GIANT PINE SCALE (*MARCHALINA HELLENICA*) NOT DETECTED IN NEW SOUTH WALES

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Summary

Giant pine scale, *Marchalina hellenica,* is a pest of pines, firs and spruce trees. *Marchalina hellenica* is endemic to Greece and was detected in Australia in both Melbourne and Adelaide in 2014. To support the national eradication response under the Emergency Plant Pest Response Deed, surveillance was undertaken to determine if the scale was present in New South Wales (NSW). This included Public Participation in Scientific Research surveys (by the public) and targeted site inspections (by government staff). A total of 283 sites were inspected across metropolitan Sydney and regional NSW resulting in more than 3,300 trees inspected with no positive detections. Additionally, data from forest health surveys of commercial *Pinus* plantations in regional NSW were used to declare pest-free status, with no giant pine scale detected in 260 site inspections. New South Wales was declared free from *Marchalina hellenica.* An eradication response was mounted in Melbourne and Adelaide, although it was ultimately unsuccessful.

Keywords exotic plant pest, citizen science, biosecurity

INTRODUCTION

The forestry sector is a significant contributor to the Australian economy with gross sales in 2015-2016 in excess of $23 billion, and an industry value-add of $9 billion. The forestry industry directly employs over 67,000 people with many of these jobs based in rural and regional Australia including New South Wales (NSW) (Lawson *et al*. 2018). Australia has one of the strongest and strictest quarantine systems in the world and has developed strong border interception surveillance programs (Carnegie *et al*. 2018a; Lawson *et al*. 2018; Nahrung and Carnegie, 2021). However, forest pest incursions do occur, and these were summarised by Carnegie and Nahrung (2019).

One of the recent incursions was giant pine scale (GPS) (*Marchalina hellenica* (Gennadius, 1883)) (Agriculture Victoria 2019). GPS is a non-cyst forming margarodid and is endemic to Greece. The host range includes Aleppo pine (*Pinus halepensis* Miller), Turkish pine *P. brutia* (Ten), stone pine (*P. pinea* (L.)), Scots pine (*P. silvestris* (L.)), and black pine (*P. nigra salzmannii* (Dunal) Franco 1943) (Bacandritsos *et al.* 2004; Gounari 2006). Firs (*Abies* spp.) and spruces (*Picea* spp.) have been found as minor hosts. GPS requires live tree material and feeds on the plant phloem by inserting its long rostrum into the nutritious cambium of the tree truck and main branches (Gounari 2006). Honeydew is excess pine sap which has not been used by the insect and is eliminated through the anus (Gounari 2006). In Greece, this honeydew is collected by honeybees which produce "pine honey". Turkey is the largest producer of pine honey and exports 85% of production to European Union countries (Unal *et al*. 2017). All GPS stages feed except the adult female (Gounari 2006; Unal *et al*. 2017). Impacts on trees include dehydration, defoliation, branch dieback, reduced plant vigour and occasionally tree death (Yesil *et al*. 2005; Fotelli *et al*. 2020).

Adult insects are up to 12 mm in length and up to 5 mm wide and covered by fluffy white cottony wax filaments (Gounari 2006). Females are univoltine, and can produce over 300 eggs which hatch into crawlers that become covered with the white cottony wax filaments once they settle on a feeding site (Gounari 2006). GPS can be found in cracks and the rough bark of trees, protected under the white cotton wax filaments that it secretes. When in large numbers, the white waxy filament coat creates the appearance of snow (Agriculture Victoria 2019; DPI NSW 2019) (Figure 1).

Natural dispersal of GPS is short, as adults are wingless (Gounari 2006). Mobile crawlers can move within and between trees, particularly when trees are planted close together: annual dispersal is about 40 m (Nikolopoulos 1965). Some local spread may occur by ants harvesting the eggs (Agriculture Victoria 2019; NSW DPI, 2019). Overseas, long distance spread occurs by human assisted movements including by beekeepers in Europe (Nikolopoulos 1965; Petaikis *et al*. 2010; Gresham and Meurisse 2019). GPS can be unintentionally spread if moved in infested plant material (mulch, logs, needles, cones), soil, contaminated machinery or clothing (Agriculture Victoria 2019; Biosecurity Queensland 2019; NSW DPI 2019).

GPS was discovered on amenity plantings of *P. radiata* (D.Don.) (Monterray or radiata pine) in Melbourne (October 2014) (Agriculture Victoria 2019) and in Adelaide (November 2014) (Primary Industries South Australia 2019). In Australia, GPS is considered an exotic pest and a threat to the softwood plantation industry and amenity pine plantings due to its ability to cause tree death (Agriculture Victoria 2019). The Australian softwood plantation industry was valued at $1.16 billion (Agriculture Victoria 2019) and therefore eradication was deemed appropriate (Carnegie and Nahrung 2019). In Adelaide, almost 100 trees were destroyed to eradicate GPS. In Melbourne, over 150 trees were destroyed however public support for the program declined when a further 4,300 trees were identified and scheduled for destruction (Carnegie and Nahrung 2019). Chemical control was revealed to be less effective than expected. The eradication program was halted and the program changed to 'transition to management'. The total costs of this program (eradication and transition to management) are likely to exceed AU $6 million (Carnegie and Nahrung 2019). The distribution of GPS in Australia is currently restricted to trees in greater Melbourne (Avtzis *et al*. 2020).

Following the detection of an Emergency Plant Pest, a National plan is developed by the lead agency and as part of that plan, delimitation surveillance was requested and conducted to determine the distribution of the pest to ascertain whether it is technically feasible to eradicate (i.e. the pest is not distributed too far) (Anderson *et al.* 2017). As part of the national GPS response, NSW Department of Primary Industries (NSW DPI 2019) surveyed for GPS in both forestry and amenity plantings. This included targeted (active) surveillance by DPI and Local Land Services staff and the use of Public Participation in Scientific Research (PPSR). PPSR is a type of citizen science and utilises existing networks of people to collect data on a particular scientific issue and can supplement specific surveys (Haywood 2014). Surveillance for GPS was considered an appropriate topic for PPSR as the pest's fluffy wax excretions are easily visible to the naked eye and pine trees are a well-recognised tree group. Here, we report on the activities undertaken in NSW to demonstrate freedom from GPS. The pest was not detected in NSW and the state was declared free from GPS.

MATERIALS AND METHODS

Public participation

The surveillance project was ideal for members of the public to participate in given the extensive plantings of pine trees in parks and gardens, and the relative ease with which GPS can be detected (Figure 1). Requests for participation were sent to Golf NSW, New South Wales Golf Course Superintendents Association, Institute of Australian Consulting Arboriculturists, Landscape Association of NSW & ACT, NSW Forest Products Association, and the Cemeteries & Crematoria Association of NSW. These associations were targeted as message multipliers and asked to pass on the request to their members. Additionally, local councils in the Sydney, Illawarra and Hunter regions that had a demographic connection with Greece were also sent requests. This demographic group was targeted due to the historical proliferation of GPS in Greece (Petrakis *et al.* 2011).

A kit was prepared to support each request. The kit contained a cover letter explaining the situation and the request for participation, a fact sheet about the pest, and a record sheet to be filled in and returned to NSW DPI. The record sheet was a simple table that asked for the name and phone number of a contact person, the location of the inspection, land use, type of tree (if known), number of pine trees inspected, and the number of trees with symptoms of GPS. A completed example of a surveillance record was provided to clearly encourage participants to report negative results as well as positive results. A webpage was developed with supporting material and the general public was encouraged to use these resources. The webpage was promoted in the NSW DPI Plant Biosecurity newsletter. Government officers, trained in biosecurity procedures, visited sites identified by members of the public, and if required, samples were taken in a biosecure manner and sent to NSW DPI laboratories for identification.

Targeted surveillance

Staff from NSW DPI and Local Land Services conducted the surveillance. Surveys consisted of inspections of pine trees and searching for the typical symptoms. Specific surveillance was conducted of *Pinus* trees across the Sydney basin and in regional areas from November 2014 to June 2015. Also, we used pre-existing surveillance data from the annual forest health surveillance program of commercial *Pinus* plantations in NSW, which are carried out by trained forest health surveillance officers (Carnegie *et al*. 2008). During this surveillance, trees were visually inspected for health issues, including inspecting for signs and symptoms on foliage, branches, and trunks. Here we assumed that these trained officers would have detected GPS symptoms if present. Forest health surveillance data from across NSW for 2014 was included for this study.

RESULTS

Public participation

During the reporting period, NSW DPI received 30 reports as a result of the request for public participation (Figures 2–3). The golf clubs were by far the most enthusiastic participants. Major cemeteries in Sydney participated to a lesser extent. We received reports from 26 different golf courses, two major Sydney cemeteries, and one local council. One report was received through the Exotic Plant Pest Hotline, a national phone service. In NSW, the hotline is monitored by NSW DPI staff and enables the general public to report suspect plant pests and diseases. Public participation surveillance provided information on the possible GPS status of more than 640 trees. No GPS was found.

Targeted surveillance

A further 2663 amenity trees in the Sydney Basin and regional NSW were inspected by government staff over the course of the GPS response surveillance (Figures 2–3). An additional 260 site assessments in commercial *Pinus* plantations were conducted as part of the 2014 forest health surveillance program (Figures 2–3). Several samples of symptoms similar to GPS were reported to and collected by NSW DPI staff (Figure 4). All were identified as pine woolly aphid *Pineus pini* (L.) or *Adelgis cooleyi* (Gillette).

DISCUSSION

Surveillance for GPS in NSW followed detection of GPS in Melbourne and Adelaide. NSW used a combination of specific and general surveillance (IPPC 2018), including utilizing the PPSR approach. PPSR can be a difficult method to collect scientific data. PPSR may not be as accurate as results gained from professional surveillance. However, PPSR can be a very useful and cheap tool to obtain large amounts of surveillance data from a wide area if the project is widespread, easy and quick to participate in and is resourced appropriately. For participants, PPSR creates a feeling of place and a sense of contribution (Haywood 2014).

More than 260 exotic pests and diseases of arborescent hosts have established in Australia (Nahrung and Carnegie 2020). Seventy-one percent of detections of these pests occurred since 1996 and have been reported through general (passive) surveillance (Carnegie and Nahrung 2019). A large proportion of these pests were detected on amenity trees. This highlights the benefits and ongoing need to encourage public participation in biosecurity surveillance. Several programs in recent years have targeted public participation for early detection of tree pests (e.g. https://extensionaus.com.au/botanicgardensbiosecurity/coordinated-surveillance-by-botanic-gardens-staff/). In 2017, PPSR was used successfully to support NSW absence claims from Tomato Potato Psyllid *Bactericera cockerelli* (Sulc) (Hemiptera: Triozidae) (Dominiak *et al*. 2020). Surveillance for exotic pests remains important for NSW, particularly with the globalisation of trade (Anderson *et al.* 2017).

Our surveillance project demonstrated that GPS was not present in NSW in 2015, and so provided support to continue the national eradication. However, in 2016, it was nationally agreed that eradication of GPS was not technically feasible (Primary Industries South Australia 2019; Carnegie and Nahrung 2019). The eradication plan transitioned to a national management plan. GPS is “prohibited matter” under the New South Wales *Biosecurity Act 2015.* Similarly, GPS has not been detected in Queensland and is “prohibited matter” under the Queensland *Biosecurity Act 2014* (Biosecurity Queensland 2019). NSW currently has an annual surveillance program for early detection of exotic forest pests, which includes surveillance for GPS (Carnegie *et al*. 2018b). GPS has not been detected from the surveillance of amenity trees and plantations to June 2021.

GPS has not been detected in New Zealand (Gresham and Meurisse 2019). However, as in Australia, early detection will be key to any eradication attempts in New Zealand if detected (Gresham and Meurisse 2019; Carnegie and Nahrung 2019). The full impact of GPS on Australia has not been assessed however climate change is likely to exacerbate pine decline (Avtzis *et al.* 2020; Fotelli *et al*. 2020). Natural enemies are absent in newly invaded countries such as Australia and Croatia (Fotelli *et al.* 2020). High populations of GPS often result in a reduction of insect biodiversity (Petrakis *et al*. 2011; Yesil *et al*. 2005). Therefore, research is required in the short term at least on pesticide control (Avtzis *et al*. 2020). In the longer term, continued forestry surveillance pre- and post-border are required to minimise the damaging impacts of other incursions on the forestry industry (Nahrung and Carnegie 2021).

ACKNOWLEDGMENTS

The work was funded by Forestry Corporation of NSW and NSW Department of Primary Industries. We are grateful to Golf NSW, New South Wales Golf

Course Superintendents Association, Cemeteries & Crematoria Association of NSW, and Bayside Local Council for responding to our survey request. We thank Martin Horwood for his work and support during this project. Also, we thank the many DPI and Local Land Services staff who inspected trees and contributed to the survey results. Two journal reviewers improved an earlier version of this manuscript.

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Figure 1. Presence of *Marchelina hellenica* (giant pine scale) on *Pinus radiata* in Melbourne: upper branches and (insert) close-up on trunk. Photo: A. Carnegie, NSW DPI.

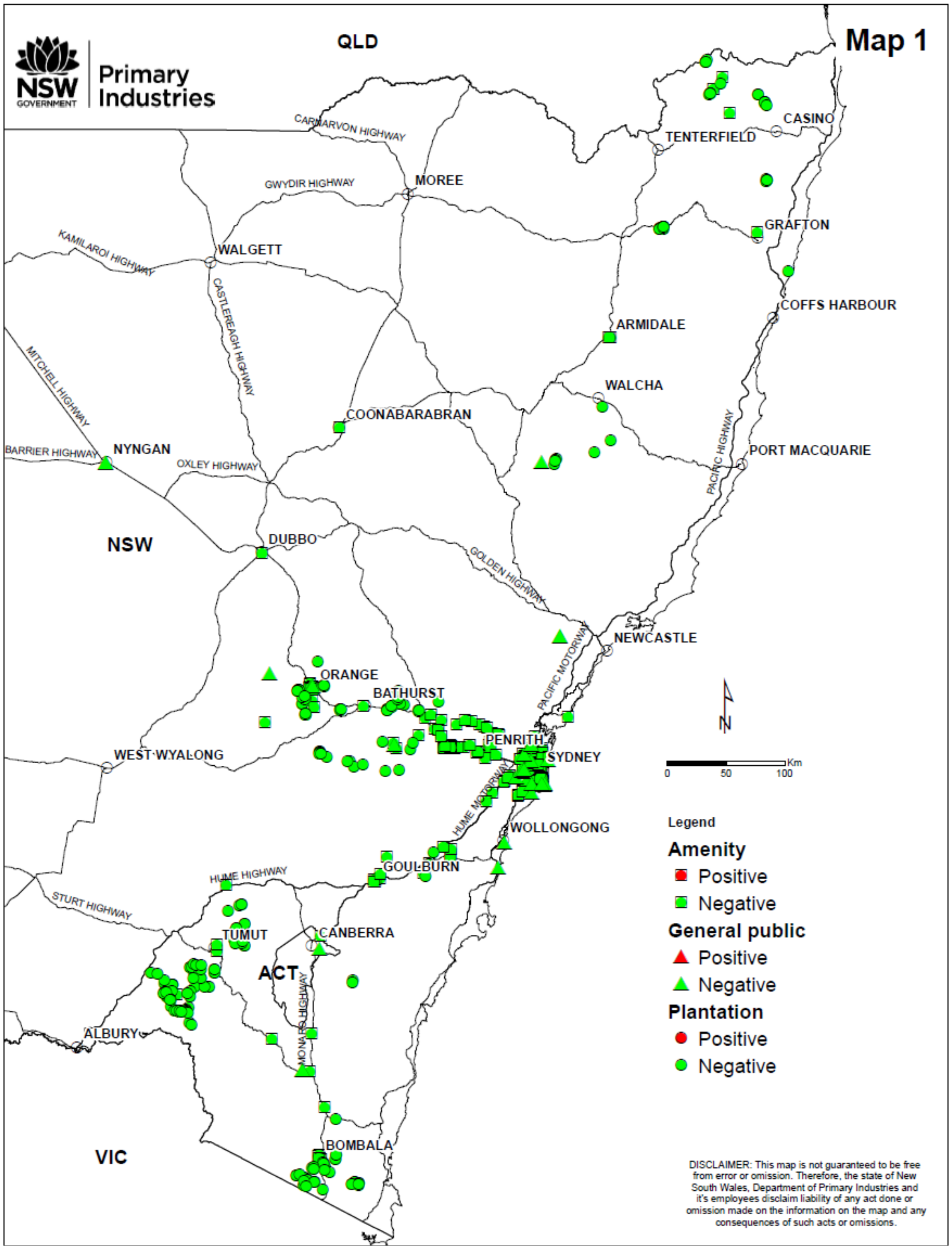

Figure 2. Map of New South Wales showing GPS surveillance from 2014 to 2015, including public participation surveillance, targeted surveillance by government staff, and surveillance in *Pinus* plantations.

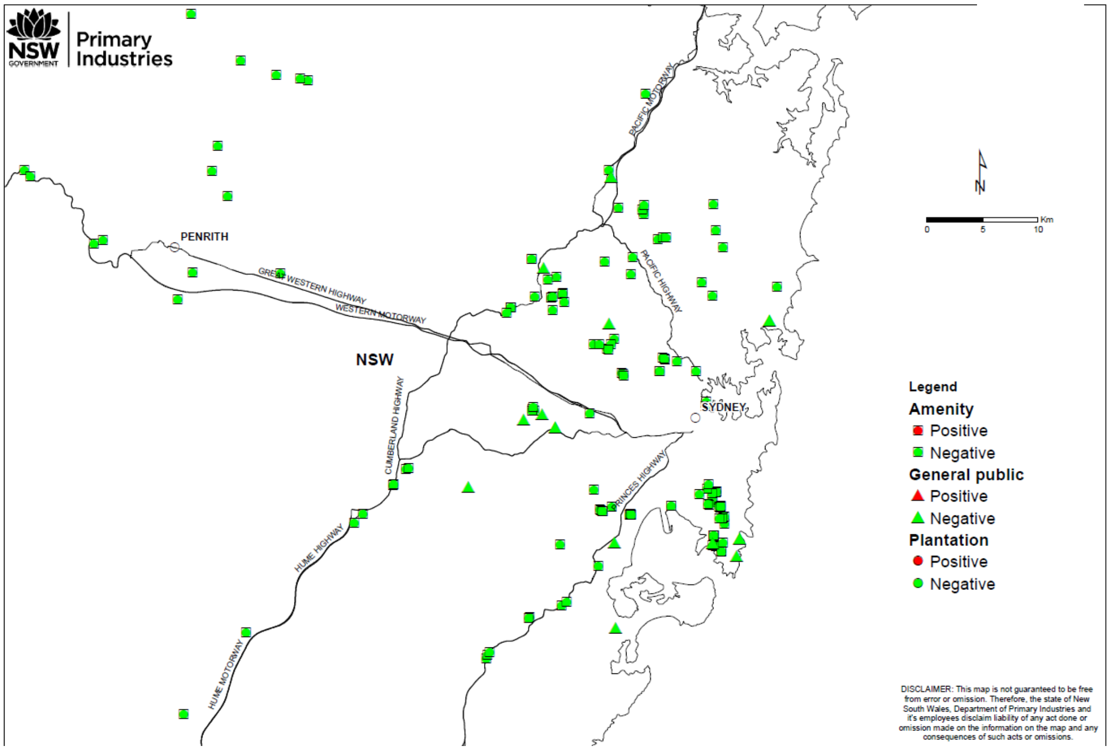

Figure 3. Map of Sydney basin showing GPS surveillance from 2014 to 2015, including public participation surveillance, targeted surveillance by government staff, and surveillance in *Pinus* plantations.

Figure 4. Pine woolly aphid, *Pineus pini*, on *Pinus radiata* from regional NSW. Appearance on bark can be similar to GPS. Photo: A. Carnegie NSW DPI