In the footsteps of cows. Using technology to predict new weed incursions

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Summary Tropical soda apple, *Solanum viarum*, is an aggressive prickly perennial shrub 1–2 m high. It invades open to semi-shaded areas, including pastures, forests, riparian zones, roadsides, recreational areas, horticultural and cropping areas. In August 2010 the plant was identified on the mid-north coast of NSW. It is believed that tropical soda apple has been present in this area for a number of years and both systematic and *ad hoc* surveys have found the weed in other satellite locations.

The discovery of tropical soda apple at several cattle handling facilities indicates that cattle are a significant vector for the weed. This has presented an opportunity to use the National Livestock Identification System (NLIS) data to trace cattle movements from affected properties throughout Australia. This has proved remarkable as there are few mechanisms to systematically trace weed incursions using such technology.

Through the use of NLIS we have been able to conduct a pathway analysis of where this weed is likely to occur across NSW. Importantly, we can use this information to pinpoint surveillance activities for local managers thus ensuring better use of resources. The data has also allowed us to model the probability of incursions at these sites using statistics gleaned from the NLIS data.

This project has proven to be a successful collaboration between various units of NSW Department of Primary Industries, Local Government and the Livestock Health and Pest Authority (LHPA).

Keywords Tropical soda apple, cattle tracing, National Livestock Identification System, NLIS, pathway analysis, modelling, probability.

INTRODUCTION

Tropical soda apple is a native of north eastern Argentina, south eastern Brazil, Paraguay and Uruguay. In was first recorded in Florida in 1987 and was known to infest 10 000 ha by 1990 and half a million hectares by 1995. By 2007 it had spread to nine other states in south eastern USA (Diaz 2008). In the USA it is a Federal Noxious Weed. Tropical soda apple has also naturalised in Africa, India, Nepal, West Indies, Honduras, Mexico and outside its native range in South America.

Tropical soda apple was first identified in Australia in the Kempsey area on the mid-north coast of New South Wales (NSW) in August 2010. However, the weed is believed to have been present in this area for a number of years. The source of the original introduction is currently unknown and unlikely to be determined. The extent of the core infestation is about 50 ha. Subsequent surveys have identified other smaller infestations in surrounding areas.

From information available it is likely to have the potential to spread to coastal and sub-tropical regions in NSW and Queensland. However, this does not take into account modified environments such as irrigated agriculture.

Tropical soda apple reproduces by seed; it is spread by stock, feral animals and birds that feed on the fruit, and *via* water, and contaminated produce, equipment, pasture seed, compost and soil. The sweet smell of mature fruit attracts animals and seed passes through the digestive system unharmed and will germinate in dung or droppings.

Evidence from the USA indicates that distribution by animals is likely to be a major vector for this weed. The occurrence of the weed at saleyards where cattle have been transported from infestation sites supports this theory.

There is evidence that stock from one particular property affected by the weed have been dispersed across NSW. Other producers in the area have more than likely transferred stock to other locations in NSW and interstate as well. This dispersal mechanism indicates that a state-wide management approach is needed in concert with efforts from neighbouring states.

Although the Macleay River may be considered a pathway for the Kempsey incursion, the distribution of the weed along the river suggests that animal movement along the corridor is a more likely factor rather than water transportation.

It is known that both native and feral animals and birds are consuming the fruit (Ensbey, pers. comm.). This is also a pathway for spread although this is likely to be more localised than the potential long distance spread *via* livestock movements.

NATIONAL LIVESTOCK IDENTIFICATION SYSTEM

Livestock movements from tropical soda apple affected areas have been a focus for trace-forward activities. All sheep and cattle movements are currently tracked by the National Livestock Identification Scheme (NLIS). Information from NLIS can be used to target weed identification and extension materials or direct surveillance priorities.

The NLIS is Australia's scheme for the identification and tracing of livestock. This system enhances Australia's ability to respond quickly to a major food safety or disease incident in order that access to key export markets is maintained. It is a key industry initiative in partnership with governments across Australia.

'NLIS Cattle' was introduced in NSW on 1 July 2004 and involves electronic identification of cattle and centralised recording of movements on a national database. NLIS Cattle uses approved NLIS ear devices or rumen boluses and reporting of all movements of cattle between properties with different property identification codes.

Privacy considerations The collection and use of information recorded in a stock identification and tracing register is subject to the provisions of the *Privacy and Personal Information Protection Act 1998* (the 'Privacy Act'). The Privacy Act applies to all public sector agencies.

When collecting personal information, an agency must take reasonable steps to ensure that landowner privacy is maintained. Personal information must not be used unless it is for a purpose directly related to the reason for which the information was collected. In the 'Terms of Use' of NLIS information, a 'Permitted Use' (section 13.1) means "any use which a government participant acting reasonably considers necessary or convenient to comply with the legislative framework within which it operates solely for biosecurity, food safety and market access purposes".

To abide with these considerations, NSW Department of Primary Industries gave local government the minimum amount of required information to enable them to complete their survey. Information regarding the origin of transferred cattle was not required to complete this task.

Pathway analysis In November 2010 Biosecurity staff at NSW Department of Primary Industries conducted a pathway analysis to model the distribution of tropical soda apple based on cattle movements across the state.

The locations of all properties with tropical soda apple present were collated and converted to standard GPS coordinates. This process resulted in a list of 756 infested properties. This list was then given to the LHPA who provided NLIS property identification codes for each property. The resulting list of properties was then used to identify 26 762 cattle movements from each infested property over a period of time.

At this point a decision was made that cattle movements would be analysed for the past six years or the period from which the data was first collected. Consideration was given as to whether the movements should be prioritised based on how long ago the movement took place. It was decided that it would be difficult to get an objective ranking of risk based on this method. Ultimately the risk of spread was based entirely on number of cattle movements.

The NLIS database was interrogated to determine the first movement of individual cattle from each infested property. Where cattle were transferred to a cattle handling facility, the following movement was also determined. When an animal went from an infested property to an abattoir the trace ended. Abattoirs and other cattle handling facilities have been the focus of local government and surveillance activities outside of this process.

The resulting list of 1048 properties that received cattle transfers from infested properties became 'properties of interest' (see Figure 1) and were processed into 57 local government areas and mapped by NSW Department of Primary Industries staff.

This process also identified nine properties of interest in Victoria and 25 in Queensland. The appropriate interstate authorities were promptly alerted to the weeds' presence.

NSW Department of Primary Industries wrote to 57 local control authorities requesting they inspect the properties of interest in their area and report the results back to NSW Department of Primary Industries. It was also requested that the identified properties receive follow up surveillance as part of routine weed inspections. This survey is still ongoing.

OUTCOMES

The early identification of three separate incursions across the State demonstrates that this is a valuable pathway analysis tool for predicting the movement of some weeds. This ground breaking technique resulted in the discovery of the tropical soda apple at Holbrook 1200 km from its original infestation. Subsequent surveys have also found the weed at Tamworth and Inverell. These incursions were able to be eradicated quickly and cheaply. Furthermore, this analysis gives managers valuable information to allow delimitation of the weed's range based on its most common vector.

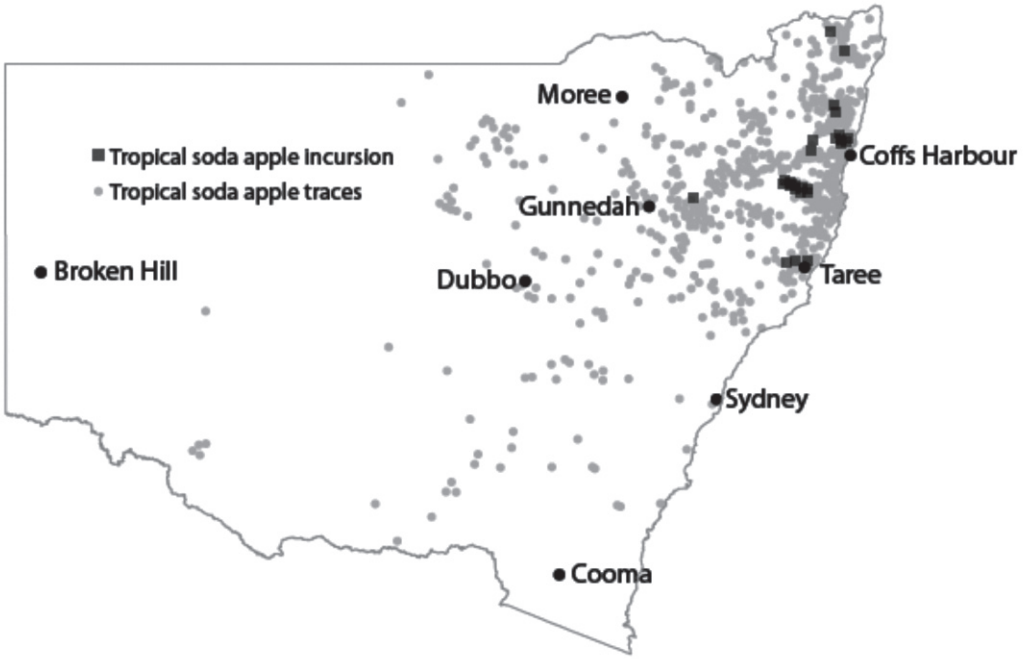

Figure 1. 'Properties of interest' derived from NLIS trace.

This program has been very successful in engaging various stakeholders across the State. Participation in this tracing activity has also provided weed officers with an opportunity to positively engage with landowners in weeds management where there is a direct benefit for the landowner. This pro-active interaction with landowners has been invaluable in building a rapport with landowners that can be used for broader weed management outcomes.

The identification of specific properties of interest has also enabled local government weed officers to target specific groups namely the beef cattle industry for the distribution of extension and education material.

Although cattle movements are considered a significant pathway, it was considered important that the beef cattle industry was not unnecessarily impeded. As a result of the trace, several hygiene protocols have been promoted to limit the risk of new weed incursions due to cattle movement.

Feedback from local government weed officers has been invaluable in identifying ways that NLIS can be improved. It was commonly reported that some property data was incorrect in many cases, for example, owners reported that they had never had cattle on their property, or that the property was used exclusively for another purpose such as cotton production. It was also established that many cattle buyers purchase bulk lots that are distributed to several other properties without changing transfer details. Other issues included the re-tagging of cattle with incorrect tags when tags are lost in transit, and the inability to trace manure from feedlots.

Since this analysis has been conducted, NSW Department of Primary Industries has commenced streamlining the tracing process through its Biosecurity Enhancement Program. These changes will allow officers quicker access to data required for tracing activities.

CONCLUSION

By manipulating NLIS data normally reserved for managing animal pests and disease, staff were able to identify high risk properties and pathways across NSW, Queensland and Victoria. This result is a tremendous advantage for weed managers and cattle producers allowing them to eradicate outlying populations before they become expensive and impractical to control.

It is important that weed managers think outside of the square when conducting pathway analysis and

exploit these types of resources where they are effective.

Although not applicable to all situations this type of approach should be considered in the repertoire of techniques for weed pathway analysis. This particular technique allows weed managers the ability to electronically trace the movements of weeds where the vector is directly related to stock movements recorded on the NLIS database.

This again reinforces the value of tools such as GIS and databases and the importance of accurate recording of information. One caveat should be stated: that the time used to analyse the pathway should be proportional to the importance of the vector you are analysing. There is not much point spending inordinate amounts of time analysing animal movement if the majority of seed is transported by water.

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