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# Editorial: The role of community and industry surveillance in managing invasive species: a review of current knowledge

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Editorial on the Research Topic
The role of community and industry surveillance in managing invasive species: a review of current knowledge

Invasive species are an important global problem. They have significant negative impacts on human health, the environment, agriculture and the economy (Bradshaw et al., 2016; Diagne et al., 2021). As a result, significant funds are invested by governments and industry to prevent and manage pests, weeds and diseases. Investing those funds wisely requires an understanding of the processes involved in effective detection and management, including the potential roles of communities, particularly in surveillance.

Surveillance is at the heart of invasive species management — it allows invasions to be located, monitored, and controlled. Surveillance methods fall on a continuum, ranging from accidental encounters and reports by members of the public, to organised activities by industry and community groups (Hester and Cacho, 2017). These activities differ from the active (targeted) surveillance carried out by dedicated agencies, which has received more attention in the literature.

The community plays an important role in surveillance by enabling more coverage at low cost and increasing the probability of early detection and successful management (Cacho et al., 2010; Epanchin-Niell et al., 2021). Different terms are used to refer to community and industry surveillance and the engagement activities which facilitate them, including passive surveillance, citizen surveillance, citizen science and general surveillance – in this Research Topic we use these terms interchangeably. Despite an abundance of general surveillance programs across the globe, analysis of program characteristics and effectiveness is rarely published. Agencies wishing to develop and implement effective programs need information about best practice. That is the motivation for this Research Topic.

Papers in this Research Topic discuss a range of general surveillance programs from Australia and New Zealand (Ticehurst and Kruger; Kruger et.al.; Arndt et al.) and North America (Lanning et al.; Hulbert et al.). A range of pests and diseases are covered in the papers, including exotic vertebrates (Caley and Barry), pests and pathogens of forests (Hulbert et al.), including *Phytophthora* spp (Lanning et al.), and pests and diseases of marine, agricultural and natural systems (Ticehurst and Kruger; Kruger et.al.; Arndt et al.).

In many countries, general surveillance programs have become a routine part of strategies to manage invasive species. They can strengthen biosecurity when integrated with early warning systems, and improve the likely success of detection and eradication programs (Lanning et al.). The trust and network building created by programs can be invaluable in emergency responses (Kruger et al.) and in future efforts involving citizens in surveillance activities by advancing baseline knowledge of invasive species (Lanning et al.). Robust surveillance data from those working in agricultural industries (e.g. agronomists) can be used to support claims of pest freedom (Arndt et al.). Hulbert et al. show the many ways in which citizen science can contribute to detection and management of forests pests, and illustrate how projects can be designed to involve citizens at any stage of the biological invasion process.

General surveillance programs can be developed for diverse contexts, and a large number of options exist for their design and implementation. Lanning et al. provide case studies of approaches for citizen surveillance of *Phytophthora* species. These include activities involving school programs, hands-on training, and mass participation activities. Ticehurst and Kruger show how systems thinking can be used to help manage complexity arising from the interacting components of the varied types of general surveillance programs — the different actors and their relationships, infrastructure, resources, formal and informal rules, and the characteristics of the invasive species and its environment.

Useful guides to developing effective programs using systems thinking are contained in Kruger et al. and Ticehurst and Kruger. When viewed as a system, the authors explain how a small change in a single component can lead to substantial improvement in sustaining program effectiveness. Importantly, an effective community engagement program needs to result in quality notifications (accurate, timely and complete), and a positive participation experience to sustain notifier involvement. Kruger et al. and Ticehurst and Kruger emphasise the importance of a dedicated program coordinator with adequate resources to identify challenges and opportunities and adapt the program accordingly.

Despite the voluntary nature of many general surveillance and citizen science activities, significant costs are involved in setting up and maintaining programs, and in data management and analysis. Kruger et al. discuss these program components in detail, and include cost data for several programs. The authors emphasise the importance of considering transaction costs when developing and maintaining programs. These include the time and effort needed to understand and gain the trust of key stakeholders, refine reporting tools, and enable context alignment to ensure the program fits well within existing arrangements. Program design should include adequate time for data collation and analysis. Unfortunately there is often a lack of capacity and capability to undertake data analysis (Kruger et al.) which means opportunities are missed to improve resource allocation in general surveillance programs and our understanding of detectability (Hester and Cacho, 2017; Epanchin-Niell et al., 2021).

Lack of data has hindered progress in understanding many aspects of community surveillance. Caley and Barry observe that historically, analyses have been conceptual and based on qualitative arguments. The authors provide a quantitative model framework and provide examples of how different forms of general surveillance data may be analysed, particularly in supporting inference of eradication. They address the effectiveness of citizen observations in providing surveillance for exotic vertebrates, but their principles are useful for citizen surveillance in general. They identify important sources of data that have remained largely untapped for measuring the effectiveness of citizen surveillance. These include growing volumes of citizen data streams produced and shared with others in social media and web-based platforms.

In cases where pests and diseases are exotic to an area and have never been detected there, no empirical data exist on detection probability that could be used to improve surveillance systems. In these cases, structured expert elicitation (Hemming et al., 2018) may be used. Arndt et al. propose such an approach for a grain pest, representing a surveillance system as a scenario-tree consisting of different detection nodes where the pest can be detected. Informed by agronomists' self-rated confidence of detection, the probabilities associated with the visual-detection node are elicited from experts, and a formal model is used to aggregate expert judgements.

The papers in this Research Topic illustrate the diversity of ways in which citizens currently contribute to surveillance and management of invasive species, identify common limitations of programs, and suggest pathways for making citizen surveillance more effective. Papers highlight the need to understand the complexity of programs when designing and resourcing them. Further progress in the field requires making the most of data that are collected via programs. There is a need for novel data analyses to help improve the design of future programs and to understand the use of general surveillance to achieve particular biosecurity outcomes.

## Author contributions

SH: Conceptualization, Writing – review & editing. HK: Conceptualization, Writing – review & editing. JT: Conceptualization, Writing – review & editing. JH: Conceptualization, Writing – review & editing. OC: Conceptualization, Writing – original draft, Writing – review & editing.

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## Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

## Publisher's note



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