

## Review

Key Questions in Marine  
Megafauna Movement  
Ecology

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**It is a golden age for animal movement studies and so an opportune time to assess priorities for future work. We assembled 40 experts to identify key questions in this field, focussing on marine megafauna, which include a broad range of birds, mammals, reptiles, and fish. Research on these taxa has both underpinned many of the recent technical developments and led to fundamental discoveries in the field. We show that the questions have broad applicability to other taxa, including terrestrial animals, flying insects, and swimming invertebrates, and, as such, this exercise provides a useful roadmap for targeted deployments and data syntheses that should advance the field of movement ecology.**

### The Breadth of Movement Ecology Studies

The advent of a range of small, reliable data-loggers and transmitters that can record horizontal and vertical movements, physiology, and reproductive biology has led to many new, amazing insights into the ecology of taxa ranging from insects to whales [1,2] (Figure 1). For example, we are now able to track and record the physiological state of animals as they travel across entire ocean basins or continents, fly over the highest mountains, or dive from the surface to the ocean depths [3–6]. These types of study have addressed holistic questions encompassing cross-taxa comparisons in both terrestrial and marine systems that have investigated how animals optimize their locomotion [7]; their search patterns for prey [8]; and the factors that constrain their migration distances [9], dive performance [10], and swimming speed [11] (Figure 2).

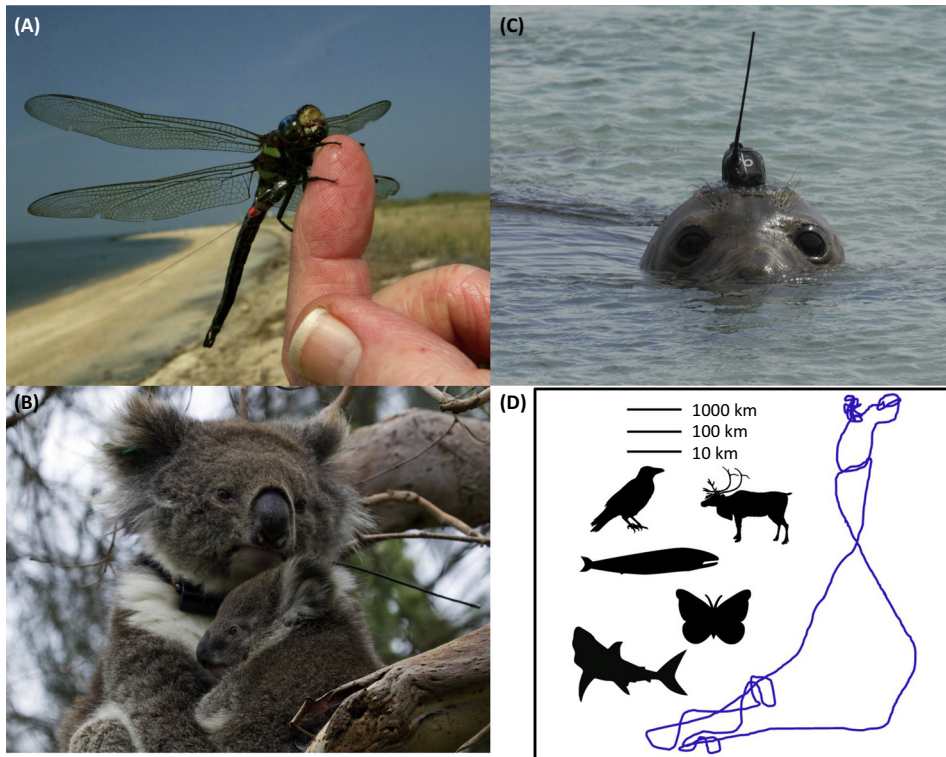
### Trends

Technical advances make this an exciting time for animal movement studies, with a range of small, reliable data-loggers and transmitters that can record horizontal and vertical movements as well as aspects of physiology and reproductive biology.

Forty experts identified key questions in the field of movement ecology.

Questions have broad applicability across species, habitats, and spatial scales, and apply to animals in both marine and terrestrial habitats as well as both vertebrates and invertebrates, including birds, mammals, reptiles, fish, insects, and plankton.

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## Trends in Ecology &amp; Evolution

**Figure 1. Commonalities across Species, Habitats, and Spatial Scales.** Similar to other mobile animals, marine megafauna move through their environment to obtain resources, such as prey, breeding grounds, and mates (and, in the case of divers, they surface to obtain air) and so movement patterns profoundly impact fitness. Marine megafauna can be tracked, in high resolution, as they move in both horizontal and vertical dimensions. As a corollary, invertebrates, including crawling, flying, and swimming taxa, as well as a range of terrestrial species can likewise be tracked. (A–C) A dragonfly (*Anax junius*), a koala (*Phascolarctos cinereus*), and a northern elephant seal (*Mirounga angustirostris*) each equipped with a tracking tag. The small size of tags, to reduce impacts on behaviour, means that they are difficult to see in (A) and (B). (D) Spatial scale of movement. Movement patterns can be examined across taxa and habitats and over scales from a few cm to 10 000s of km, illustrated schematically here. Across this breadth of studies, many common questions exist, such as whether general ‘rules’ might underpin complex movements, the roles of learning, navigation cues used, the role of predators and prey distribution in shaping movements, and how climate change might impact movements. This track could equally be from a broad range of taxa that walk, fly, or swim, and any of the scale bars might apply. In this case, it is the track of a shearwater (*Puffinus griseus*) flying the length of Pacific [6]. Reproduced, with permission, from Martin Wikelski (A), Desley Whisson (B), and Dan Costa (C).

The deployment of tracking devices, especially for extended periods, can impact the wellbeing of equipped animals [12, 13] and tags and deployment efforts can also be costly. For these reasons, there is an urgent need to triage the most important fundamental and applied questions in the field of **movement ecology** (see [Glossary](#)) for targeted research, particularly in the case of marine species, for which technical advances in tagging have been profound. To this end, we assembled 40 leading experts in the field of **biologging of marine megafauna** to identify key questions. We illustrate how many of these questions apply not only to these taxa, but also to terrestrial vertebrates and other animal groups, including mobile invertebrates in both terrestrial and marine environments. Our objective was to focus the agenda for the field of movement ecology in an informed way that encompassed both fundamental questions of high interest and priority questions that have more direct impact on management and conservation.

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