Potential spread of invasive species in NZ: modelling, mapping & art

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Invasive Species

The Risk

- Pests, Non-native, Alien Species
- Greatest Threat to Biodiversity and Native Species
- Impacts Agriculture, Horticulture, Forestry and Related Industries
- Economic/Social Costs: Risk Management and Mitigation, Health and Socio-Cultural Well-being

Mitigation

- Biosecurity 2025: “Biosecurity team of 4.7 million”
- Predator Free 2050: remove major threats to native wildlife

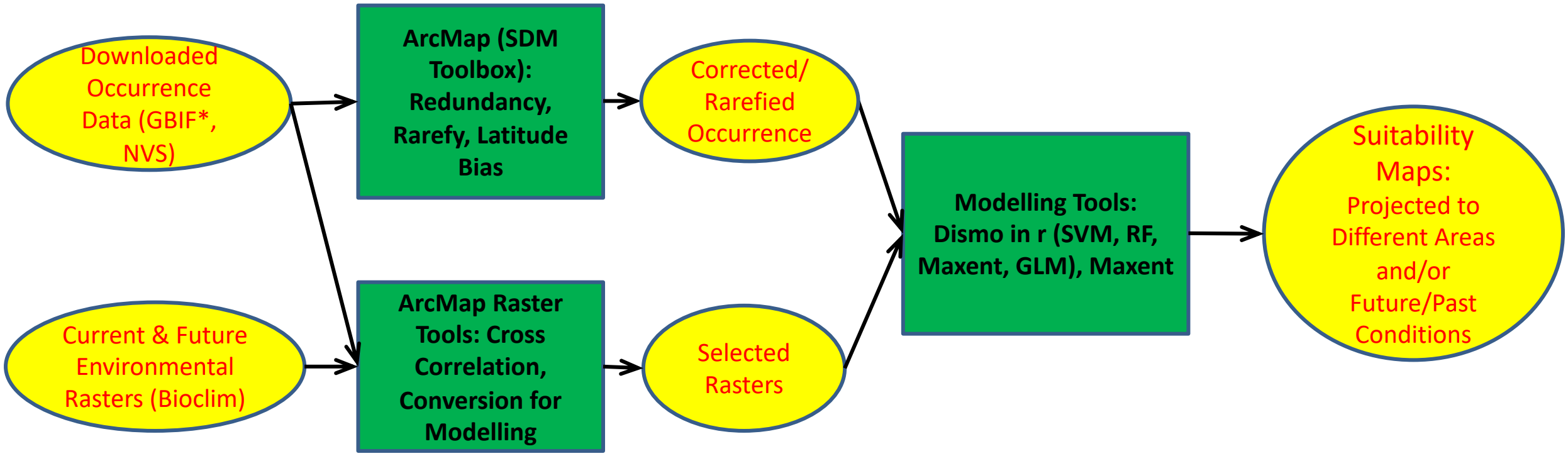
- Decision and Planning
- Information and Education
- Scientific data -> Models -> Maps -> Art as a Cultural Lens

RAMIFICATION by Hamish Foote

Invasive Species Suitability Mapping

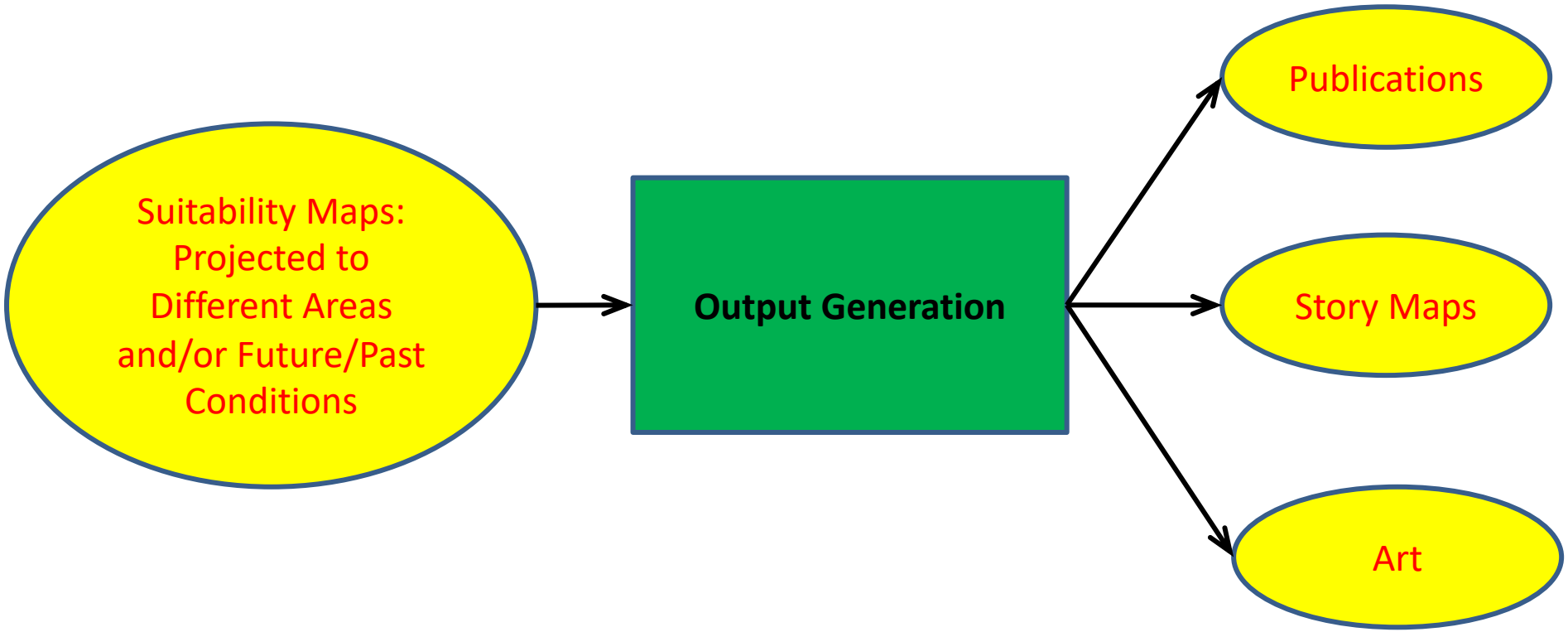
Year	Project	Outputs
2011	Suitability modelling of Argentine ant, Northern Pacific seastar, Rosy Wolf Snail – (Applied GIS Students Unitec)	*NETS Biosecurity Conference*
2013	House Crow Distribution Models	*NETS Biosecurity Conference, International Ornithological Conference, ISPRS International Journal of Geo-Information*
2014	Alien Nation (Queensland Fruitfly, Chinese Fan Palm, Alpine Newt, Red Eyed Slider Turtle, Red-vented Bulbul), NSF/STEM Research Student Exchange	*Perspectives in Biosecurity - Unitec e-Press, Ecological Informatics, NETS Biosecurity Conferences, Art Gallery, Story Maps*
2017	Brown Marmorated Stinkbug, Myrtle Rust	*Climate Journal, NETS Biosecurity Conference*
2018	Species Distribution Models – Applied GIS, Self-Directed Studies (Bachelor of Applied Science), Drone Imagery for Vegetation Mapping	

Model and Map Production Workflow



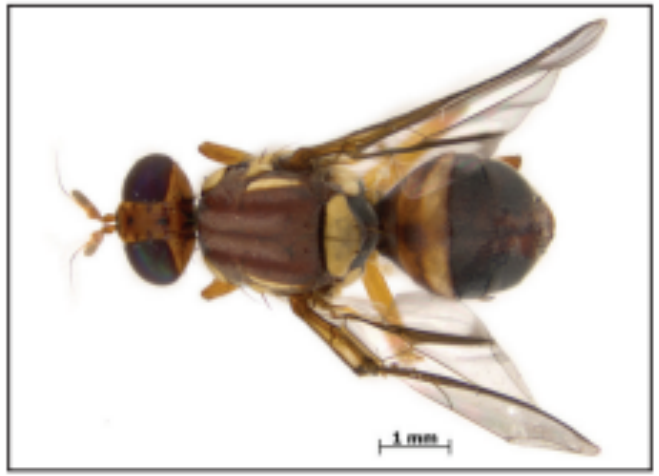
*Global Biodiversity Information Facility

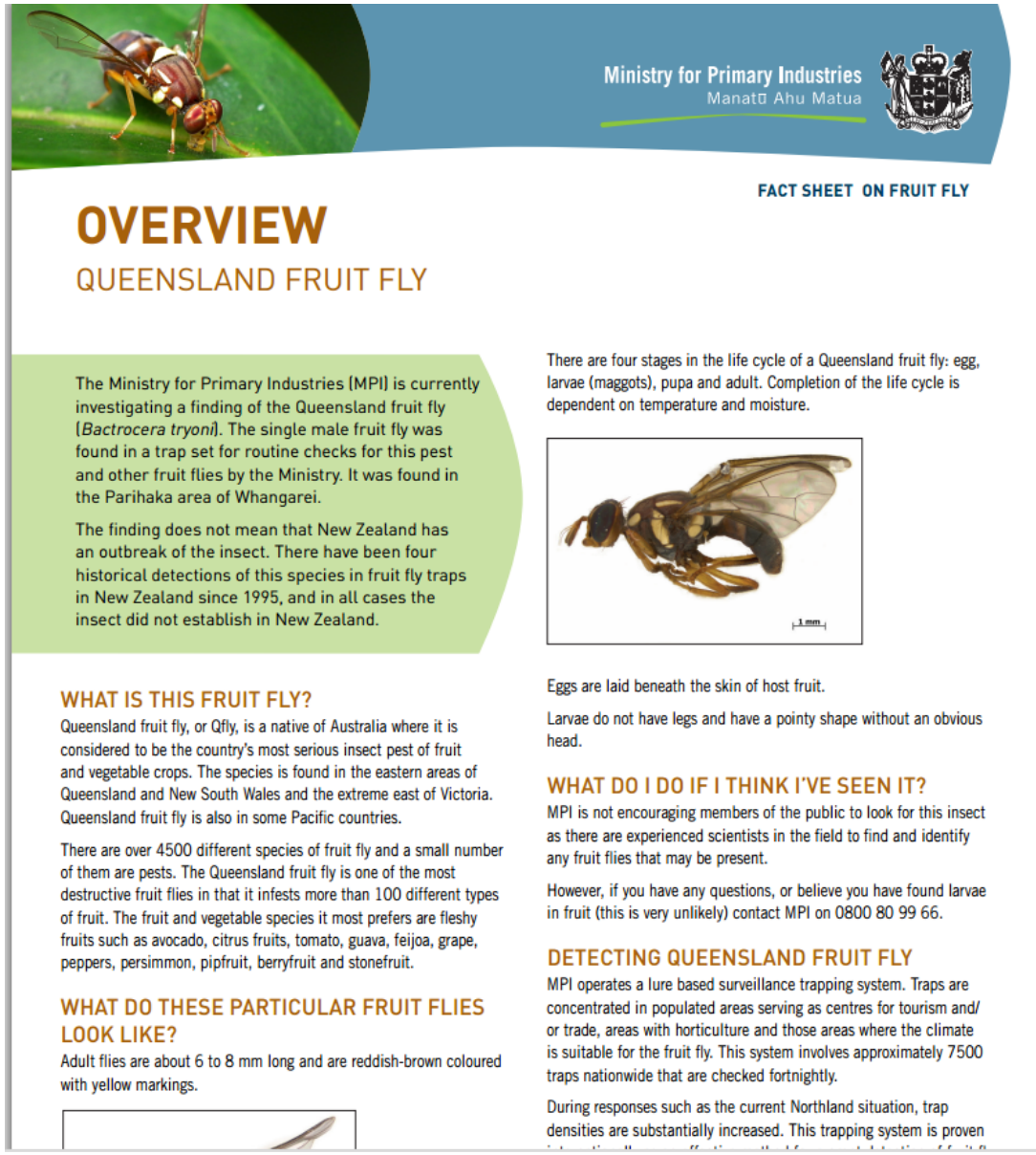
Art and Information Production Workflow



Bractocera tryoni (Queensland fruitfly)

- Native of Australia
- Most serious pest for fruits and vegetables
- Single fly findings cause for major control efforts in Auckland (2012) and Whangarei (2014)
- Impacts:
- Major pest of Fruit Crops





Ministry for Primary Industries
Manatū Ahu Matua

FACT SHEET ON FRUIT FLY

OVERVIEW

QUEENSLAND FRUIT FLY

The Ministry for Primary Industries (MPI) is currently investigating a finding of the Queensland fruit fly (*Bactrocera tryoni*). The single male fruit fly was found in a trap set for routine checks for this pest and other fruit flies by the Ministry. It was found in the Parihaka area of Whangarei.

The finding does not mean that New Zealand has an outbreak of the insect. There have been four historical detections of this species in fruit fly traps in New Zealand since 1995, and in all cases the insect did not establish in New Zealand.

WHAT IS THIS FRUIT FLY?

Queensland fruit fly, or Qfly, is a native of Australia where it is considered to be the country's most serious insect pest of fruit and vegetable crops. The species is found in the eastern areas of Queensland and New South Wales and the extreme east of Victoria. Queensland fruit fly is also in some Pacific countries.

There are over 4500 different species of fruit fly and a small number of them are pests. The Queensland fruit fly is one of the most destructive fruit flies in that it infests more than 100 different types of fruit. The fruit and vegetable species it most prefers are fleshy fruits such as avocado, citrus fruits, tomato, guava, feijoa, grape, peppers, persimmon, pipfruit, berryfruit and stonefruit.

WHAT DO THESE PARTICULAR FRUIT FLIES LOOK LIKE?

Adult flies are about 6 to 8 mm long and are reddish-brown coloured with yellow markings.

There are four stages in the life cycle of a Queensland fruit fly: egg, larvae (maggots), pupa and adult. Completion of the life cycle is dependent on temperature and moisture.

Eggs are laid beneath the skin of host fruit.

Larvae do not have legs and have a pointy shape without an obvious head.

WHAT DO I DO IF I THINK I'VE SEEN IT?

MPI is not encouraging members of the public to look for this insect as there are experienced scientists in the field to find and identify any fruit flies that may be present.

However, if you have any questions, or believe you have found larvae in fruit (this is very unlikely) contact MPI on 0800 80 99 66.

DETECTING QUEENSLAND FRUIT FLY

MPI operates a lure based surveillance trapping system. Traps are concentrated in populated areas serving as centres for tourism and/or trade, areas with horticulture and those areas where the climate is suitable for the fruit fly. This system involves approximately 7500 traps nationwide that are checked fortnightly.

During responses such as the current Northland situation, trap densities are substantially increased. This trapping system is proven

Ref/image source:http://www.biosecurity.govt.nz/pests/
http://www.issg.org/database/species/search.asp?st=100ss

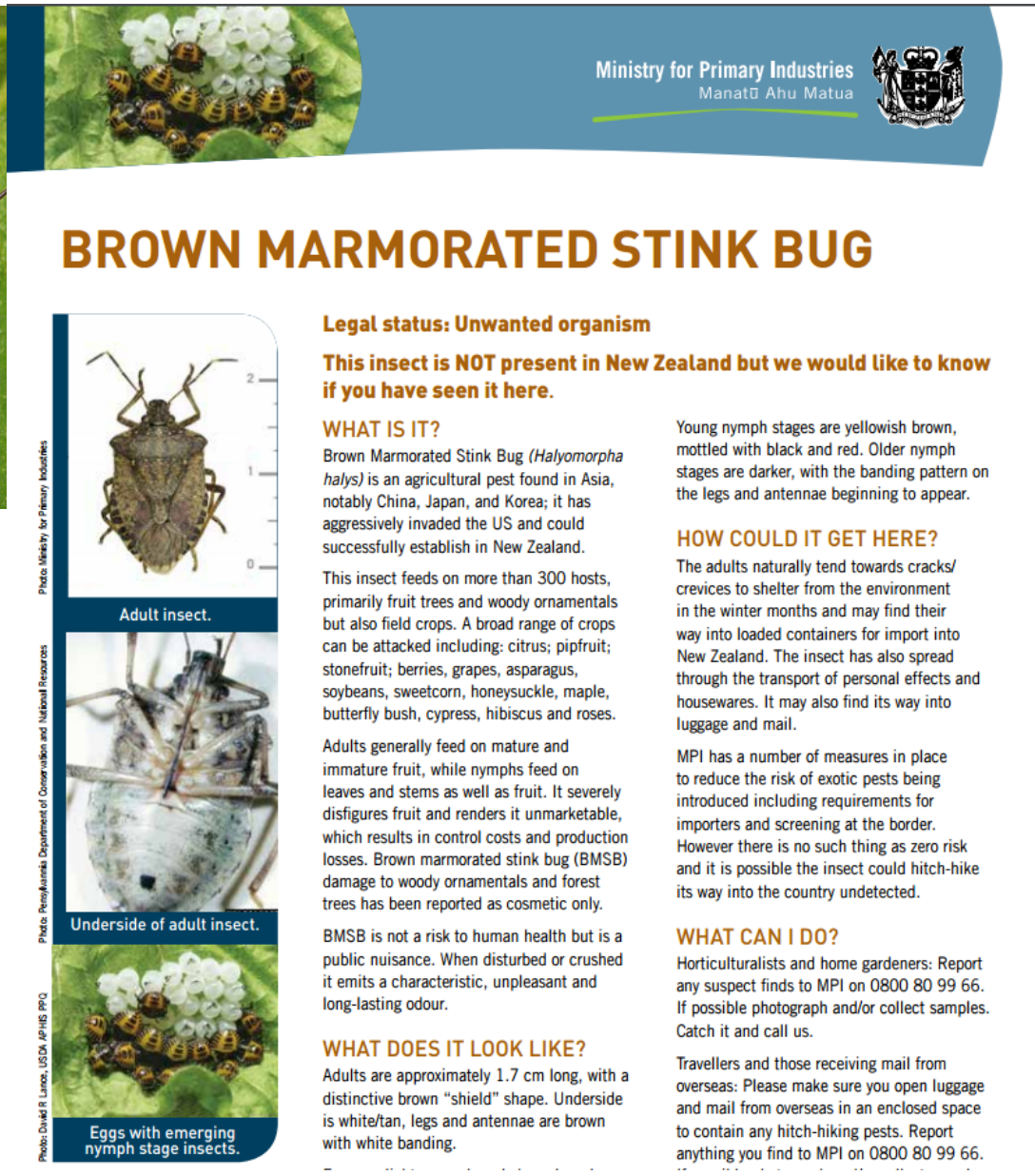
Trachycarpus fortunei (Chinese Fan Palm, Chinese Windmill Palm)

- Native to Central South China, Burma and Northern India
- Cold-hardy palm
- In 100 of World's Worst Invader List
- Climate change bio-indicator
- Impacts:
- competition
- shade
- form dense stands

Ref/image source: http://www.issg.org/database/species/search.asp?st=100ss

Halyomorpha halys (Brown marmorated stink bug)

- Very Destructive orchard pest
- Stinky household invader
- Native to China, Japan, Korea and Taiwan
- 4 Ships with BMSB turned away in 2018
- $1.8-$3.6B Impact to NZ Economy



Ministry for Primary Industries
Manatū Ahu Matua

BROWN MARMORATED STINK BUG

Photo: Ministry for Primary Industries

Adult insect.

Photo: Pennsylvania Department of Conservation and Natural Resources

Underside of adult insect.

Photo: David R Lance, USDA APHIS PPQ

Eggs with emerging nymph stage insects.

Legal status: Unwanted organism

This insect is NOT present in New Zealand but we would like to know if you have seen it here.

WHAT IS IT?

Brown Marmorated Stink Bug *(Halyomorpha halys)* is an agricultural pest found in Asia, notably China, Japan, and Korea; it has aggressively invaded the US and could successfully establish in New Zealand.

This insect feeds on more than 300 hosts, primarily fruit trees and woody ornamentals but also field crops. A broad range of crops can be attacked including: citrus; pipfruit; stonefruit; berries, grapes, asparagus, soybeans, sweetcorn, honeysuckle, maple, butterfly bush, cypress, hibiscus and roses.

Adults generally feed on mature and immature fruit, while nymphs feed on leaves and stems as well as fruit. It severely disfigures fruit and renders it unmarketable, which results in control costs and production losses. Brown marmorated stink bug (BMSB) damage to woody ornamentals and forest trees has been reported as cosmetic only.

BMSB is not a risk to human health but is a public nuisance. When disturbed or crushed it emits a characteristic, unpleasant and long-lasting odour.

WHAT DOES IT LOOK LIKE?

Adults are approximately 1.7 cm long, with a distinctive brown "shield" shape. Underside is white/tan, legs and antennae are brown with white banding.

Young nymph stages are yellowish brown, mottled with black and red. Older nymph stages are darker, with the banding pattern on the legs and antennae beginning to appear.

HOW COULD IT GET HERE?

The adults naturally tend towards cracks/crevices to shelter from the environment in the winter months and may find their way into loaded containers for import into New Zealand. The insect has also spread through the transport of personal effects and housewares. It may also find its way into luggage and mail.

MPI has a number of measures in place to reduce the risk of exotic pests being introduced including requirements for importers and screening at the border. However there is no such thing as zero risk and it is possible the insect could hitch-hike its way into the country undetected.

WHAT CAN I DO?

Horticulturalists and home gardeners: Report any suspect finds to MPI on 0800 80 99 66. If possible photograph and/or collect samples. Catch it and call us.

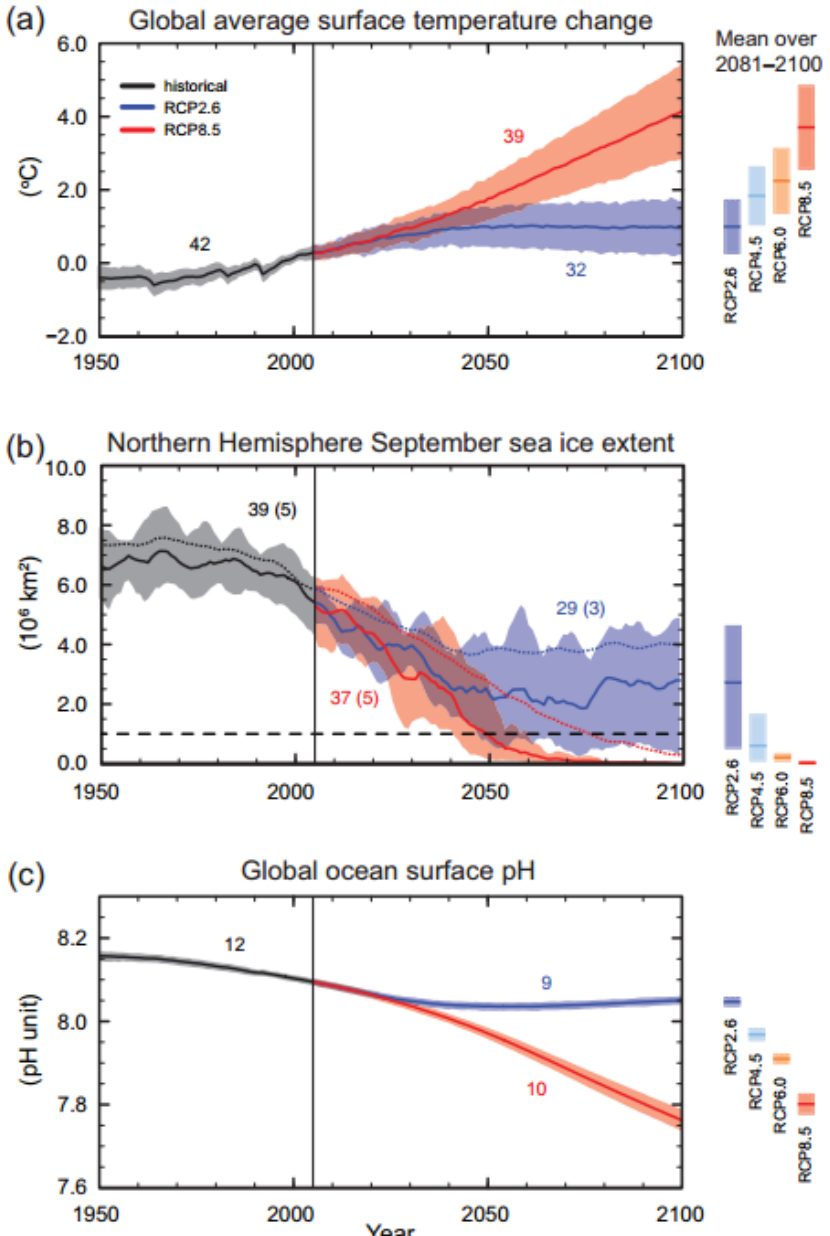
Travellers and those receiving mail from overseas: Please make sure you open luggage and mail from overseas in an enclosed space to contain any hitch-hiking pests. Report anything you find to MPI on 0800 80 99 66.

Ref/image source:http://www.biosecurity.govt.nz/pests/ http://www.issg.org/database/species/search.asp?st=100ss

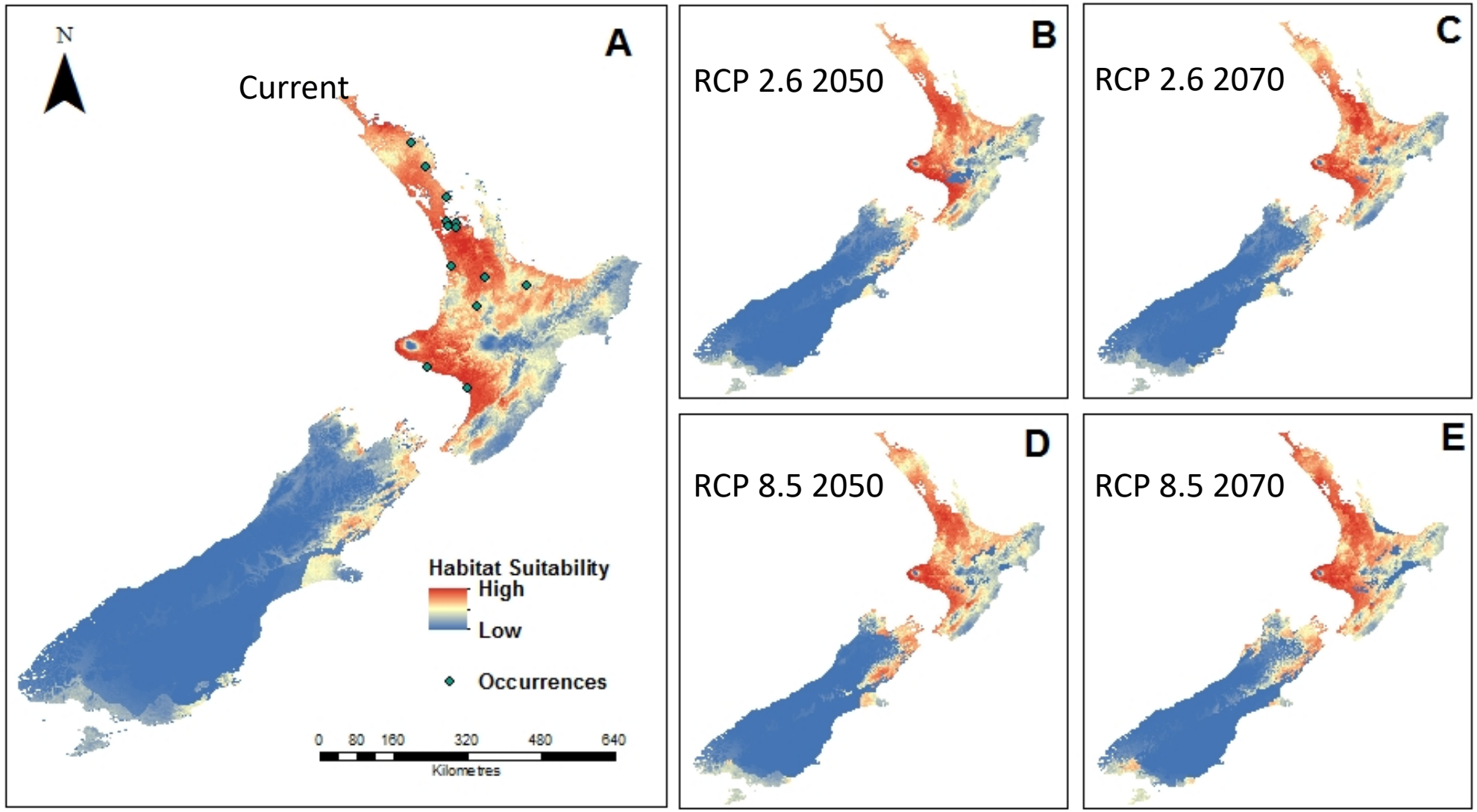
Environmental Variables: based on IPCC 5th Report

- Current – Worldclim database
- Future: 2050 and 2070 – CGIAR database
- Representative Concentration Pathways (RCP) and their Corresponding CO_2 concentrations
- (RCP2.6) 421 ppm
- (RCP4.5) 538 ppm
- (RCP6.0) 670 ppm
- (RCP8.5) 936 ppm

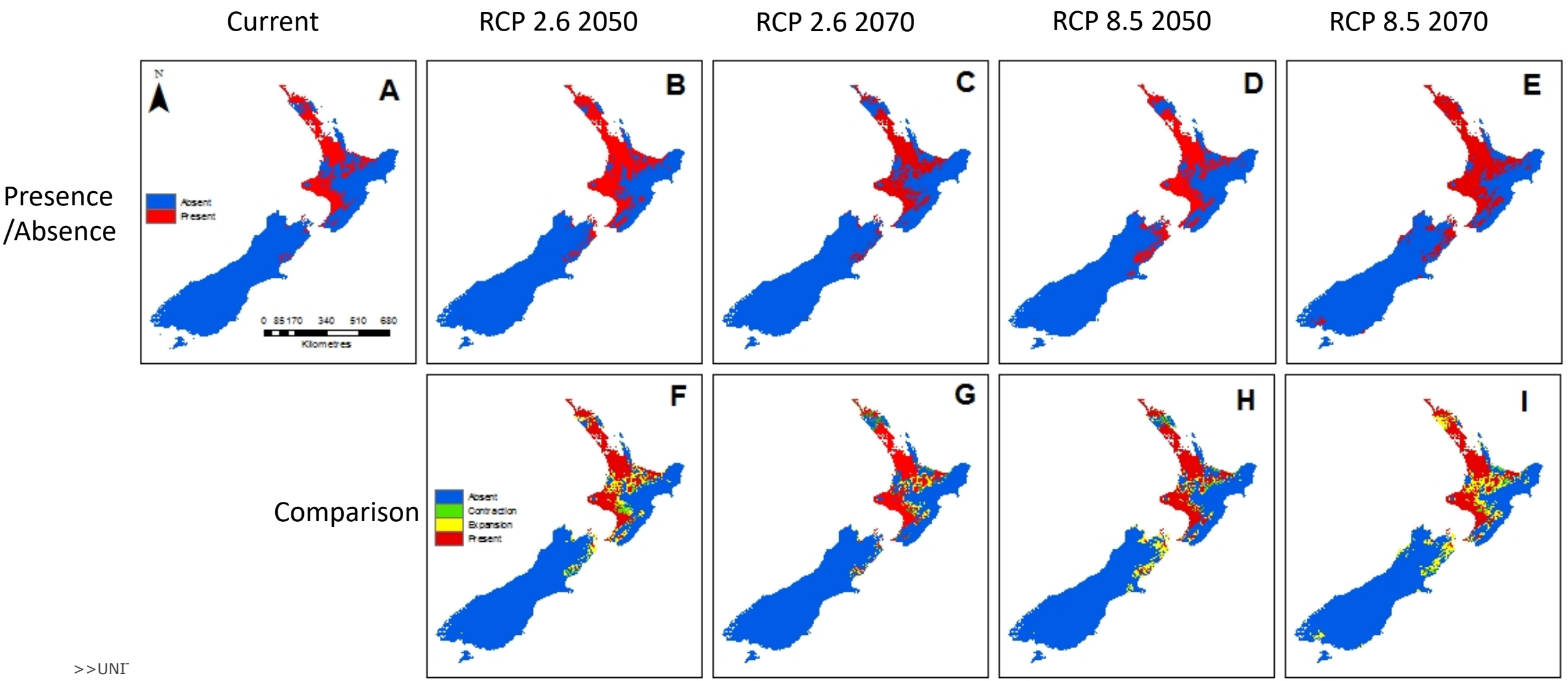
- Downscaled and Clipped to NZ territory



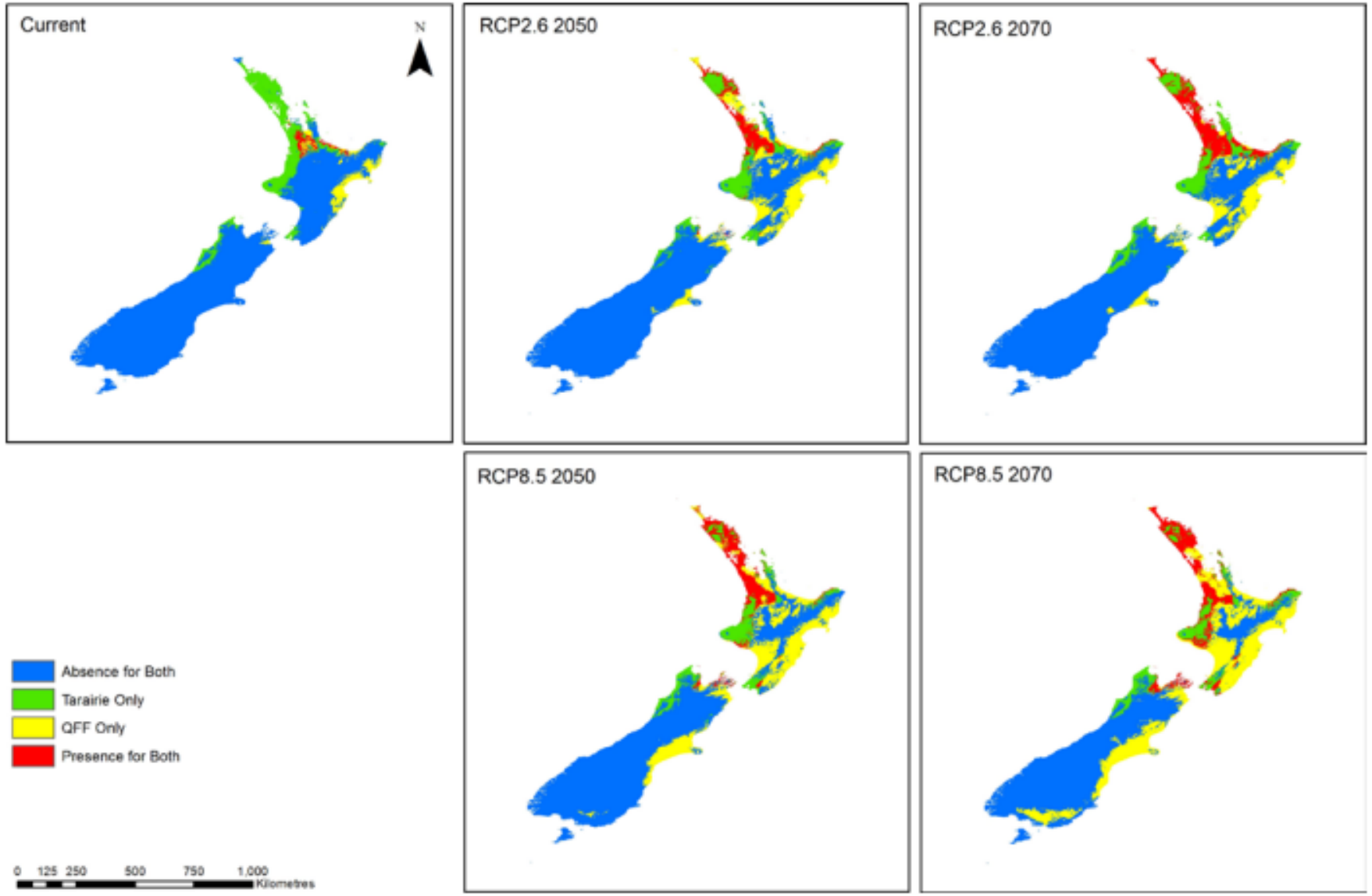
Results: Chinese Windmill Palm



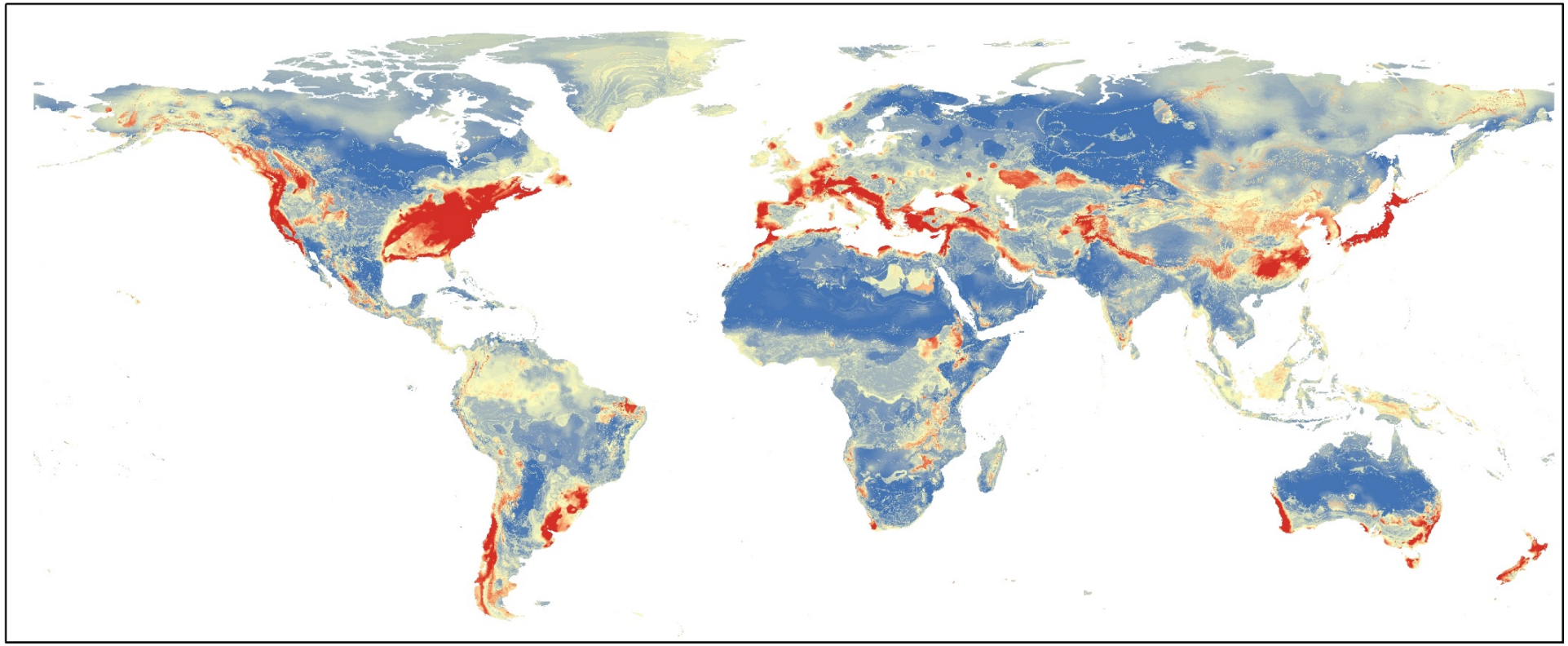
Results: Chinese Windmill Palm Model

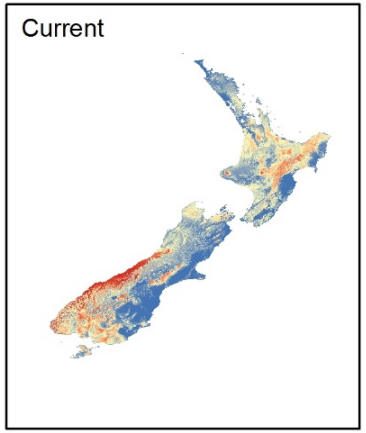


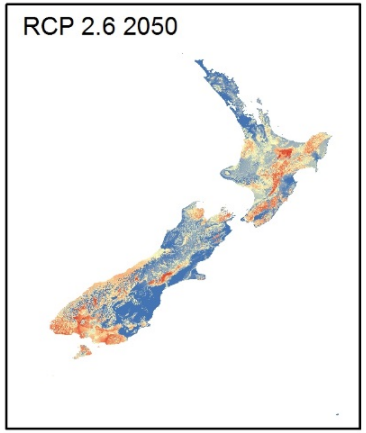
Results: Queensland Fruitfly

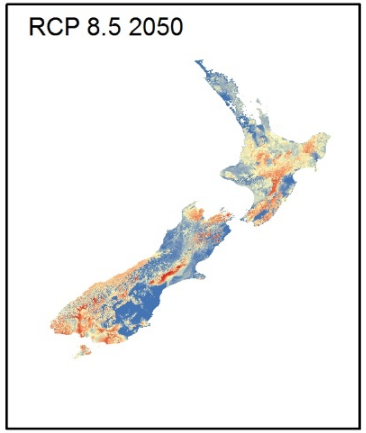


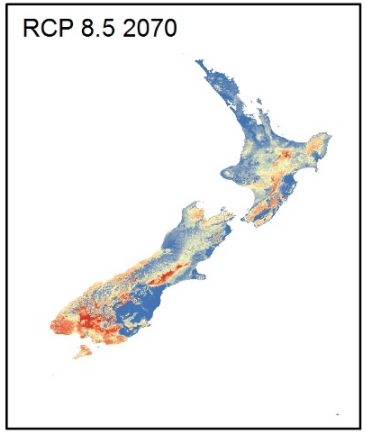
Results: Brown marmorated stink bug





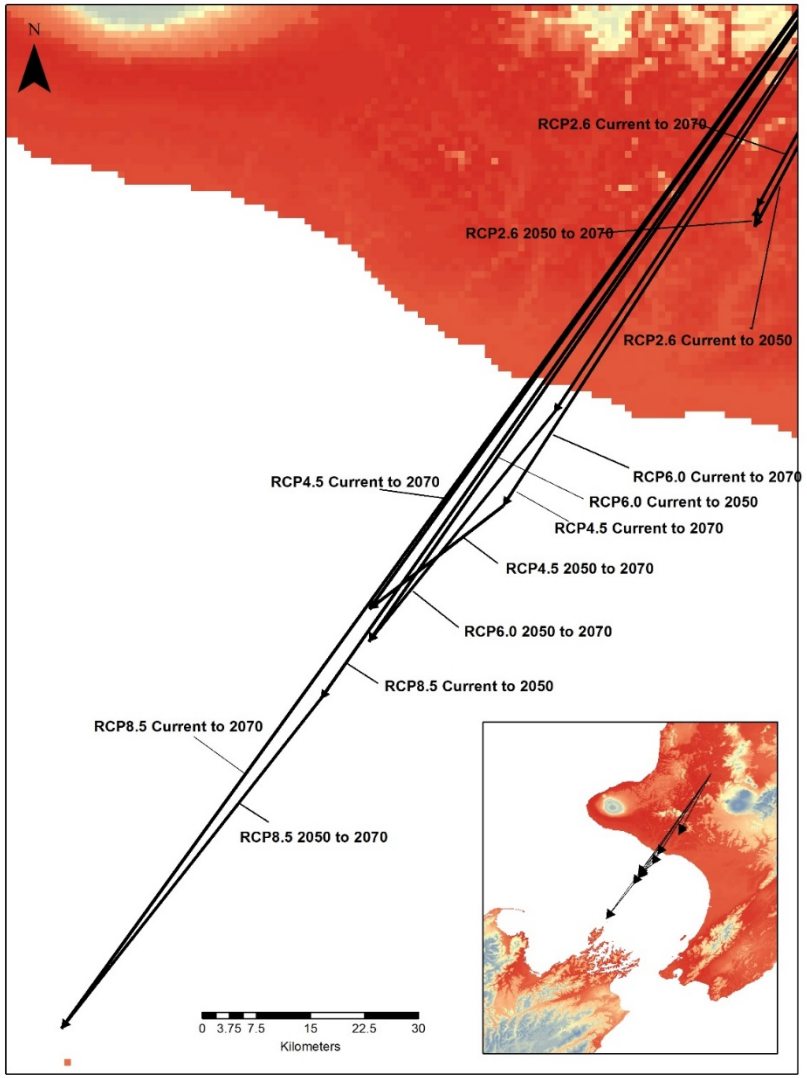




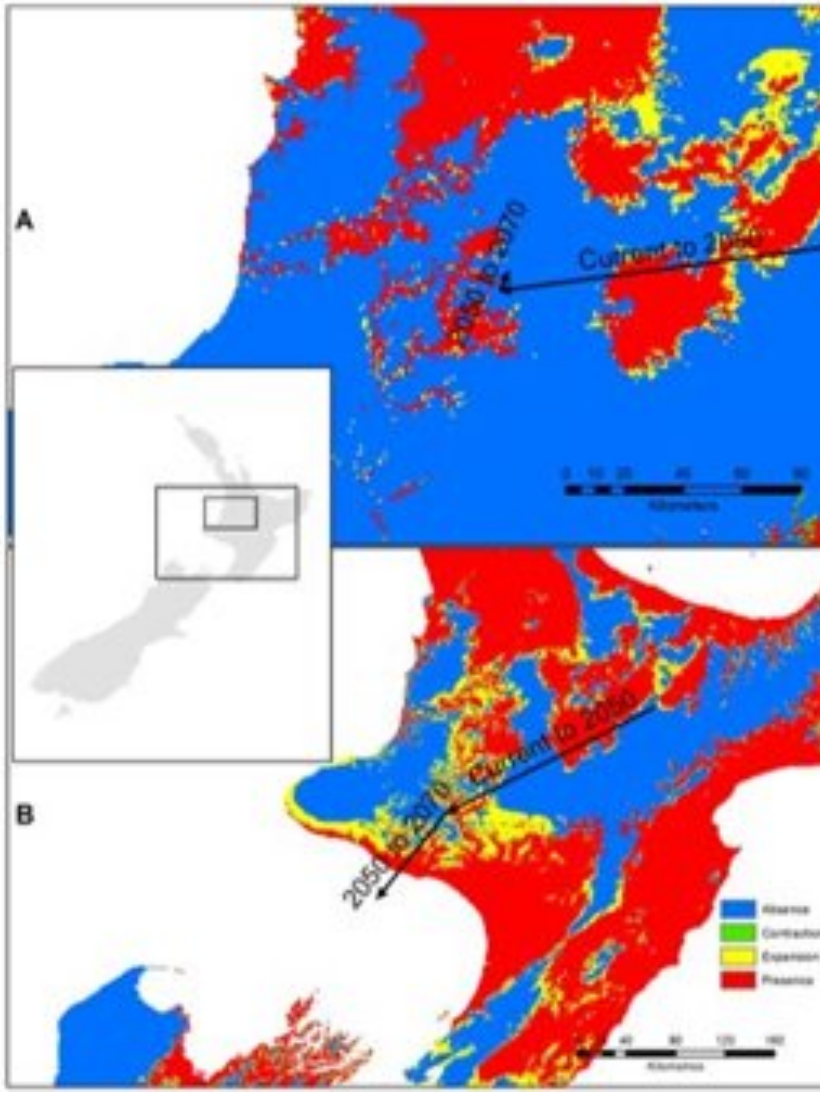


Centroid Movement

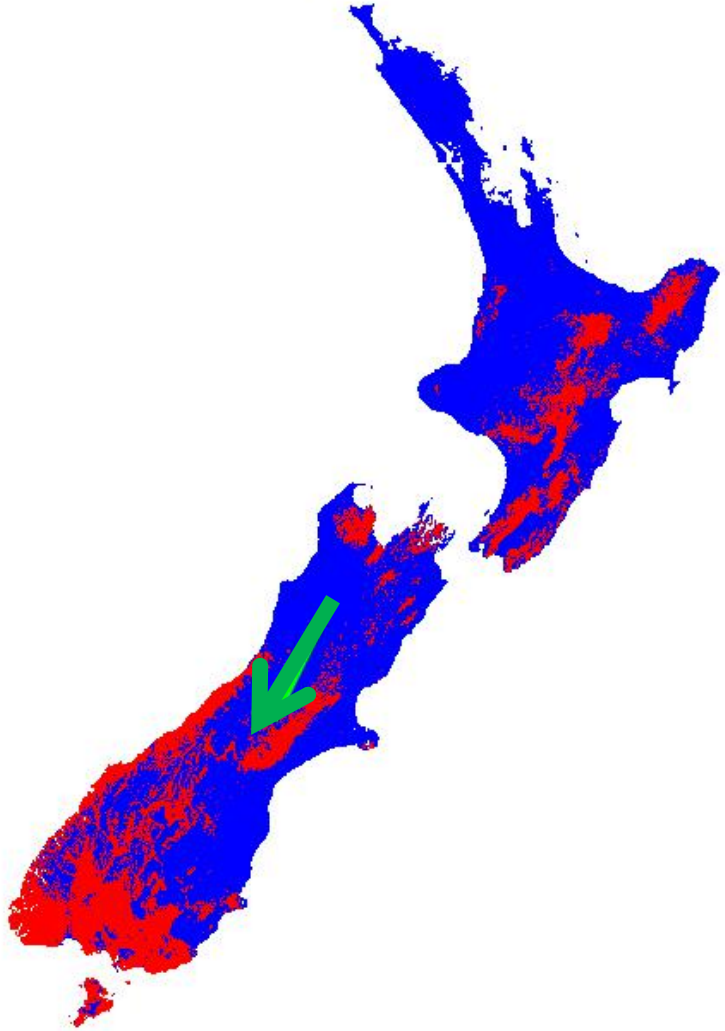
CFP



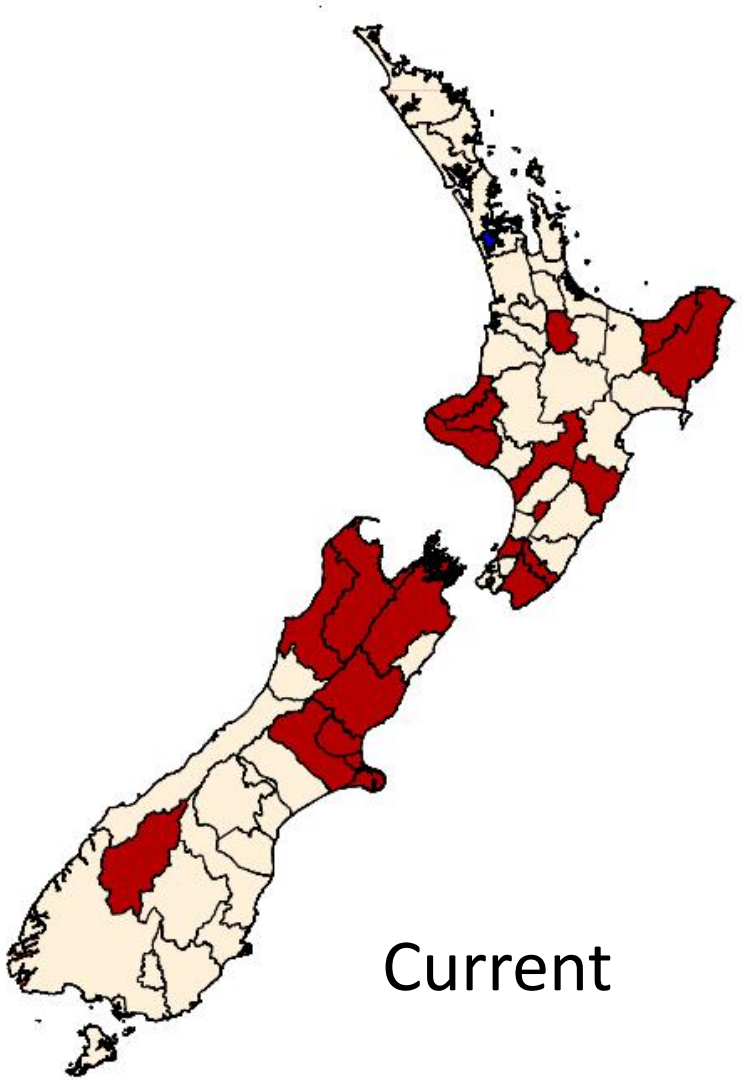
QFF



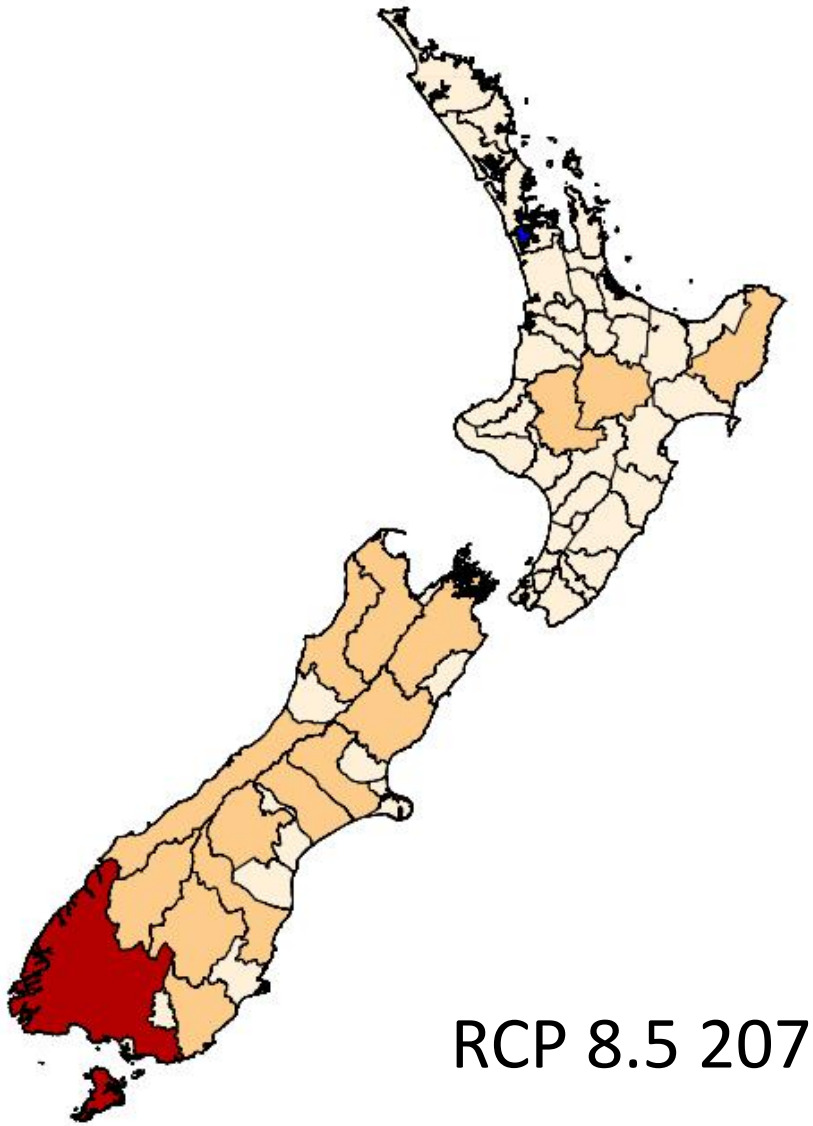
BMSB



NZ Territories BMSB presence prediction with climate change



Current



RCP 8.5 2070

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A performance based consensus approach for predicting spatial extent of the Chinese windmill palm (*Trachycarpus fortunei*) in New Zealand under climate change

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ARTICLE INFO

Keywords:
Predictive mapping
Ecological modelling
Machine learning
Species distribution modelling
New Zealand
Trachycarpus fortunei

ABSTRACT

The predicted distribution of the Chinese Windmill Palm (*Trachycarpus fortunei*) was modelled using several algorithms with inputs consisting of occurrence information and bioclimatic datasets. A global species distribution model was developed and projected into New Zealand to provide a visualization of suitability for the species in current and future conditions. To ensure model robustness, occurrence data was checked for redundancy, spatial auto-correlation and the environmental variables checked for cross-correlation and collinearity. The final maps predicting suitability resulted from ensembling the predictions of all the algorithms. The resulting ensembled maps were weighted based on the evaluation parameters AUC, Kappa and TSS. When reclassified into low, medium and high suitability categories, results show an expansion of high suitability areas accompanied by a reduction of low suitability areas for the species. The centroids of the high suitability areas also exhibit a general movement towards the Southwest under future climate conditions. The range expansion was proportional with the representative values of emission trajectories RCPs (2.5, 4.5, 6.0 and 8.5) used in projecting into future conditions. The movement magnitude and direction of predicted high suitability area centroids for the palm supports the use of the plant as an indicator of climate change.

climate

MDPI

Article

Mapping the Potential Global Range of the Brown Marmorated Stink Bug, *Halyomorpha halys*, with Particular Reference to New Zealand

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Abstract: Originating from Asia, the brown marmorated stink bug (BMSB) is a significant pest of horticultural/agricultural crops, grapes, woody ornamental and herbaceous plants, and is also a nuisance to people, due to its overwintering behavior in human habitation. The global range of this pest is steadily increasing and previous predictions of environmental suitability have shown New Zealand to be highly suitable. Due to the economic value of horticultural and agricultural industries to the New Zealand economy, it is vital to understand the range of potential risk within the country. Global and New Zealand potential suitability for BMSB was modeled using three algorithms and the resulting predictions ensembled to predict the potential range under current climatic conditions and under trajectories of future low (Representative Concentration Pathways, RCP, 2.6) and high (RCP 8.5) greenhouse gas emissions for both 2050 and 2070. Under current conditions, models showed a high global suitability within latitudes 25°–50° N, southern South America, southeast and southwest regions of Australia and large areas of New Zealand. Modeling the effect of climate change on BMSB range in New Zealand resulted in a southerly range shift over time, particularly with high emissions trajectory. Currently, BMSB is not established in New Zealand and it is vital that this remains the case.

Keywords: brown marmorated stink bug; insect; pest; modeling; range; global; New Zealand; climate change

Queensland fruit fly invasion of New Zealand: Predicting area suitability under future climate change scenarios

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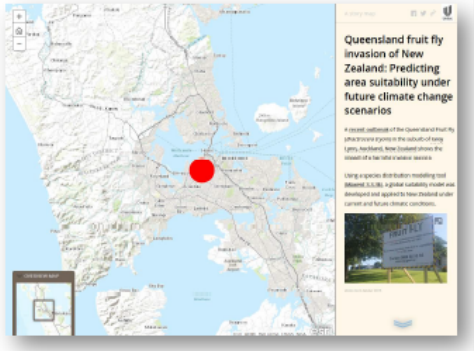
Abstract

The Queensland fruit fly (Bactrocera tryoni) *is a significant horticultural pest in Australia, and has also established in other parts of the Pacific. There is a significant risk to New Zealand of invasion by this species, and several recent incursions have occurred. The potential effects of climate change on the distribution and impacts of invasive species are well known. This paper uses species distribution modelling using Maxent to predict the suitability of New Zealand to the Queensland fruit fly based on known occurrences worldwide and Bioclim climatic layers. Under current climatic conditions the majority of the country was generally in the lower range, with some areas in the medium range. Suitability prediction maps under future climate change conditions in 2050 and 2070, at lower emission (RCP 2.6) and higher emission (RCP 8.5) scenarios generally show an increase in suitability in both the North and South Islands. Calculations of the shift of suitable areas show a general movement of the centroid towards the south-east, with the higher emission scenario showing a greater magnitude of movement.*

Click here to visit the Queensland fruit fly suitability prediction map



ePress

Unitec Institute of Technology

***Alien Nation*: Art serving science and science serving art**

Hamish Foote, Dan Blanchon, Nick Waipara and Glenn Aguilar

Alien Nation: Art serving science and science serving art

Hamish Foote, Dan Blanchon, Nick Waipara and Glenn Aguilar

Abstract

New Zealand has stringent biosecurity measures to prevent and manage the invasion of new organisms, many of which have harmful effects on human health, wealth and culture, or the natural environment. However, public resistance to control methods, or a lack of awareness of the impacts of invasive species, can act to prevent effective management of the risks. Art has a role in promoting conversation and debate about controversial issues. The premise of Alien Nation is to use scientific data and modelling to predict possible future invasion scenarios for selected plant and animal species, and to then use art to depict and explore these scenarios in a way that challenges perception. The first species to be modelled is the Queensland fruit fly (*Bractocera tryoni*), and its potential interaction with taraire (*Beilschmiedia tarairi*), a New Zealand native tree species. Modelling shows that there is a high likelihood of the Queensland fruit fly spreading widely in New Zealand and coming into contact with taraire forests. Based on what is already known of the impacts of the Queensland fruit fly on the fruits of a range of species, and of the ecology of

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Article

The House Crow (*Corvus splendens*): A Threat to New Zealand?

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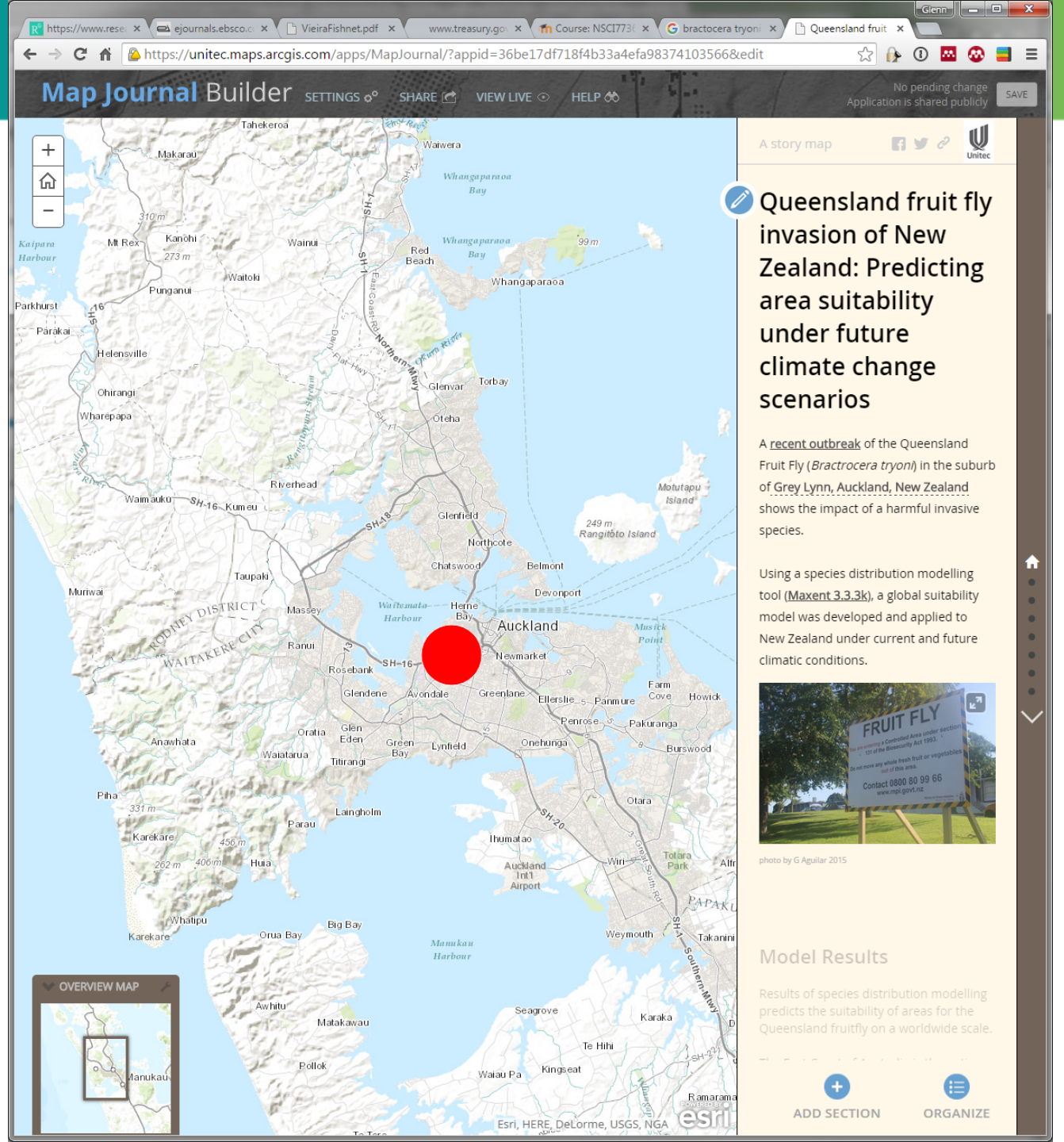
Story Maps

http://arcg.is/1zSTASH



3D Viewing Output from ArcGIS Pro

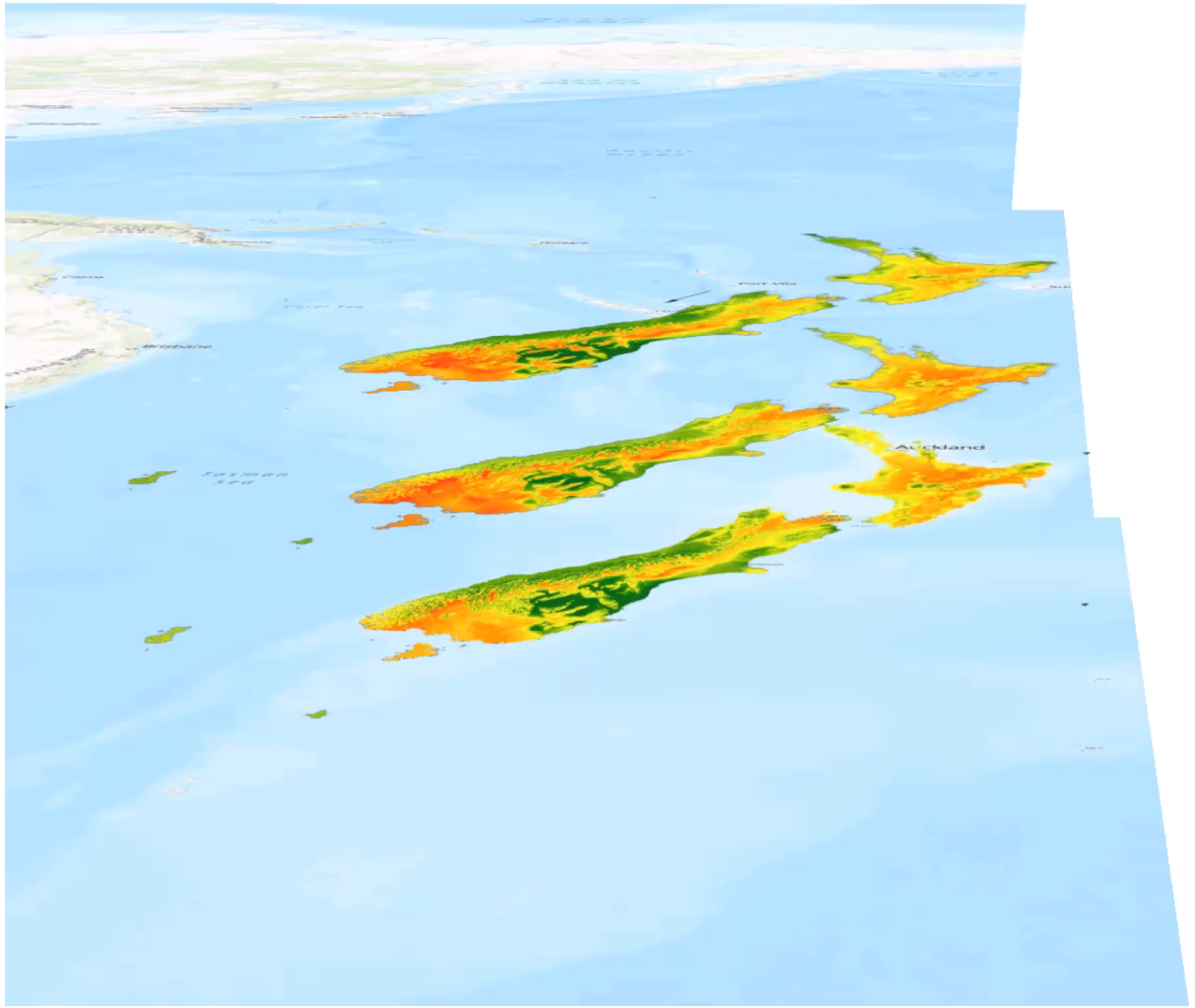
Suitability Models:

RCP8.5 2070

RCP2.6 2070

Current

Centroid Movement



Fly in the Ointment by Hamish Foote, 2015

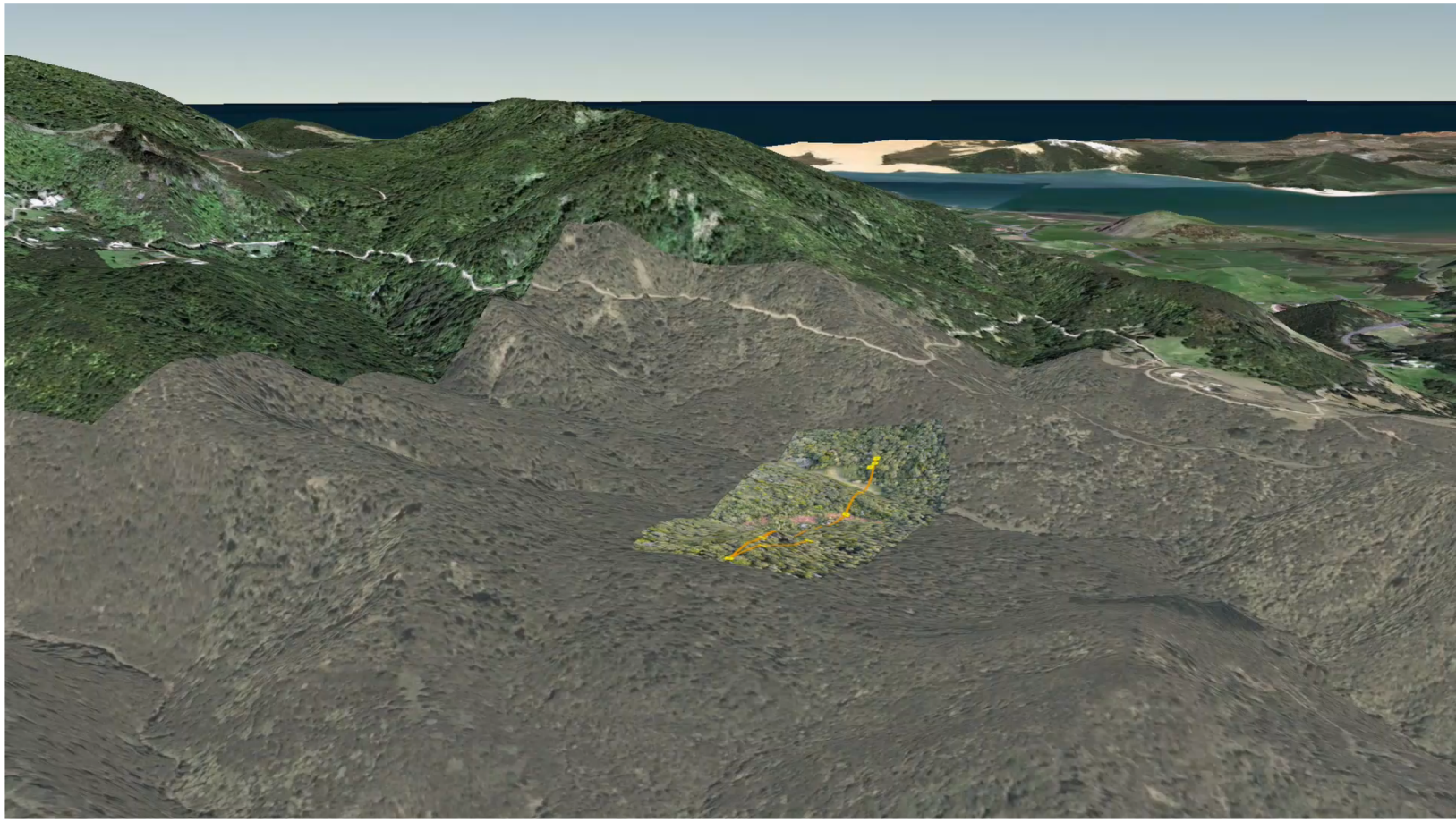
QFF and impact on Taraire, with associated Silver Paint Lichen

“The painting requires the viewer to see the impacts of invasion on native biodiversity, an examination through the lens of a cultural rather than fiscal currency” (Foote et al., 2017)

PREDATION by Hamish Foote

Current and Future Work

- Drone Acquired Imagery for Ecological Restoration/Weed Management
- NDVI/NDRE Based Vegetation Classification
- GIS Capability Building for He Ripo Kau



Summary and Conclusion

Suitability mapping of invasive species provides knowledge and information products that supports decision making, planning and strategy formulation for risk management

Presentation of map outputs in different formats ensures provisions for varied interpretations, provide the ability to cater to a diverse audience and allow for a variety of provocations when looking at invasive species through different lenses, including cultural, scientific and fiscal ones.