Monitoring species through telemetry

Tracking technologies are revolutionising how we monitor populations, allowing us to record high-resolution data on the behaviour and movements of animals. Institute researchers lead the way in combining telemetry and novel analyses for conservation.

Understanding the long-term behaviour of animals in their natural habitat is crucial for effective conservation. The development of smaller, cheaper and more powerful tracking equipment is enhancing the scale and variety of species that can be monitored across the globe.

This increasing sophistication of tag design is transforming species conservation from determining simply where and when species are present to understanding and predicting how changes in the environment and ecology of species drive patterns of distribution. The volume and richness of data available from animal-borne data devices require increasingly versatile and powerful tools to extract and interpret this vital information; Institute research continues to play a leading role in advancing both tagging and analytics for improved species conservation.

Inferring behaviour through machine learning approaches

The Institute currently monitors a host of populations using a broad range of tracking technologies. These include, but are not limited to, acoustic transmitters on sharks in Palmyra (Central Pacific Ocean), the Chagos Archipelago (Central Indian Ocean) and the Bahamas; light-based geolocation tags on seabirds in the UK, Chagos and Mauritius; and our own open-source, low-cost GPS trackers (Mataki tags) deployed on tigers (*Panthera t. tigris*) in India, pygmy three-toed sloths (*Bradypus pygmaeus*) in Panama, Manx shearwaters (*Puffinus puffinus*) in the UK, and a variety of large carnivores in Africa.

Typically, researchers and conservationists wishing to employ telemetry to monitor species have faced a trade-off; with limited budget, should one favour a small number of sophisticated, often satellite-linked and expensive electronic tags that give high spatial and temporal resolution, or a larger number of less precise, but cheaper, devices such as geolocation or acoustic tags? In recent years, research at the Institute has demonstrated how more information can be extracted from both high- and low-resolution devices using novel machine learning methods – the automated recognition of patterns in big data by computers – as an important tool for conservation.

A priority for developing these machine learning tools is to better measure the interaction of wide-ranging animals with one another and their local environments in order to understand the broad and complex drivers of population dynamics. Our recent work in this area revealed that patterns of global wind speed and direction obtained via remote sensing can be used to predict the behaviour and movement energetics in a wide-ranging seabird, the Manx shearwater (Gibb et al. 2017).

Machine learning methods in the marine environment can play a significant role in species conservation. For fish species that rarely surface and for which it is therefore difficult to obtain frequent satellite positions, acoustic transmitters and receivers provide coarse residency and space-use patterns. Recently, we developed a widely applicable method for inferring social interactions from acoustic telemetry data, enabling us to establish patterns of social leadership behaviour in a population of grey reef sharks (*Carcharhinus amblyrhynchos*) at a remote atoll in the Pacific Ocean (Jacoby et al. 2016). It is hoped that behavioural inference at the population level will ensure that characteristics, such as a species' tendency to aggregate or move in a specific way, can be built into future vulnerability assessments.

Applied telemetry

Remote refuges can provide wilderness areas where we might expect animal populations to thrive, but these are also some of the hardest places to monitor species. This challenge is epitomised through our research on species that occupy the marine realm, particularly as the remote nature of some of these locations makes them susceptible to unregulated activity, such as illegal fishing.

Spatial network analyses that quantify how animals link different habitats, in combination with electronic monitoring, offer a broad set of analytical tools that help us to assess the efficacy of protected areas for highly mobile species such as sharks and seabirds. Developments in these tools, and how they are likely to contribute to improved conservation strategies, were recently assembled in a comprehensive review (Jacoby and Freeman 2016).

From tags to targets

Alongside their application for conservation management, these sophisticated monitoring tools can have broader use in assessments of species extinction risk and in feeding into global biodiversity indicators (eg estimating changes in population size, range size or the impact of specific threats). Indicator development for the Sampled Red List Index and Living Planet Index relies on monitoring data but often lacks information for difficult-to-monitor species in remote locations. Improvements in telemetry to monitor populations could help fill gaps in our knowledge of biodiversity trends worldwide.

Our research is at the forefront of communicating global biodiversity trends (eg McRae et al. 2016), developing indicators for policy used to measure progress towards international biodiversity targets. These advances in biodiversity monitoring therefore contribute not only to single-species management, but to the conservation of biodiversity more broadly.

Learn more about the Living Planet Index at livingplanet index.org

Below: *data from remote sensing can help predict the behaviour of Manx shearwaters.* **Below right:** *a common guillemot with a Mataki tag.* **Bottom right:** *the Institute uses acoustic transmitters to study grey reef sharks in the Pacific Ocean.* **Bottom left:** *an acoustic receiver used to monitor movement patterns and social networks in sharks*

For further information, contact
Robin Freeman: robin.freeman@ioz.ac.uk

References

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