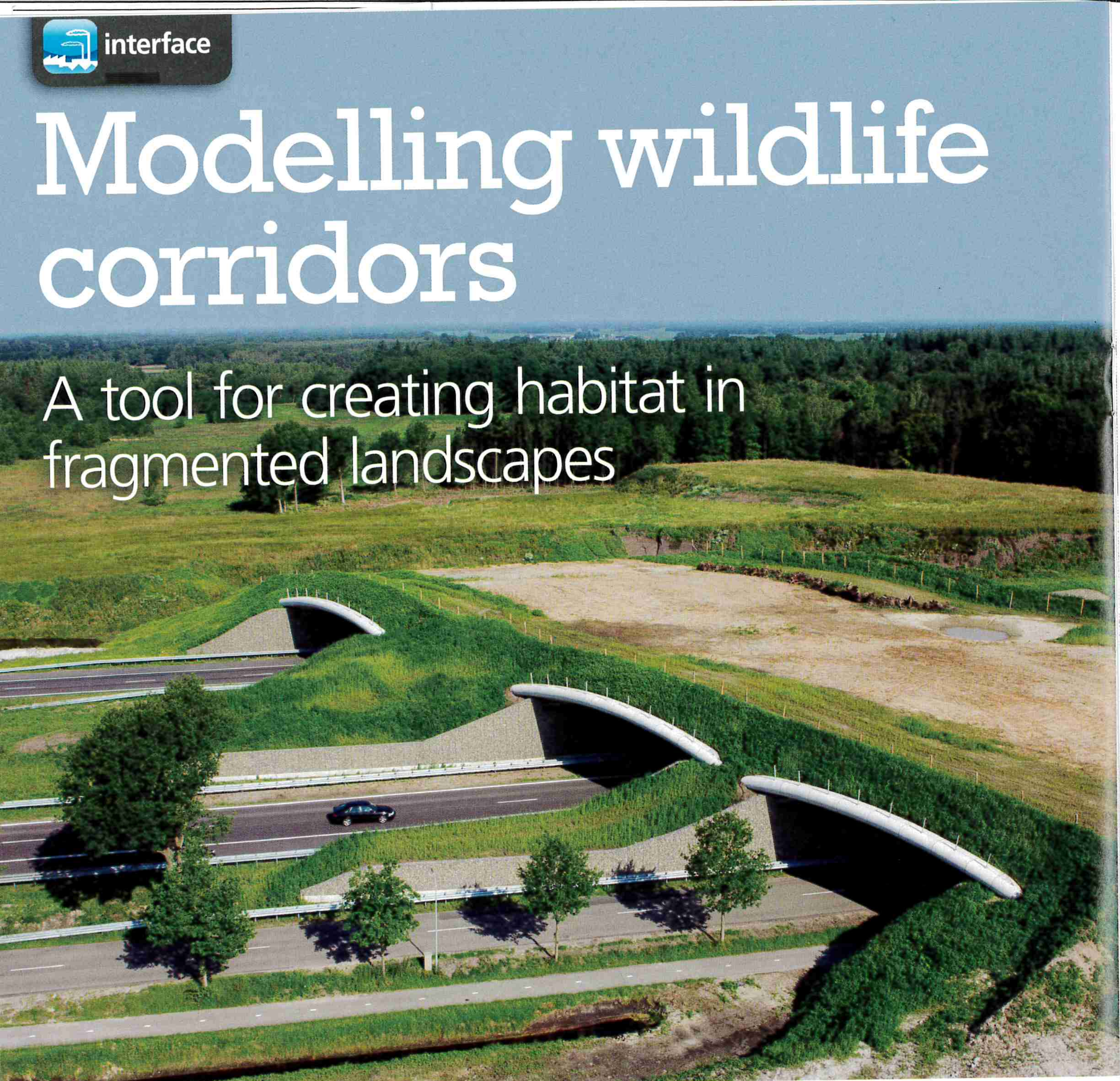
Modelling wildlife corridors

A tool for creating habitat in fragmented landscapes



Increasing human population and climate change are impacting wildlife habitats. Conservation ecologist Lydia Cole explains how conservation biologists can model movement corridors and create new habitats for threatened populations

As the human population grows, the space left for wildlife is reducing and becoming more **fragmented**. As some areas become uninhabitable owing to climate warming or other human impact, species have to move to other patches to survive. A new computer program, Condatis, could help us to map the most important connections needed to enable species to move between suitable habitats.

Key words

- Species
- Climate change
- Habitat loss
- Fragmentation
- Wildlife corridors

The need to disperse

Each population of a species has a particular type of habitat in which it can survive for multiple generations. For example, the habitat of a nectar-feeding butterfly may be a wildflower meadow, where there is food for each individual and its offspring, opportunities for mating and places to shelter.

But ecosystems are dynamic and the habitats within them change easily. The wildflower meadow may be ploughed up

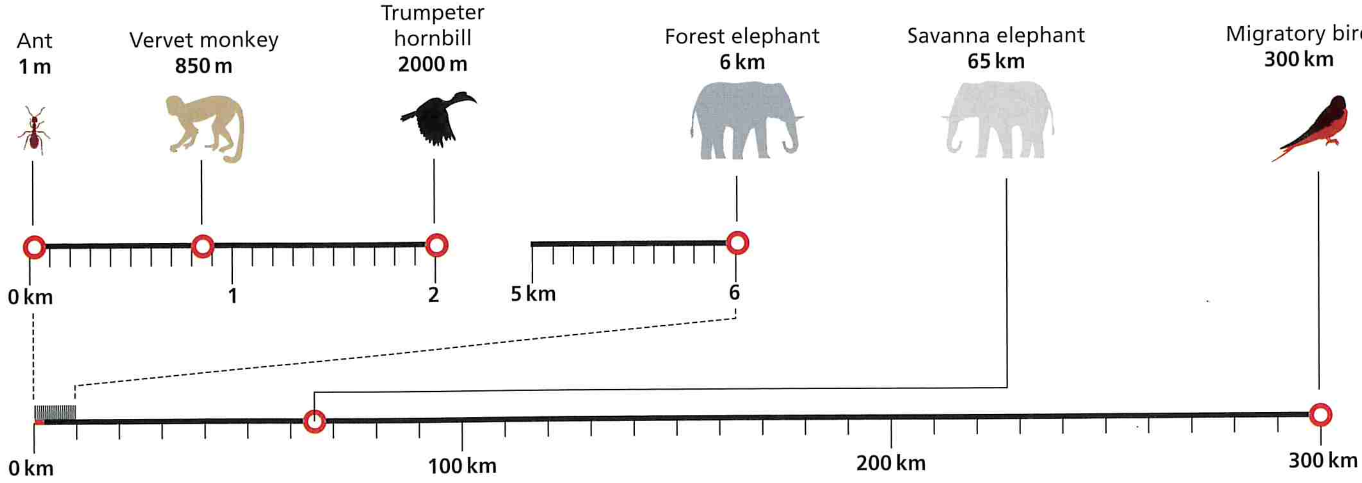


Figure 1 Range of dispersal distances for a variety of different-sized animal species

by a farmer to create more land on which to grow food. Even if a small patch remains, it might be too small to allow the butterflies to find a mate, making relocation necessary for reproduction. The meadow may be invaded by a species of plant that out-competes the native flowers and does not provide suitable food for the butterflies. Or it might become too warm for the butterflies to survive, as the **abiotic** conditions change due to global warming.

Habitat loss and fragmentation, invasive species and climate change, as well as other abiotic and **biotic** factors, can cause habitats to become unsuitable for a particular species. For some species, there will be sufficient diversity within a population to enable adaptation to the environmental changes through natural selection. For many others, changes will be happening too quickly for the species to adapt. Thus these populations often migrate to a more suitable habitat.

Patterns of dispersal

Which route would enable a population to reach its new home fastest? It will only be able to move along certain 'safe' pathways within the landscape **matrix**. For example, certain conditions may put individuals at risk, such as very windy routes which could disturb flight. These pathways will differ from species to species. As well as the type of landscape in the matrix between habitat patches, the distance between the patches is important. If they are too far apart and the matrix is relatively dangerous, an individual is unlikely to reach the new habitat.

What determines a 'safe' distance between habitat patches is partly governed by how far an individual can travel in its lifetime. This is termed the dispersal distance. Larger animals tend to have a greater dispersal distance than smaller animals (see Figure 1). For example, a savanna elephant may travel over 50 km between habitat patches in its lifetime, in search of food, water or a suitable mate. At the opposite end of the spectrum, an ant living in the same savanna **ecosystem** may spend its whole life within the same 1 km^2. The dispersal distances for the savanna species shown in Figure 1 have been inferred by researchers measuring how far individuals have transported plant seeds. Other techniques for measuring dispersal distances are detailed in Box 1.

The species-specific pattern of dispersal is determined mainly by the distribution of habitat patches within the landscape matrix and the distance over which an individual of the species can disperse in its lifetime.

The Adonis blue butterfly lives in wildflower meadows on chalk and limestone areas in the south of the UK

Further reading

Condatis website: **www.condatis.org.uk** Use the links to see the Buglife B-Lines project.

Buglife B-Lines project: **www.buglife.org.uk/b-lines-hub/map**

Inferring dispersal distances by measuring how far seeds travel: **https://tinyurl.com/yyzeo6c6**

Wildlife corridors for assisting movement

For a population to survive the potential changes to its external environment, its members either adapt to those changes within that original environment, or move. Climatic change brought about by global warming is one key reason why species move. In the UK, some species are likely to move north to escape the warming climates in the south. Their speed of movement will have to track the pace at which the climate warms in order to stay within the range of abiotic conditions that they can tolerate.

Conservation biologists may be able to help. Conservation biology is a scientific discipline concerned with understanding how to protect species from threats to their survival. Key questions we seek to answer are why, when, where and how quickly a threatened population moves from one habitat to another. We also try to understand what the barriers to the movement of populations are. With this knowledge, we can design and create effective movement **corridors** that enable species to relocate to suitable new habitats.

Movement, or wildlife, corridors are an important intervention in species conservation as habitat patches become more fragmented and the matrix between them becomes more inhospitable for species on the move. In order to design effective corridors, we need to understand the movement patterns of individuals.

Understanding how species move through a landscape can be a challenge. It would be nearly impossible to track enough individuals in a population over their lifetimes, and over the lifetimes of their offspring, to get a clear idea of how they are moving between habitat patches. Therefore, a method is needed to **model** this movement, based on factors that we know affect these patterns.

UK conservation organisations such as Buglife and the RSPB needed a tool to enable them to understand which parts of a landscape are the most important for providing habitat and/or movement corridors for threatened populations. Being able to make evidence-based decisions on where to allocate their limited resources is of huge value.

Modelling connectivity using Condatis

This is where Condatis comes in. Condatis was developed by Dr Jenny Hodgson, a lecturer in evolution, ecology and behaviour at the University of Liverpool. Condatis is a computer model developed to answer the question of how quickly (in numbers of generations of a population) and by which routes a population can move from one patch of habitat to another.

Condatis takes information about a species and a landscape and produces a map of how quickly and by which routes that species is likely to move between different patches of habitat. A user therefore needs to know something about the ecology of the species — what habitat it requires, where it is currently found (the source), where it may need to disperse to (the target) and why, and how far one individual can move in its lifetime. This information can be obtained through ecological surveys and observing individuals in their natural environment (see Box 1).

Once data are available for the species of interest, Condatis is ready to go. The tool can be accessed through a website and is freely available to everyone. Figure 2 illustrates how

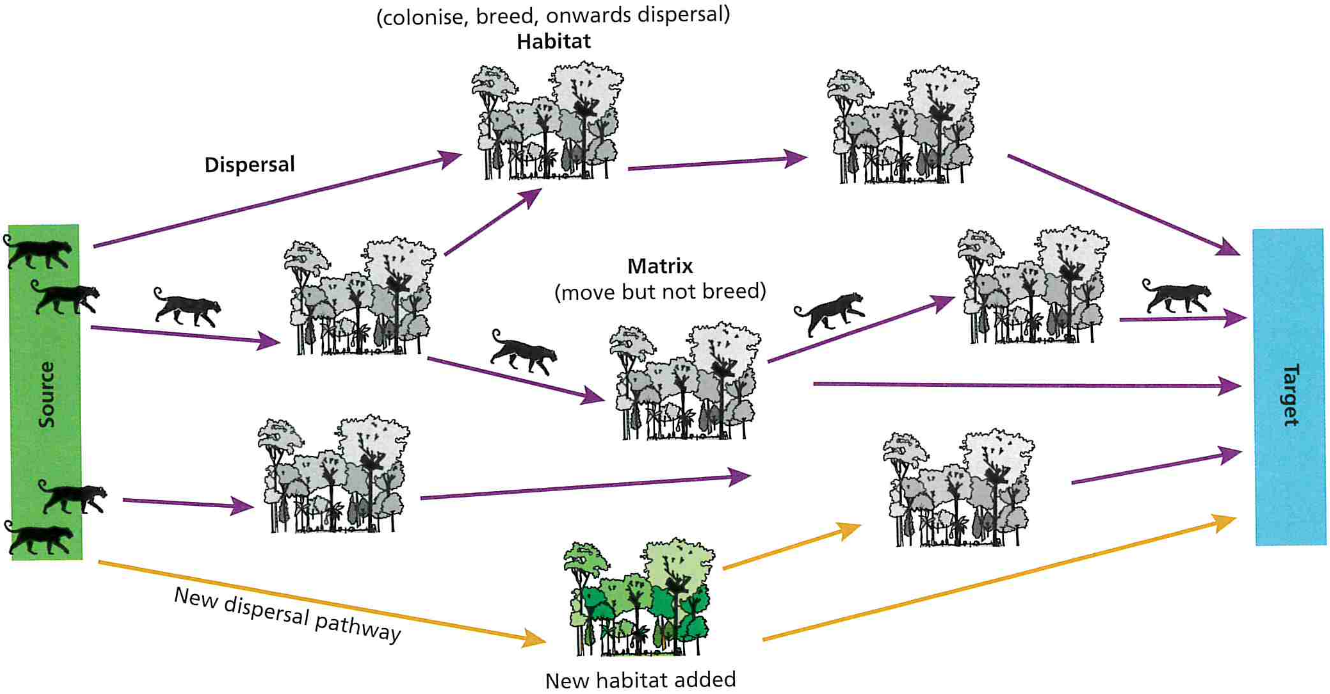


Figure 2 An illustration of an example landscape analysed using the Condatis computer model. The Javan leopard is the example species, and Condatis is modelling its movement pathways across the tropical forest corridor shown in Figure 2.1

Box 1 Quantifying dispersal distances

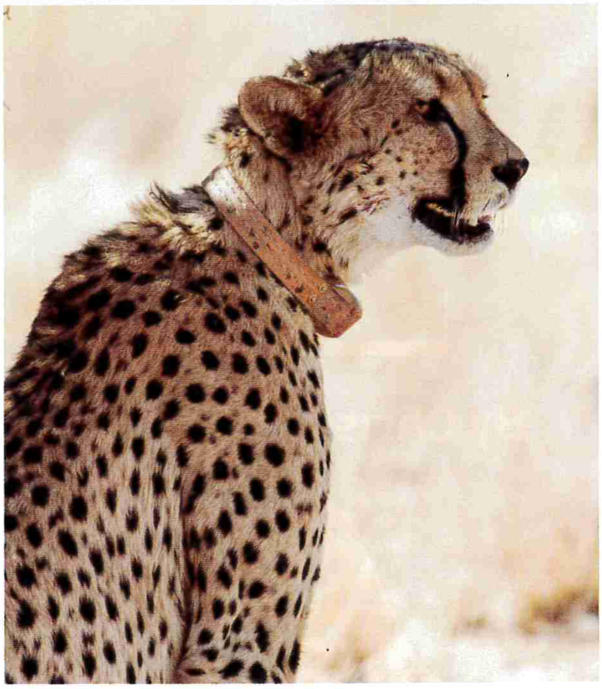
Here are some examples of ways to measure the dispersal distances of individuals.

Mark-release-recapture

One or more individuals are caught and marked, released, and then recaptured in another location to judge the distance moved by each individual.

GPS-tagging

An individual is fitted with a geographical positioning system device, for example a radio collar, that enables the location of that individual to be monitored.



Box 2 The Javan leopard

Figure 2.1 (top) is a Condatis map showing the modelled pathways (purple to black) that the Javan leopard is likely to use to cross the forest corridor (pink) between Mount Halimum (source, in green) and Mount Salak (target, in blue). Mount Halimum Salak National Park is one of the largest remaining areas of tropical forest on the Indonesian island of Java. Despite its protected status, the habitats it contains (including the corridor between the two mountains) are threatened by human impacts such as agricultural expansion and settlements. These land uses make up much of the landscape shown in yellow.) The managers of the National Park are using maps from Condatis to understand which patches of habitat are more important to conserve or restore to enable the movement of some of the National Park's most threatened species, such as the leopard.

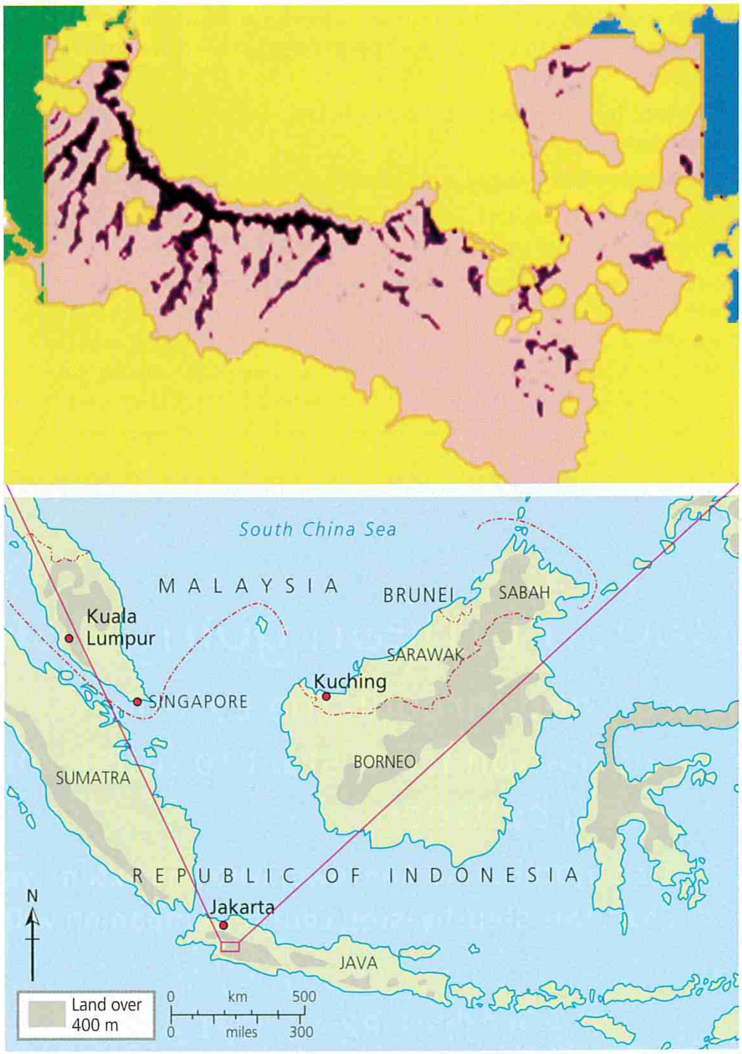


Figure 2.1

Condatis can map movement between the source and the target through a network of habitat patches. Purple arrows represent where individuals are likely to move to cross the landscape, colonising existing habitat, breeding and creating colonists that disperse to the next habitat patch, until the target is reached. If a new patch of habitat is added to the landscape (green habitat), e.g. through restoring a patch of tropical forest, the route taken across the landscape may be altered (orange arrows) and the population may reach the target habitat in fewer generations.

How are Condatis connectivity maps being used?

Users of Condatis aim to create maps that will enable the creation of 'bigger, better and more joined up habitat networks' (see Box 2).

Buglife, a UK-based charity working on the conservation of invertebrates, has been using Condatis to understand how pollinators move between wildflower meadows and where links between these habitat patches need to be restored. Researchers at Buglife have used the information on pollinator movement generated by Condatis to create maps of corridors, referred to as B-lines, which are likely to be the most important strips of land to connect populations of bees, butterflies and other key pollinators across the UK into the future. See 'further reading'.

The maps produced by Condatis only tell one side of the story, however. The missing component is how people are involved in the planning and creation of movement corridors for wildlife. Especially in England, people are living in, or having an influence on, every square kilometre of environment. Therefore, any conservation action requires the people living there to agree to that action and, ideally, to be involved.

Terms explained

Abiotic Referring to the physical components of an environment, e.g. soil type, temperature, climate.

Biotic Referring to the biological, i.e. living, components of an environment, e.g. species diversity, tree height, population growth rate.

Corridor Definitions of corridors vary. In this article, a movement/wildlife corridor is defined as a stretch of habitat, whether continuous or in a stepping stone formation, which improves the ability of a species to move across a landscape.

Ecosystem The interacting living (biotic) and non-living (abiotic) components of an environment.

Fragmentation The breaking-up of habitat into small and isolated patches.

Matrix The part of the landscape that is not habitat, but which surrounds habitat patches, in which populations can move but not reproduce.

Model A description of a system using mathematical concepts, which can predict how that system will behave when elements of it change. In this case, the system is the landscape containing patches of habitat and the species moving through it. When we change the configuration of the habitat, the ability of the species to move will be changed and the model can predict how.

Topics for discussion

- Which species might be moving through the landscape in which you live?
- What is their habitat?
- Which parts of the landscape can/can't they move through?
- Could you predict their dispersal patterns?

Dr Lydia Cole is a conservation ecologist at the University of St Andrews. Her work focuses on developing maps that show how wildlife moves between protected areas in Ghana, Indonesia and Malaysia, as tools to guide habitat restoration.