Wild horses in the Australian Alps: SPADE suggests management strategies for reducing the abundance and distribution of invasive plant and animal species. Photo: Regina Magierowski

Managing invasive animals and plants: finding cost-effective strategies

- SPADE is a desktop computer model that can predict the likely spread of invasive animals and plants over time for different scenarios at the landscape scale.
- Park managers can use SPADE to explore and compare the likely cost and impact of several strategies for managing invasive species, and identify those that are cost-effective and socially acceptable.
- Park rangers have played a critical role in designing and testing SPADE, making sure it is practical and useful for their operational needs.

Research summary

Park managers responsible for managing invasive species have no easy way to identify management strategies that fit within their budgets and that work at the landscape scale.

We worked with Parks Victoria, the NSW National Parks and Wildlife Service and ACT Parks and Conservation to develop SPADE, a spatially-specific desktop model that predicts the likely spread of invasive plant and animal species given estimates of current population size, and information about habitat suitability and the biology of the species.

Park managers can use SPADE to explore and compare the likely cost and impact of strategies for managing invasive species, and identify those that are most cost-effective and socially acceptable.

The challenge of finding cost-effective strategies

In 2012, at a forum hosted by the Australian Alps Liaison Committee and the Landscapes and Policy Hub, park managers described the challenges of managing invasive species. As an example, even if they meet their annual targets for capturing and relocating wild horses, they have no way of knowing whether they are having enough impact to limit the spread of wild horses and the damage wild horses cause to wetlands and bogs.

They wanted a way to explore cost-effective management scenarios for different target densities for different landscape zones — a tool that that would help them make decisions and communicate the likely outcome of different strategies in a format that they could present to policymakers.

Sophisticated approaches are available to simulate the population dynamics of wild animals but they are often best suited to small spatial scales, require technical skills to get them to work for a particular landscape and species, and usually ignore financial constraints crucial for managers looking for cost-effective management approaches.

SPADE – a tool designed for park managers

SPADE (the Spatial Population Abundance Dynamics Engine) is a spatially-specific computer model that predicts the likely spread (range and population density) of invasive plant and animal species, given estimates of current population size and information about habitat suitability and the biology of the species. We developed SPADE with park managers following a science-management forum in 2012.

Policymakers and park managers can use SPADE to explore and compare the impact and cost of several management strategies and identify cost-effective and socially acceptable strategies for managing invasive species. For example, they might compare mustering and trapping wild horses with aerial culling. SPADE's ability to model the movement of animals and diseases over large areas gives managers a powerful means of exploring the likely outcomes of different management interventions decades into the future.

For greater impact, park managers can collaborate with neighbouring jurisdictions to run SPADE using different assumptions for the species' current range, population growth rates, control methods, and the timing and intensity of control.

SPADE is intended only as a guide — park managers ultimately have to choose which strategy to implement.

We tested SPADE using data on wild horses in the Australian Alps, fallow deer in Tasmania and feral cats on Marion Island in the Indian Ocean. We are currently (2014) exploring its potential to model orange hawkweed, an invasive plant species, in Tasmania and the Australian Alps.

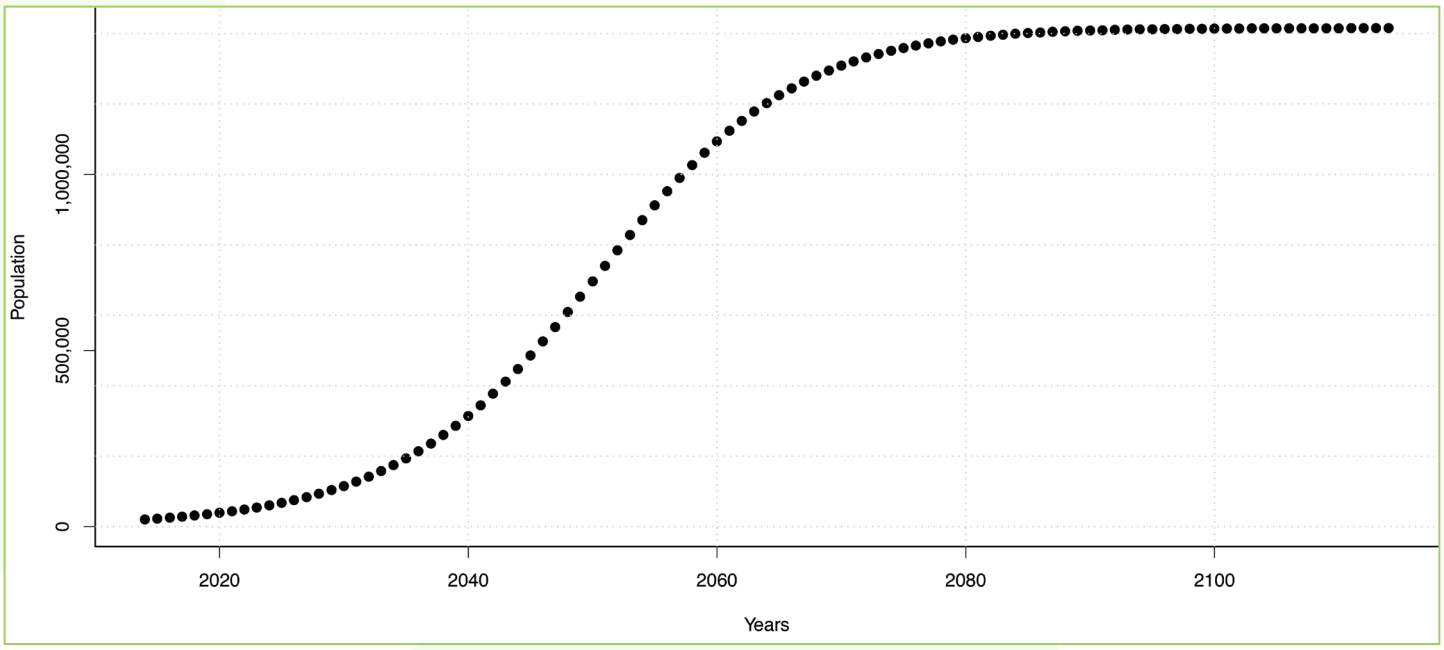
SPADE runs on a standard desktop computer or laptop. It is easily adapted to work for any landscape around the world.

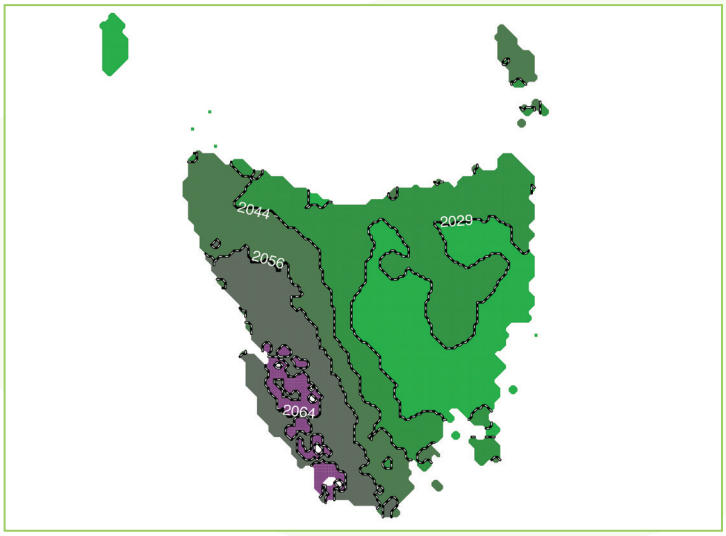
How SPADE works

SPADE simulates a species' reproduction, mortality and dispersal throughout the landscape, and suggests management strategies for reducing the abundance and distribution of the species.

Estimating abundance

For a specified landscape (for example, the Australian Alps), SPADE uses information on the current and potential abundance of the species, its breeding and its mortality to calculate a spatially-explicit estimate





Fallow deer population in Tasmania (top). The growth in deer population as projected by SPADE for the period 2014 to 2064.

Fallow deer density in Tasmania (left). The spread of deer as projected by SPADE for the period 2014 to 2064. Contour lines denote where the population density reaches three deer per square kilometre. Light green areas reach this density before 2029. Mid-green areas reach this density before 2044. Dark green areas reach this density before 2056. Purple areas remain below this density in 2064.

Images: Nick Beeton

of the species' abundance over time. SPADE also presents summary output data as maps and graphs.

Evaluating management strategies

Park managers can enter different parameters to simulate different management strategies and gauge their potential effectiveness. As an example, they might want to determine the cost-effectiveness of a 'high early removal' strategy whereby a big effort is made to reduce numbers in the first few years. SPADE predicts how long it will take the population to recover to defined levels and compares the cost-effectiveness of the selected strategy with other strategies. The park manager specifies how long it will take for the population to return to detectable levels and SPADE compares the cost-effectiveness of the strategy with more modest annual targets.

Plans are underway to enhance SPADE so that park managers can use it to score management strategies on a variety of criteria such as their cost-benefit ratio and the level of stress caused to the animals.

Modelling interactions between species

SPADE can model the interactions between multiple species in the landscape over time.

Park rangers become SPADE champions

Park rangers played a critical role in shaping the design of SPADE and testing it to make sure it is practical and useful for their operational needs. In February 2014, park rangers from New South Wales and Victoria visited the hub to refine SPADE and test potential management scenarios using wild horse field data they had collected. They set parameters for demographics, carrying capacities and dispersal rates to make sure SPADE captured, as well as possible, what is happening on the ground. These park rangers have become SPADE champions in their respective organisations, sharing their knowledge of SPADE with their colleagues and helping them to use SPADE for a range of applications. They expect to be running SPADE operationally in 2015 for managing wild horses in the Australian Alps.

How to access SPADE on the hub's website

SPADE and its accompanying user manual are available free of charge from Dr Nick Beeton. Contact details are below.

Who are the researchers?

Professor Chris Johnson

Chris leads the hub's Wildlife Project which is developing distribution models for species of mammals, birds, frogs and reptiles; examining habitat-climate patterns for Tasmania; and modelling distributions of invasive animals in the Australian Alps.

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Nick is an ecological modeller who specialises in novel ways of estimating species distributions and population dynamics.

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Collaborators

Dan Brown (Parks Victoria) and Rob Gibbs (NSW National Parks and Wildlife Service).

Further reading

Beeton NJ, McMahon CR, Williamson G, Potts J, Bloomer J, Bester MN, Forbes L & Johnson CN (in review) Spatially explicit population modelling for conservation management. *Methods in Ecology and Evolution*.

Potts J, Beeton NJ, Bowman D, Williamson G, Lefroy E & Johnson C (in press) Predicting the future range and abundance of fallow deer in Tasmania, Australia. *Wildlife Research*. Available online: http://www.publish.csiro.au/view/journals/dsp_journals_pip_abstract_Scholar1.cfm?nid=144&pip=WR13206

About the NERP Landscapes and Policy Hub

The Landscapes and Policy Hub is one of five research hubs funded by the National Environmental Research Program (NERP) for four years (2011–2014) to study biodiversity conservation.

We integrate ecology and social science to provide guidance for policymakers on planning and managing biodiversity at a regional scale. We develop tools, techniques and policy options to integrate biodiversity into regional-scale planning.

The University of Tasmania hosts the hub.

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