Movements networks in field biology

We live in a world that is more and more connected. Fundamentally, this reflects a world of increasing information, of big data, where we use technology to log our health, our journeys, even our calorie intake and where we can organize and record our social engagements and share them with friends on the other side of the planet. These vast online networks of information track linkages in both space and time, a constant shifting of dynamic social media connectivity at a global scale. In many cases simple technologies such as radio frequency ID chips allow millions of people to commute around our cityscapes, logging the route and cost of their journeys on a daily basis. Similar logging techniques are also frequently adopted by researchers to study animal behaviour and movement; indeed the presence (or absence) of animals gathered remotely at different locations is sometimes the only information we have about wide ranging or elusive animals.

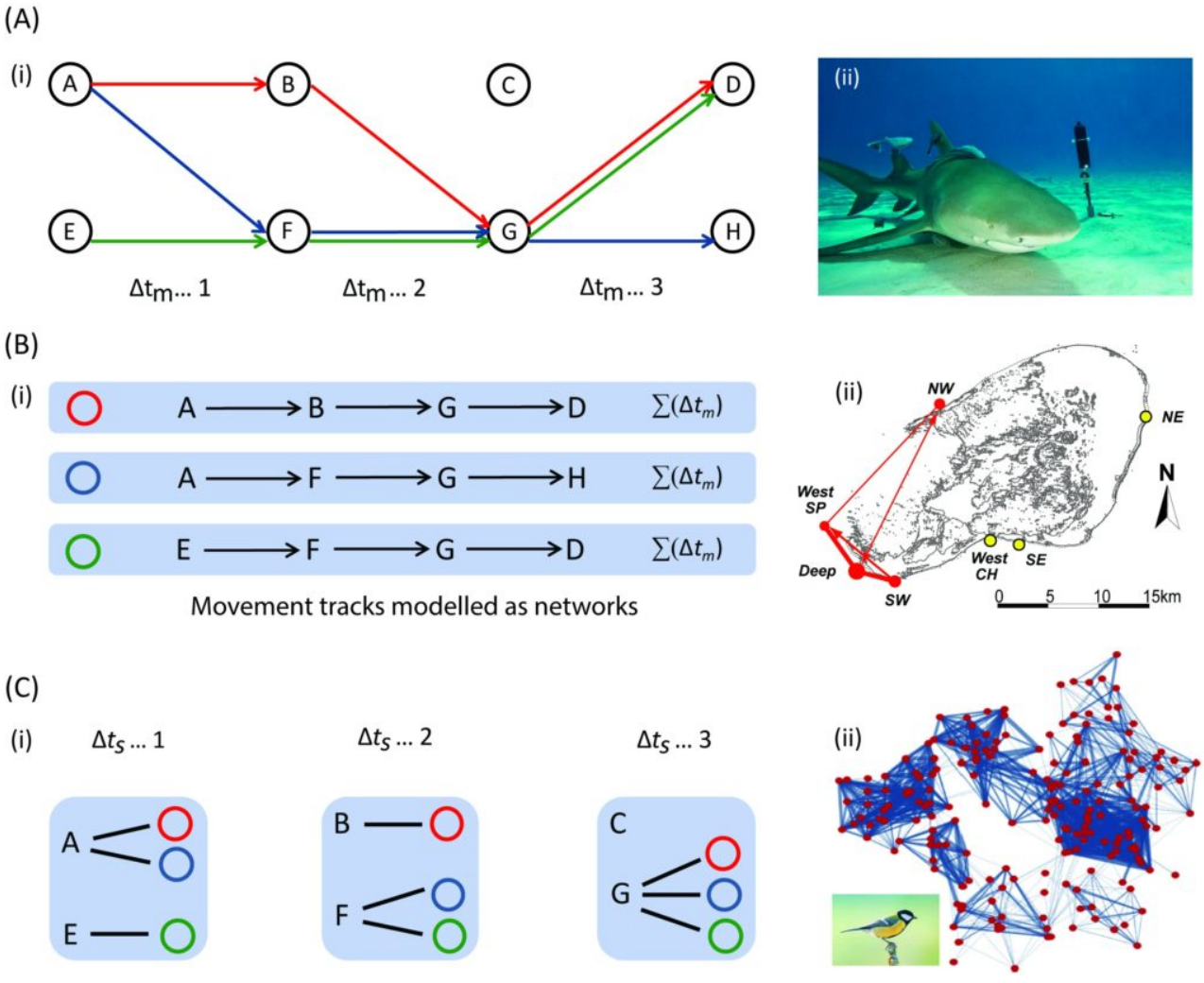

Fig. 1. A schematic illustration of the construction of movement and social networks from animal

tracking data.

Network analyses, with their foundation in mathematical graph theory, have emerged across multiple disciplines from telecommunications and computer sciences to sociology and biology. All however, offer means to reduce and measure complex interconnected systems at multiple scales. Using network analyses we can explore how the 'global' properties influence individual nodes – to use network parlance – but equally how individual nodes influence global connectivity. To illustrate, the same underlying analytical approach can be used to address for example, how important individual matriarchal females are in the social connectivity of elephant societies, or alternatively how the overall structural properties of a computer network make it more or less vulnerable to cyber-attack. This convergent development of network analyses across disciplines means that there are now a broad range of tools available that have evolved to fill specific niches within different respective fields but that offer enormous scope for interdisciplinary application.

Network-based tools now available to analyse automated animal tracking data are beginning to open up new ecological insight into the drivers of animal movement, the connectivity of fine-scale habitat as well as the social behavior of animals derived through the shared visitation patterns of individuals in space and time (Fig 1). Aside from clear application for better understanding the ecology of electronically-tagged animals, movement networks provide a predictive tool which for forecasting the outcome of positive and negative events (e.g. habitat regeneration or environmental disasters) on habitat connectivity and animal dispersal, something that is likely to prove key in the future conservation of endangered species. Indeed, modelling the structural properties of movement networks can inform the robustness (or vulnerability) of the biological landscape in which animals live and move. Still in its relative infancy however, this application of network tools will no doubt continue to benefit from the advances made in disciplines as seemly far reaching as urban planning, human geography and disease dynamics; in doing so they will likely improve our understanding of the mechanisms driving wild animal behaviour and improve how best to go about conserving them.

*Dr **David Jacoby***
Institute of Zoology
Zoological Society of London, UK

Publication

Emerging Network-Based Tools in Movement Ecology.
Jacoby DM, Freeman R
Trends Ecol Evol. 2016 Apr