WORKSHOP PROGRAMME AND ABSTRACTS (preliminary version)

Movement ecology of marine organisms

Workshop: 10-13 September 2018
University of Cape Town, South Africa

The workshop will host 15-20 PhD candidates and early career scientists (PostDocs) interested in movement ecology in the marine environment. It will bring together experts in observing and tracking marine organisms, statisticians skilled at analysing spatial data and modellers with experience in developing and using models to project likely responses of organisms to varying environments. There will be a mixture of lectures and hands-on practical sessions. Participants also will be expected to prepare an electronic poster to present their own work (on day 1) and to do some pre-workshop preparation regarding potential "workshop projects".

The workshop programme highlights linkages between 1) observations, 2) data analysis tools (including data visualisation and statistics) and 3) models. It starts on day 1 with an overview lecture on each of these three aspects. Day 2 is devoted to (stochastic) agent-based models, with some lectures on case studies and an introduction to the Netlogo and Ichthyops software. Workshop participants will present their proposed workshop projects in a speed-presentation format, and lecturers will form a panel that trims down the topics to a smaller subset. Each of these final workshop projects will have a champion (the person who proposed it) and participants will be asked to sign up for one of the projects (maximum of three per project). The workshop project will form the basis of much of the hands-on work during the rest of the week, starting on day 2 by developing a model to address the topic. On day 3 the workshop will progress to considering data, with some lectures on different kinds of observations collected when studying movement ecology. There will be a field trip in the afternoon to observe some marine animals in the field. Day 4 will link observations to the models, showing how data sets can be analysed to extract information needed to model animal movement. The workshop will conclude with groups presenting their workshop projects.

Learning outcomes

- Knowledge of several different kinds of data used to study movements and distribution of marine organisms.
- Ability to apply selected statistical methods to analyse spatial data of marine organisms
- Understanding of how individual-based models are used to construct and test hypotheses of movements and behaviour of marine organisms
- Enhanced skills in teamwork in analysing data and applying an IBM to address a scientific research question or hypothesis

Teachers during the course

1. Prof. Paul Cowley (South African Institute for Aquatic Biodiversity, South Africa)
2. Professor Øyvind Fiksen (University of Bergen, Norway)
3. Dr Christophe Lett (IRD and UCT, France)
4. Dr Christian Lindemann (University of Bergen, Norway)
5. Professor Coleen Moloney (University of Cape Town, workshop organiser)
6. Dr Theoni Photopoulou (St Andrews University, Scotland)
7. Dr Pierre Pistorius (Nelson Mandela University, South Africa)
8. Professor Steven Railsback (Humboldt State University, USA)
9. Dr Josefin Titleman (University of Oslo, Norway)
10. Professor Rory Wilson (University of Swansea, Wales)

MONDAY 10 SEPT: Introductory session

09h00-09h45	Welcome and introductions
09h45-10h30	*Observations: Telemetry and dead-reckoning methods, Progressing from quantifying home ranges and distributions to identifying environmental correlates and understanding animal behaviour* (**Rory Wilson**)
10h30-11h00	COFFEE / TEA BREAK
11h00-11h45	*Using hidden Markov models to analyse animal movement data* **(Theoni Photopoulou)**
11h45-12h30	*Individual-based models* **(Steve Railsback)**
12h30-13h30	LUNCH
13h30-15h00	Poster presentations by participants[1]
15h00-15h30	COFFEE / TEA BREAK
15h30-17h00	Poster presentations by participants[1]

[1]Each participant describes their current research on marine organism movement or distribution

TUESDAY 11 SEPT - Developing and using individual-based models

09h00-09h40	*Using IBMs to understand phytoplankton* (**Christian Lindemann)**
09h40-10h20	*Using IBMs to understand zooplankton distribution and ecology* (**Øyvind Fiksen)**
10h20-11h00	*Using IBMs to understand fish distribution and ecology* (**Christophe Lett)**
11h00-11h30	COFFEE / TEA BREAK
11h30-12h45	Speed presentations (3 minutes each). Workshop participants will present their proposed workshop projects, and lecturers will form a panel that trims down the topics to a smaller subset. Each of these final workshop projects will have a champion (the person who proposed it) and participants will be asked to sign up for one of the projects (maximum of three per project). The workshop project will form the basis of much of the hands-on work during the rest of the week
12h45-13h30	LUNCH
13h30-14h00	*Introduction to NetLogo* (**Steve Railsback**)
14h00-14h30	*Introduction to Ichthyops* (**Christophe Lett**)
14h30-15h30	IBM Tutorial (**Steve Railsback**)
15h30-16h00	COFFEE / TEA BREAK
16h00-17h00	Groups work on workshop model

WEDNESDAY 12 SEPT - Collecting and using movement data

09h00-09h45	*Tracking marine top predators: Common Research questions, approaches and challenges* **(Pierre Pistorius)**
09h45-10h30	*Fish and acoustic telemetry* (**Paul Cowley)**
10h30-11h15	*Zooplankton movement ecology* (**Josefin Titelman)**
11h15-18h00	FIELD TRIP & SNACK LUNCH
18h00-21h00	WORKSHOP DINNER

THURSDAY 13 SEPT - Analysing spatial data and linkIng observations to models

09h00-09h45	*Visualising data* (**Rory Wilson**)
09h45-10h30	TUTORIAL: *Analysing a data set using hidden Markov models in R to derive estimates of movement states and state variable distributions* (**Theoni Photopoulou**)
10h30-11h00	COFFEE / TEA BREAK
11h00-12h30	TUTORIAL *Analysing a data set using hidden Markov models in R to derive estimates of movement states and state variable distributions* (**Theoni Photopoulou**)
12h30-13h30	LUNCH
13h30-15h00	Completing models, preparing presentations
15h00-15h30	COFFEE / TEA BREAK
15h30-17h00	Presentations by participants (~six groups)
17h00-17h15	Close workshop

Abstracts

Fish and acoustic telemetry

Paul Cowley
South African Institute for Aquatic Biodiversity, Grahamstown, South Africa

<<ABSTRACT - to be confirmed>>

Using IBMs to understand zooplankton distribution and ecology

Oyvind Fiksen
University of Bergen, Norway

The more inconspicuous animals in the ocean are often treated as particles drifting passively with currents, almost by definition. However, they are sophisticated organisms, with strategies and behaviours to increase their growth, survival and reproduction. In fact, understanding their behaviours are just as important as understanding their physiology in terms of population dynamics. For instance, if the zooplankton or fish larva have access to lots of food, it is less active and encounter few ambush predators and it may also spend more time deeper in the water column to hide from planktivorous fish. These behavioural decisions have strong influence on the death rates of plankton and feeding rates of predators, and are important to capture in any population model. Here, I will present how behavioural processes can be built into IBMs either in a very simple, pragmatic way - or in ways that resembles fundamental cognition, neurology and heuristics of even tiny plankton.

Using IBMs to understand fish distribution and ecology

Christophe Lett
Institut de recherche pour le développement (IRD), Sète, France

<<ABSTRACT - to be confirmed>>

Introduction to Ichthyops

Christophe Lett
Institut de recherche pour le développement (IRD), Sète, France

<<ABSTRACT - to be confirmed>>

Using IBMs to understand phytoplankton

Christian Lindemann
University of Bergen, Norway

<<ABSTRACT - to be confirmed>>

Using hidden Markov models to analyse animal movement data

Theoni Photopoulou
University of St Andrews, Scotland

Tracking data are able to provide exciting and novel insights into the life-history and ecology of animals, however they also present analytical challenges. Hidden Markov models (HMMs) are one class of model that has become very popular for analysing animal tracking data. HMMs are time series models that can be used to make inferences, or draw evidence-based conclusions, from data that are time ordered. HMMs explicitly model the data at two levels; the level of the observation process - the way in which the observations arise, and the level of the state process - the process we want to learn about. I will present a very brief overview of HMMs with examples, aiming to motivate why we need statistical models, why HMMs are a particularly useful modelling tool, and how we might use them to better understand movement ecology through the analysis of tracking data. The practical on the last day of the workshop will give participants a chance to implement HMMs for tracking data in R.

Tracking marine top predators: common research questions, approaches and challenges

Pierre Pistorius
Nelson Mandela University, Port Elizabeth, South Africa

Technological developments and miniaturization of tracking instruments over the past few decades have spurred an enormous growth in the field of movement ecology. In the marine environment, this is particularly relevant for seabirds and seals due to their accessibility at breeding colonies during key life history stages. Tracking studies have been motivated on several grounds. For threatened species, of which seabirds have a disconcerting large representation, an understanding of at-sea distribution, habitat requirements and inter-specific resource partitioning often underpins informed conservation management. African penguin tracking studies, for example, have informed the required extent of spatial protection in terms of fisheries closures around breeding colonies. Another common objective in marine top predator tracking studies relates to the use of tracking data, ideally from multiple species, to identify Ecologically or Biologically Significant Marine Areas (EBSA's). These animals generally target areas of high productivity and identification of where they spend most of their time foraging can be useful in this regard. Often, this involves habitat modelling where important environmental features relevant to study species are identified through the use of remote sensed environmental data. This approach, based on tracking data from 12 seabird and mammal species at the Prince Edward Islands, was recently used to identify important habitat around these islands to inform marine spatial planning. Interpreting tracking data in the marine environment relies on inferring specific behaviours, foraging generally being most important, based on movement data.

Time-depth recorders and accelerometers deployed on tracked animals can greatly assist in identification of foraging localities. *In situ* observations, through animal-borne cameras, have also helped to partly overcome this challenge and hold great potential for better understanding inter- and intra-specific interactions at sea. This is exemplified by some of our recent work on Gentoo penguins at the Falkland Islands.

Individual-based models

Steve Railsback
Humboldt State University, USA

Individual-based models (IBMs) are simulation models that predict population characteristics such as abundance, distribution, and persistence from the behavior, growth, reproduction, and survival of the population's individuals. IBMs are especially useful when spatial processes such as movement are important and when individual fate is affected by adaptive behavior. Modern software platforms make IBMs easier to build and use, but it is essential to design them carefully so they are complex enough to serve their purpose but not too complex to be useful. "Pattern-oriented modeling" is a strategy for using field and laboratory observations to design IBMs with the right level of complexity: models include the entities, mechanisms, and variables necessary to solve a specific problem and to reproduce a variety of patterns observed at both the individual and population levels. Many IBMs include adaptive behaviors such as vertical migration, which marine organisms may use to reduce predation risk while obtaining sufficient food. Adaptive behavior can be modeled using at least three general approaches. Stochastic rules based on statistical analysis of observations can be used to make model individuals reproduce observed behaviors. Adapted behavior approaches use artificial evolution within an IBM to generate decision modules such as artificial neural networks that produce successful behavior. State- and prediction-based theory assumes that behavior acts to approximately maximize a measure of future fitness such as the probability of surviving to adulthood or the expected number of future offspring. While IBMs can be challenging to build and test, they can be essential for linking data and knowledge about a species into a useful tool to support management decisions.

Introduction to NetLogo

Steve Railsback
Humboldt State University, USA

NetLogo (http://ccl.northwestern.edu/netlogo/) is a widely used platform for individual-based modeling. NetLogo includes a high-level programming language specifically for IBMs, graphical interfaces, and tools for essential tasks such as importing GIS and file data, writing output files, and automating simulation experiments. NetLogo is free, open-source, and extremely well designed, supported, and documented. The platform allows scientists to spend far less time on software development and much more time on model testing and analysis. This introduction will illustrate the basic features of NetLogo, provide examples of simple and complex ecological models in NetLogo, and point students to resources for learning to use the platform.

A second session will provide a hands-on tutorial in programming NetLogo. We will step through the process of coding, debugging, and observing a simple model.

Zooplankton movement ecology

Josefin Titelman
University of Oslo, Norway

<<ABSTRACT - to be confirmed>>

Observations: Telemetry and dead-reckoning methods, Progressing from quantifying home ranges and distributions to identifying environmental correlates and understanding animal behaviour

Rory Wilson
Swansea University, United Kingdom

<<ABSTRACT - to be confirmed>>