

# Understanding the system matters – Stepping back for general surveillance

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**Summary** General surveillance, also known as passive surveillance, is a process whereby people from all walks of life monitor and report weeds, pests and diseases. General surveillance programs are complex systems, and actions in one part of the program can create unintentional consequences elsewhere. Social scientists applied systems thinking to explore what works well for nine general surveillance case study programs from across Australia and New Zealand. Two of the case studies focus on weeds, namely the Weed Spotters programs in Victoria and Queensland. These well-established and long-running initiatives, based on the same ‘Weed Spotters’ framework, adapted and evolved to best meet their goals and local contexts. This paper highlights some of the similarities and differences in these weed-based programs, and how systems thinking provides valuable insight.

**Keywords** Systems thinking, general surveillance, weed spotters

## INTRODUCTION

As our climate changes and international travel and trade increase, the risk to Australia’s biosecurity also increases, including the introduction, establishment and spread of weeds. Surveillance is a vital component of weed management because it supports early detection; helps understand weed spread; and informs prioritisation and management. General surveillance engages people from all walks of life in the monitoring and reporting of pests, weeds and diseases. It has elements of opportunism that enable broad surveillance coverage and/or more cost-effective surveillance than targeted, active surveillance. It also fits well within the current paradigm of shared biosecurity responsibility between government, industry and the community.

**Background to Weed Spotters programs** There have been several different weed detection systems in Australia including the Weed Alert program in Victoria from the late 1990s to 2002 (Morton 2007), which made the first call to community members to become ‘Weed Spotters’. Weed Spotters programs are general surveillance programs designed to support the monitoring and reporting of targeted weed species for a particular region. Drawing from the Weed Alert program and others, Morton (2007)

proposed a conceptual framework for a weed detection network to guide a national program of surveillance. It identifies five key program components: 1) establish community and professional detection and surveillance networks to enhance surveillance and reporting potential; 2) provide the capacity for rapid and accurate identification of reports; 3) have notification systems in place to act if a new plant is confirmed; 4) provide the means for a rapid risk assessment if a new plant is confirmed; and 5) have an information management system(s) to support the storage and use of personal and plant-based data collection.

Like most general surveillance programs, Weed Spotters programs are complex systems involving various functions (including monitoring, species identification, data management and use, and supporting weed spotters). The complexity stems from the interactions between the elements or parts thereof.

Systems thinking describes an approach to consider how a group of interdependent components interact through time to achieve a purpose (Arnold and Wade, 2015). Systems thinking facilitates management of complex problems with principles. For example, seemingly inconsequential actions in one part of the system may create unexpected and undermining consequences elsewhere. Feedback loops can also occur, and their impacts may be delayed. People from throughout a system will often view it from a different perspective. Systems are also inherently dynamic and change through time.

In this research, systems thinking was used to explore two Weed Spotters case studies, Weed Spotters Network Queensland (WSNQ) and Weed Spotters Victoria (WSV). The research aimed to inform what is needed to make weed general surveillance programs sustainable, practical and effective.

## MATERIALS AND METHODS

**Research framework** We adjusted the Agricultural Innovation Systems structural framework (Wieczorek and Hekkert 2012) to guide our research. Based on this framework, the structural components of innovations systems used are (i) actors and their interactions, (ii) the institutions (rules) that influence

their behaviour, and (iii) physical, financial and knowledge infrastructure. We add a biophysical component to include considerations related to invasive species and their environment that shape general surveillance programs. Through the resulting framework (shown in Kruger et al 2022; Figure 1) we use systems thinking to consider the components of both Weed Spotters programs and the interactions between them to (i) identify the process and system around data flow; (ii) develop a timeline of program change and development; and (iii) enquire about what works and doesn't work in meeting program goals.

**Data collection** In July and August 2020 research began on the WSNQ and WSV, respectively. For each case study, we reviewed relevant literature and webpages provided by the program representatives. For each program semi-structured interviews were carried out with up to 11 people from throughout the system including weed spotters, weed spotters coordinators, experts who identify submissions, data managers and users, funders and policy makers, and government officers who respond to high-risk detections. Interview topics were tailored to the interviewee's role in the program, including what works and doesn't work from their perspective. Interview transcripts were analysed with NVIVO software. A focus group with another six to eight people from throughout the system reviewed a summary of the interview findings. The main findings were discussed with program coordinators and key program staff for clarification and feedback. An online survey link was emailed to weed spotters in both programs in November 2020 to capture motivations and barriers to participating, and what they think works and does not work. Seventy-two surveys were completed for the WSNQ and 83 for WSV. A more detailed description of the data collection methods is available in Kruger et al. (2022), including the interview and survey questions and detailed survey results.

## RESULTS

**The Weed Spotters framework** Data flow diagrams for WSNQ and WSV can be found on the project website ([WSNQ](#) and [WSV](#)). The diagrams show how both programs conform to the Weed Spotters framework. As such, (1) weed spotters provide the surveillance network, (2) the Queensland Herbarium and Agriculture Victoria identify submissions, (3) Biosecurity Queensland and Agriculture Victoria Biosecurity Officers act if a detection is made, (4) if a new plant is confirmed, detections are assessed by Biosecurity Queensland and the High Risk Invasive Plants team (HRIP) (WSNQ and WSV respectively)

for their potential risk, and 5) they have information systems to support data storage.

**Comparison of the Weed Spotters programs** Table 1 shows various similarities and differences between the two Weed Spotters programs structured around the four components of the framework. Figure 1 shows key points in evolution and change for each program.

## DISCUSSION

Systems thinking provides valuable insight into the effective functioning of the Weed Spotters programs. Integrating knowledge, keeping weed spotters engaged and evolving the program through time is important for it to remain successful.

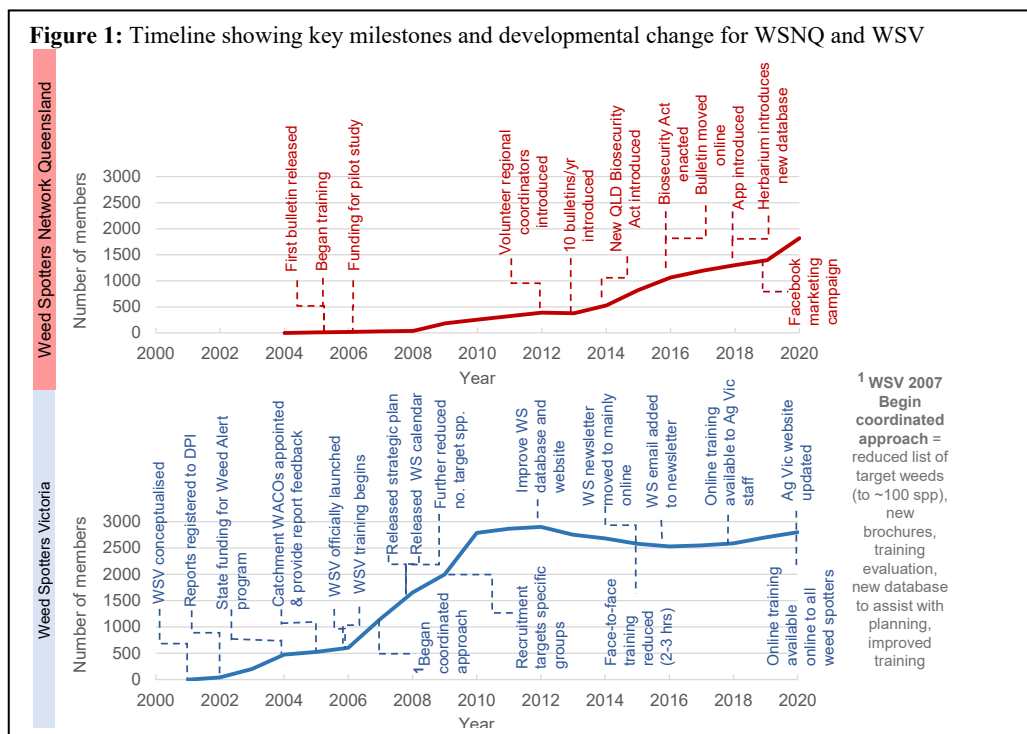
**Knowledge integration benefits program development** Sharing knowledge and the experiences of people from throughout a program is beneficial because changes or weaknesses within one component are likely to have implications elsewhere. This avoids making wrong assumptions about other parts or people in the program, produces nuanced knowledge about design to make the program more effective and practical, and helps people to feel more connected. For example, the pilot study that initiated the WSNQ involved a small number of Natural Resource Management Regions with an interest in weeds and the Queensland Herbarium to co-design the initial program. It allowed the herbarium to make the needed adjustments, e.g. introducing new protocols relating to dealing with weeds, hygiene and notifications. As part of this design, regional coordinators were enlisted to provide a friendly local face to notifiers, and to apply regional knowledge and context to the state-wide information provided by Biosecurity Queensland and Queensland Department of Environment and Science (DES). As such they provide an important knowledge broking connection between the weed spotters and the program coordinator. Knowledge is also shared throughout the program in the newsletters, which provide regional information on program activities and detections, as well as through informal meetings between the coordinator and regional coordinators in conjunction with other weed related meetings.

WSV also use a newsletter to keep weed spotters informed, including about what is being found across the state and potential new threats. Their half-day in-person training course is also very important for sharing knowledge about what the target species are, and how they can be identified, and for weed spotters to interact directly with Weed Spotters staff, providing feedback on the effectiveness of the training.

**Table 1.** Comparison of Weed Spotters characteristics against the research framework.

	Topic	WSNQ	WSV
Actors and their relationships	<b>Weed spotter motivations</b>	Protect the environment and ecosystems services	
	<b>Weed spotter barriers</b>	Lack of time Limited motivation/interest in target species	
	<b>Engagement and outreach</b>	Targeted to people with skill, motivation and ability to make accurate, timely and complete (i.e. quality) reports Newsletters containing interesting finds and background information are emailed to weed spotters directly 10 newsletters/year report regional activity Handbook Android app In 2019/20, used Facebook to advertise for members	
	<b>Regionally based positions</b>	Volunteer regional coordinators know local context, triage some reports & are 'trusted friendly faces'	No longer have regionally based positions. Reports are triaged by the state coordinator
	<b>Identification</b>	State government Queensland herbarium (DES)	Experts within Agriculture Victoria State/national herbarium (if required)
	<b>Funding bodies</b>	State government Biosecurity Queensland (Qld Dept for Agriculture and Fisheries) Qld herbarium (DES) Local governments	Agriculture Victoria
	Infrastructure	<b>Reporting tools</b>	Email, Android app or specimen submission
<b>Training</b>		Face-to-face, regionally based training to add local context and respond to local interests Online training under development	Face-to-face training coordinated and run at state level to ensure consistency Online training also available Live specimens available for viewing at regional centers
<b>Data users</b>		Biosecurity Queensland Atlas of Living Australia Community groups Local governments	Agriculture Victoria High Risk Invasive Plant team
<b>Resourcing</b>		Australian Virtual Herbarium Legislative requirements support ongoing funding	
Institutions	<b>Key external institutions</b>	Qld <i>Biosecurity Act 2014</i> DES Strategic Plan 2019–23 Qld Biosecurity Strategy 2018-2023	<i>Catchment and Land Protection Act 1994</i>
	<b>Focus species</b>	240 species in scope – includes prohibited and restricted plants	8-12 specific State Prohibited Weeds
	<b>Specimen submissions</b>	Specimen requested if photos indicate a species of concern	Prefer plants remain <i>in situ</i> to reduce risk of spread
Weeds and their env.	<b>Surveillance spread</b>	Weed spotters focus on monitoring regions they are most knowledgeable about	Address monitoring gaps by targeting regions that have few weed spotters

**Figure 1:** Timeline showing key milestones and developmental change for WSNQ and WSV



**Keeping weed spotters engaged** To limit transaction costs for training new weed spotters and identifying inaccurate reports, both programs target people with motivation, opportunity and skill to make quality reports (including various field staff to who work outside, e.g. council weed officers, as well as gardener groups in WSNQ). Quality reports refer to reports that are timely, accurate and complete. Both programs make participation simple and easy knowing that weed spotters are time poor. For example, WSV provide multiple reporting options, such as a hotline, a dedicated email address and its web form, to suit people’s personal preferences. WSNQ introduced a reporting app in 2018 to minimise the need for more laborious specimen submissions. To minimise costs, the app was developed for Android devices only, by Masters students from the University of Queensland. Developing and maintaining an app for WSV is deemed too costly to service a few reports for a small number of target species, especially when three reporting options are available and do not require additional cost or maintenance.

Keeping people motivated can be challenging when target species aren’t of interest or seldom present. To help, both programs focus on delivering a positive reporting experience by providing personal feedback to all reports, including the species’ identity

and updates on follow-up outcomes. For example, WSNQ provides management information for out-of-scope weeds or connects weed spotters with local government officers to address their concerns. Furthermore, providing a win-win situation will secure people’s ongoing engagement. For example, the WSNQ provides local governments with valuable services such as weed identification training and easy access to Qld Herbarium staff. In return, the Qld Herbarium receives more specimens for their collection and Biosecurity Queensland have a greater spread of surveillance effort.

**Adapting and evolving through time** Systems are dynamic and change through time. Both programs have conducted considerable monitoring and evaluation since they began to identify and address challenges and utilise opportunities to remain effective and relevant. Methods include conducting Weed Spotters surveys, dedicated research (e.g. WSV program review and resultant strategic plan) and collating and analysing notification data. Monitoring and evaluation can identify important system behaviours such as leverage points, most limiting factors and feedback loops.

*Leverage points* are areas in the system where a small shift can deliver considerable beneficial change in other points(s) or the whole program. For example, the Queensland *Biosecurity Act 2014* supports the

WSNQ because it sets out information sharing requirements for reporting of notifiable species: This facilitates data sharing between organisations which in turn, enables more people to look out for incursions. The Act's emphasis on shared responsibility encourages people to support the program. Notifiable species under the Act set the scope of the program, and as the need to prevent related incursions is set in legislation, it encourages departmental investment in the program. The Act also sets weed related requirements for local governments, which encourages local governments to use WSNQ services. The resulting strengthened relationship between local governments and WSNQ means the program has access to more eyes and ears and can refer out-of-scope public enquiries to local government officers.

WSV reduced the number of target species from *all* newly emerging weeds to only 8-12 State Prohibited Weeds. This made it easier for weed spotters to focus intently on species assessed as posing the biggest risk to the state, and therefore increase the likelihood of accurate detections. It also reduced the resources required to develop and maintain training and identification material (e.g. Weed ID cards) and made it easier to target weed spotters who are most likely to be in high risk areas for the target weeds. Clearly defining which species are in scope also makes it easier for the program coordinator to triage incoming reports.

The *most limiting factor* is the variable that is most important to the system to bring about change. Once identified, the most limiting factor can be managed to improve program effectiveness. The most limiting factor may be time constraints for weed spotters to make reports (discussed above), or could be the capacity of staff to identify incoming submissions. In the latter case, interviewees in both programs emphasised the importance of receiving quality, rather than many, reports. Accurate and complete reports minimise the need for lab/herbarium staff to wade through species that are out of scope or to follow-up with notifiers for missing information. Notifier training, providing well considered reporting tools, triaging reports (such as via the WSNQ regional coordinators or WSV coordinator) and providing feedback on every report to assist in learning and increasing awareness, help to maintain report quality and avoid overloading the system.

*Feedback loops* occur when changes in one component flows through the system creating effects back on the same component. For example, there are feedback implications if the quality of incoming notifications is too low. WSV initially conducted widespread recruitment of anyone interested in being

involved in reporting weeds. This grew weed spotters' numbers considerably, but most target species notifications came from people working in the field. Thus, much of the training costs were not justifiable. If weed spotters' numbers were allowed to increase unchecked, it could have caused out-of-scope notifications to flood the system. This could slow the triage and identification process, and confirmation of state prohibited weed detections could be delayed. The program team moved to targeting individuals well placed to find and submit accurate notifications, such as those having existing knowledge and interest, being involved in outdoor work activities or residing at certain locations. Resources were then freed up to better support the most effective weed spotters. Similarly, although QWSN ran a generalised recruitment campaign via Facebook in 2019-2020, targeted at people interested in the environment or gardening, they were aware of the risk in creating an influx of reports. Thus, they closely monitored reports to ensure they did not overwhelm lab/herbarium staff to maintain the ability to provide a positive reporting experience through timely and personalised feedback to reporters.

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