conditions they encounter. Yet, despite revolutionary improvements in data collection, management, and statistical analyses, linking movement processes to population dynamics remains a daunting and unresolved task. Energy expenditure is the common currency linking movement ecology, individual life history, and population dynamics. We present the case of high-resolution movement data (GPS and accelerometer) collected year around on the high-Arctic muskox (Obivos moschatus). By coupling empirical data with Individual Based - Dynamic Energy Budget models, we propose an overarching framework able to quantify energetic flow throughout the full lifetime of individuals and model the influences of physiology and external forces on critical life history traits (e.g. growth, survival, fecundity). We present this framework as a tool for bridging the gap between movement ecology, individual fitness, and population dynamics. We link theoretical and empirical fields, making use of high-resolution movement data aiming for both a better understanding of resource selection and energy use/acquisition processes, and for increased focus on habitat use, survival and fecundity rates. The framework we highlight will facilitate ecologists in their quest to scale up the fine-scale behavioral and energetic processes observed through bio-logging of individuals to the population-level. Doing so opens up much needed avenues to test how altered (future) environmental conditions shape animal decision making and population processes.



Thursday June 20th 2019 at 14.00

Seminar room at Zoophys, Build 1131

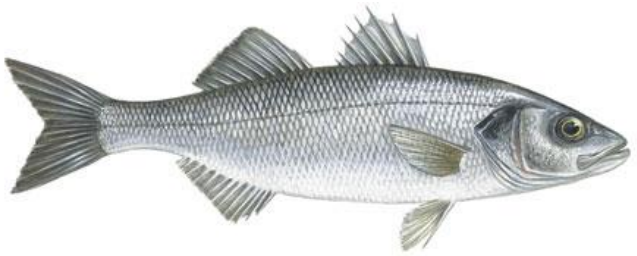
Seminars in Zoophysiology at Aarhus University

Inferring European sea bass behaviours and its drivers from vertical movements and thermal experience

Karine Heerah

Department of Biosciences, Aarhus, Denmark

Detecting animal's behavioural switches and periodicities in link with environmental factors is a key question in ecology. However, extracting these information from movement time-series requires tools that objectively describe and quantify these behaviours. In a previous study, we have developped an approach coupling spectral analyses and hidden Markov models (HMM) to classify behavioural states along 1-D European seabass depth time series according to activity levels and cyclic patterns. Here, we aimed at identifying the drivers of individuals behavioural switches by testing the influence of a set of variables directly implemented in the HMMs. Applying this to 80 high-resolution European sea bass depth time series (collected with Data Storage Tags) from five deployment sites, we demonstrated that the fishes occupied different parts of the water column and had different activity according to daylight duration and thermal experience. The presence of different behaviours were well defined and appeared at similar times throughout the annual cycle amongst individuals, suggesting these behaviours are likely related to seasonal functional behaviours (e.g. feeding, migrating and spawning). Similarly, the influence of daylight duration and temperature on the switching dynamics underlined seasonnal changes in behaviours. Finally, differences in individual behavioural switching dynamics revealed some level of behavioural plasticity among and within sites in relation to the abiotic environment. This is the first study linking seabass behaviour to their environment, and thus a significant step in current gap of knowledge of wild European seabass ecology despite an urgent need to better manage this overexploited species.



Thursday June 20th 2019 at 15.00

Seminar room at Zoophys, Build 1131