Evaluating the health of Australia's biosecurity system

CEBRA 170714

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Executive Summary

Objective of the project

This is the final report of CEBRA Project 170714 *Evaluating the Health of Australia's Biosecurity System*. It represents the final phase of a three-year project commissioned by the Australian Government Department of Agriculture, Water and the Environment. The primary objective of the project is to develop a rigorous method or framework that can be used repeatedly to evaluate and report on the health, or performance, of the national biosecurity system. The framework proposed in this project is designed to capture all components of the biosecurity system and all participants in the system; to articulate relevant attributes of system performance; and to establish appropriate performance indicators. It responds to the contemporary focus of the Australian and state and territory governments on evaluating the performance of their activities.

Performance evaluation in the biosecurity system underpins the accountability of agencies. It provides a basis for identifying risks in the system and areas for improvement, as well as guiding evidence-based investment decision making. The outcomes of performance evaluation can also contribute to governments' consideration, both individually and collectively, of the future strategic direction of the biosecurity system and to future system design. The subject of performance evaluation will be of interest to a range of participants and other stakeholders who seek confidence that the objectives of the biosecurity system are being met. These include governments; industry; natural resource managers, custodians and users; and the broader community.

The intention of this report is not to provide a final blueprint for how to evaluate the biosecurity system but rather to start a conversation with stakeholders on the shape that this might take and the purposes that it might serve. For example, the indicators and measures of performance that are proposed in the report are candidates only and are likely to be refined with further consideration by stakeholders in the system. There will be many issues to resolve along the path to implementing an evaluation framework of the scale proposed in this report. Implementation will be progressive and iterative. The benefits of rigorous and transparent performance evaluation will increase over time as data are gathered and refinements made.

This Executive Summary provides information for stakeholders with a broad and overarching view of the system. Other readers will require the additional detail provided in the main report.

Australia's biosecurity system

The broad goal of the biosecurity system is defined in the Intergovernmental Agreement on Biosecurity (IGAB) as being to '*minimise the adverse impacts of pests and diseases on Australia's economy, environment and community, while facilitating trade and the movement of plants, animals, people and products* (COAG, 2019). Beneath this, the IGAB identifies four objectives of the system:

(i) reduce the likelihood of exotic pests and diseases, which have the potential to cause significant harm to the economy, the environment and the community (people, animals and plants) from entering, becoming established or spreading in Australia;

(ii) prepare and allow for effective responses to, and management of, exotic and emerging pests and diseases that enter, establish or spread in Australia;

(iii) ensure that, where appropriate, nationally significant pests and diseases already in Australia are contained, supressed or managed by relevant stakeholders; and

(iv) enable international and domestic market access and tourism.

Through meeting these objectives, the biosecurity system helps to deliver important outcomes for Australia's economy, environment and people. By reducing the impacts of pests and diseases, an effective biosecurity system supports the sustainability, profitability and competitiveness of Australia's agriculture, fisheries and forestry industries, which, in turn, helps drive a stronger Australian economy. The reduction in pest and disease impacts contributes to the health of the environment through better functioning ecosystems. It supports a healthier population by reducing the incidence of mortality and morbidity arising from pests and diseases, and underpins resilient communities through its protection of social assets in natural and built environments and the amenity values they create.

Australia's biosecurity system is complex, comprising multiple actions undertaken by system participants at different points along the biosecurity continuum – off-shore or pre-border, at the border, and on-shore or post-border. Collectively, system participants invest significant resources in biosecurity risk management, exceeding $1 billion annually (Craik *et al.,* 2017). Landholders and community groups also make substantial in-kind contributions.

The biosecurity system consists of sets of activities that:

- **anticipate** biosecurity risk;
- **prevent** biosecurity risk material arriving at the border;
- **screen** entry pathways to detect non-compliance;
- **prepare** for an incursion or outbreak of pests and diseases;
- **detect** pest and disease incursions or outbreaks in Australia;
- **respond** to an incursion or outbreak of pests and diseases; and
- **recover** from an incursion or outbreak and adapt to new circumstances.

These sets of activities are referred to throughout this report as the *components* of the biosecurity system.

In addition, there are enabling or influencing factors that underpin these biosecurity system components and are fundamental to system performance and the value it creates. These comprise:

- its capacity to develop a clear and coherent long term strategy that has the support of system participants and provides a basis for consistent and harmonised policy development;
- governance arrangements that provide a sound framework for the leadership and management of the system;

- a shared responsibility or partnerships approach that underpins awareness and acknowledgement of the roles and responsibilities of system participants;
- engagement and communications activities that support effective cooperation of system participants, increase stakeholder awareness of biosecurity and enhance the effectiveness of risk management activities;
- advanced information, data management and analytics capabilities to support a well-functioning system;
- a research and innovation system that drives innovative science-based solutions to biosecurity problems; and
- the capacity to undertake insightful monitoring and evaluation of the biosecurity system that can lead to improvements in system performance.

A key principle of the biosecurity system, articulated in the IGAB and in each state and territory biosecurity strategy, is that biosecurity is a shared responsibility or partnership between all participants in the system. Underpinning a partnerships approach is the awareness and acknowledgement by key participants in the system of their roles and responsibilities and those of other system participants. It recognises that cooperation between governments and other participants and recognition of common goals will strengthen the national system and deliver better outcomes for pest and disease management.

Methods

The methods applied in this project consist principally of literature reviews covering key concepts and methodological approaches to performance evaluation, their applications in different domains, followed by extensive stakeholder engagement. The literature reviews informed the selection of the evaluation method and the approach to the development of the biosecurity system description, the attributes of health, the key evaluation questions and the performance indicators. Extensive stakeholder engagement throughout the project influenced and endorsed the methodological choices. Engagement activities included workshops, meetings and the assessment of project reports by departmental and independent reviewers.

A theory-driven approach has been used to develop an evaluation framework for the biosecurity system because this approach is used widely to evaluate complex systems in the public sector, including health. As part of the theory-driven approach, a conceptual description of the biosecurity system was developed, based on the protocol of a logic model, complemented with a comprehensive narrative. This description of the system links activities undertaken in the system to system outputs and outcomes. It also considers contextual factors such as inputs to the system, as well as factors that enable or influence system performance. The description provides the basis for the selection and development of performance indicators.

Both quantitative and qualitative indicators of performance are proposed in this project. This mixed methods approach can enhance evaluation outcomes by balancing the limitations of one type of information with the strengths of the other. Rubrics are introduced in the project as a tool to capture qualitative information, including judgments by experts, in a rigorous and transparent manner. Qualitative information, summarised in rubrics, is used in the project where quantifying the performance of the biosecurity system would be difficult or ambiguous. All rubrics can be found in chapters 5–9 of this report.

Evaluation framework

The seven-part evaluation approach proposed in this project is illustrated in Figure ES 1. The first four parts of the evaluation approach are the subject of this project. Parts five to seven are discussed in the report but would be undertaken as part of the implementation of the evaluation framework. This is out of scope of the current project.

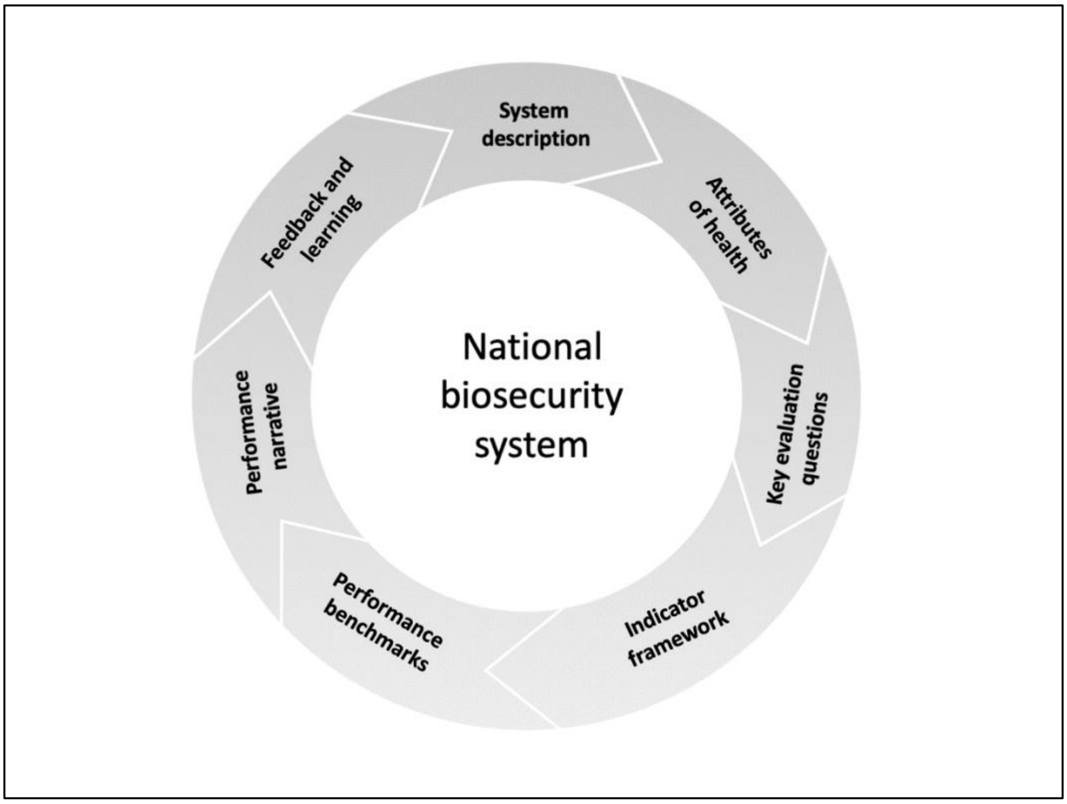

Figure ES 1: Framework for evaluating the performance of the national biosecurity system

1. Use a system description that describes how the biosecurity system is intended to work as the basis for the evaluation framework

The system description (Figure ES 2), using the protocol of a logic model, defines and describes the biosecurity system, including the broad context in which the system operates. It articulates the links between the resources, or inputs, invested in the system, the activities undertaken and the outputs delivered, as well as the immediate and longer term outcomes to which investments in the biosecurity system contribute. The system description explicitly links activities to outputs and outcomes at different points in the system.

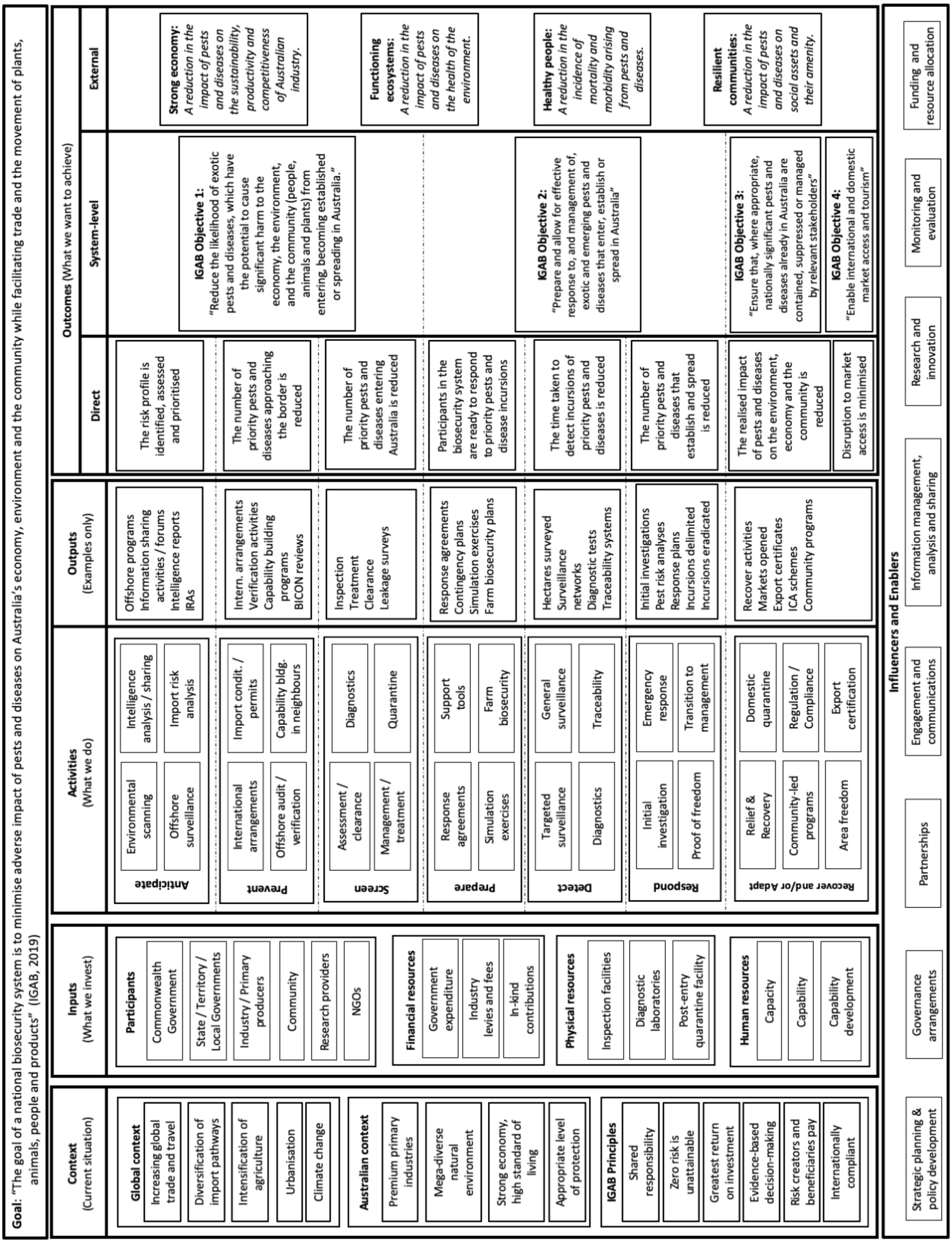

Figure ES 2: Description of the biosecurity system

2. Develop the attributes of health against which the performance of the system will be assessed

Attributes of health are the characteristics of the system that are considered important and will contribute to achieving its objectives. Five attributes (Box ES 1) were chosen to characterise a healthy biosecurity system and to underpin the evaluation of its performance. These attributes are (1) effectiveness, (2) efficiency, (3) capacity and capability, (4) robustness and resilience, and (5) sustainability. Defining these attributes of system health is partly subjective – different participants in the system might differ in their views about the choice of attributes and their importance.

Box ES 1 Attributes of system health

Effectiveness
The system or activity achieves its objectives.

Efficiency
Productive efficiency is maximised when the goals of the system or intervention are achieved at the lowest possible cost. A system that maximises productive efficiency uses the least costly combination of inputs to produce the desired output. *Allocative* efficiency is maximised when resources are invested across the system such that it achieves the best overall outcome from scarce resource.

Capacity and capability
The extent to which the system has the appropriate quantity and quality of financial, physical, human and organisational resources to meet its objectives, that is, its expected outputs and outcomes.

Robustness and resilience
The system's ability to withstand the impacts of an external shock or disturbance, to respond to and recover from the impacts of such a shock or disturbance, and to adapt to changed circumstances.

Sustainability
How well the system performs through time – its ability to meet its objectives over the medium to long term taking into account pressures expected to arise from growth in system demands and complexity.

3. Define the key evaluation questions that address the objectives that the system or component of the system is seeking to achieve

Key evaluation questions (KEQs) are high level questions about the overall performance of the system that the evaluation is designed to answer (Box ES 2). They are derived from the system's objectives, defined in the IGAB, and the attributes of health defined as part of this project (Box ES 1). KEQs can be posed at different levels, from whole-of-system to individual system components or activities.

Box ES 2 Attributes of system health

Effectiveness

1. How effectively does the national biosecurity system reduce the likelihood of exotic pests and diseases, which have the capacity to cause significant harm to the economy, environment and community, from entering, becoming established or spreading in Australia? (IGAB objective 1)
    a. How effectively do activities to anticipate biosecurity risk contribute to the direct outcome that the risk profile is identified, assessed and prioritised?
    b. How effectively do activities to prevent biosecurity risk material arriving at the border contribute to the direct outcome that the number of priority pests and diseases approaching the border is reduced?
    c. How effectively do activities to screen entry pathways to detect non-compliance contribute to the direct outcome that the number of priority pests and diseases entering Australia is reduced?
2. How effective is the national biosecurity system's preparation for and capacity to respond to and manage exotic and emerging pests and diseases that enter, establish or spread in Australia? (IGAB objective 2)
    a. How effectively do activities to prepare for an incursion or outbreak of pests and diseases contribute to the direct outcome that participants in the biosecurity system are ready to respond to priority pest and disease incursions or outbreaks?
    b. How effectively do activities to detect incursions or outbreaks of pests and diseases contribute to the direct outcome that the time taken to detect incursions or outbreaks of priority pests and diseases is reduced?
    c. How effectively do activities to respond to an incursion or outbreak of pests and diseases contribute to the direct outcome that the number of priority pests and diseases that establish and spread is reduced?
3. How effectively does the national biosecurity system ensure that, where appropriate, nationally significant pests and diseases already in Australia are contained, suppressed or managed by relevant stakeholders? (IGAB Objective 3)
4. How effectively does the national biosecurity system enable international and domestic market access and tourism? (IGAB objective 4)
    a. How effectively do activities to recover from an incursion or outbreak and adapt to new circumstances contribute to the direct outcomes that the realised impact on the economy, environment and community of pests and diseases that establish in Australia is reduced and that international and domestic market access and tourism are enabled?

Efficiency

5. Are the resources invested in the biosecurity system allocated across activities in a manner that maximises the efficiency of the system and delivers the highest return on investment?

Capacity and capability

6. Does the system have the appropriate capacity and capability, that is the quantity and quality of financial, physical, human and organisational resources, to meet its objectives?

Robustness and resilience

7. Does the biosecurity system have the resilience to reasonably withstand external shocks and disturbances without significant consequences, or to recover from shocks and disturbances in a reasonable time, and to adapt to changed circumstances?

Sustainability

8. Is the biosecurity system sustainable? Does it have the appropriate structures and mechanisms in place to ensure its continued effective and efficient operation over the medium to longer term, taking into account pressures expected to arise from growth in system demands and complexity?

4. Select existing or develop new performance indicators that link activities undertaken in the biosecurity system to the outputs and outcomes they are designed to achieve, as described in the system description; and collect, analyse and interpret indicator data

Well-designed performance indicators derived from appropriately measured data provide evidence of the impacts of activities on system performance. Indicators can be quantitative (based on numbers) or qualitative (based on opinion). An evaluation approach that uses both forms of evidence is likely to result in better understanding of performance than either quantitative or qualitative information alone. Figure ES 3 illustrates the linkage between attributes of health, KEQs and performance indicators.

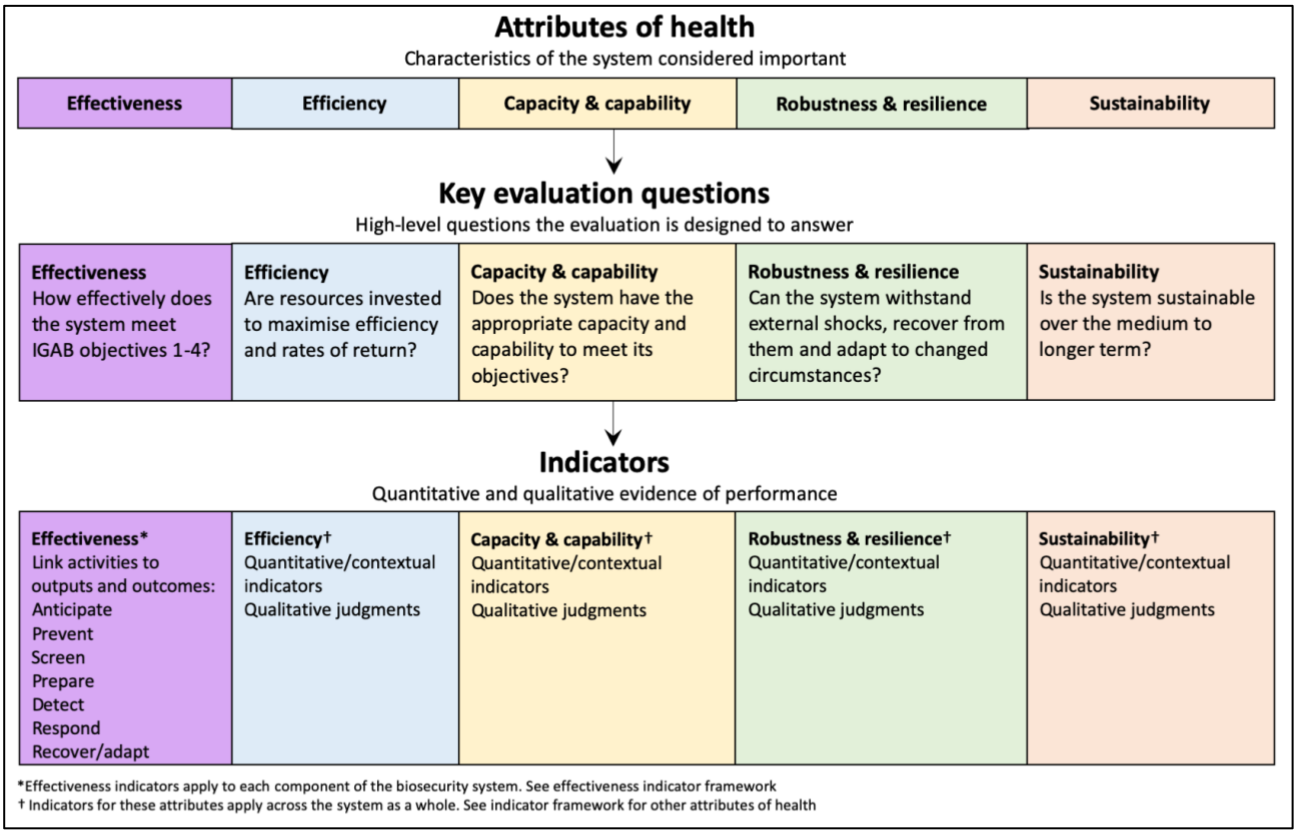

Figure ES 3: Sequence of indicator development

Separate frameworks are developed for indicators of effectiveness and for indicators of the other attributes of health. This is because effectiveness indicators are linked to each component of the biosecurity system, while indicators of the other attributes apply across the system as a whole.

Table ES 1 provides an overview of the set of indicators and measures developed in the project, grouped by the attributes of health and linked to the KEQs. The shaded area shows how the effectiveness indicators are linked to the KEQs and the components of the biosecurity system. In summary, across the two indicator frameworks, a total of 13 quantitative indicators and 20 qualitative indicators are proposed.

Table ES 1 also includes 84 activity measures across each component of the system. These are relevant because they assess the scope and scale of activities undertaken in the system.

They provide context for the performance indicators and rubrics as well as material to support the performance narrative. They are not of themselves indicators of the performance of the biosecurity system.

Table ES 1: Summary of proposed performance indicators and measures

Attributes of health	Key evaluation question	Quantitative indicators	Qualitative indicators	Activity measures
Effectiveness	1-4	13	7	84
Anticipate	*1a*	*2*	*1*	*10*
Prevent	*1b*	*1*	*1*	*19*
Screen	*1c*	*1*	*1*	*24*
Prepare	*2a*	*1*	*1*	*9*
Detect	*2b*	*2*	*1*	*9*
Respond	*2c*	*2*	*1*	*6*
Recover/adapt	*3,4a*	*4*	*1*	*7*
Efficiency	5	-	1	-
Capacity/capability	6	-	10	-
Robustness/resilience	7	-	1	-
Sustainability	8	-	1	-
Total		13	20	84

Figure ES 4 provides an overview of the effectiveness indicator framework and Figure ES 5 an overview of the framework for the other attributes of health proposed in this report.

The effectiveness indicator framework consists of:

- *20 Indicators (13 quantitative, 7 qualitative)* – these link activities and outputs to the direct and system-level outcomes. Direct outcomes are the immediate consequences of the type and quantity of outputs in the biosecurity system. System-level outcomes are higher level and longer-term consequences of system activities and outputs.

- *84 Activity measures* – these link activities to outputs (the direct products and services produced by these activities). Quantitative measures are proposed at the output level. Activity measures are descriptive or contextual in nature and do not address how effective these activities are in achieving the objectives of the system.

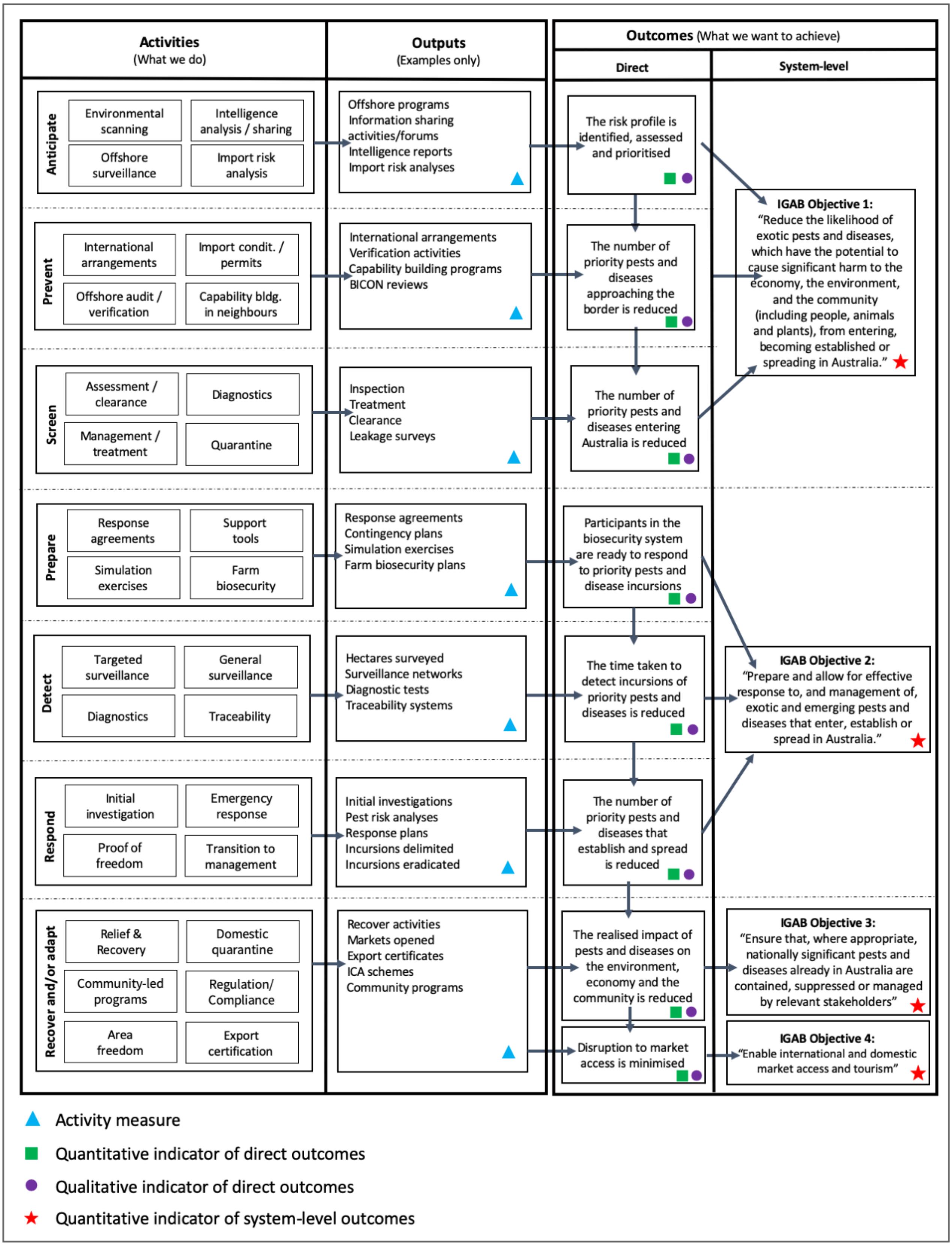

Figure ES 4: Effectiveness indicator framework, addressing KEQs 1-4

INDICATOR FRAMEWORK

Qualitative indicators	Quantitative measures
Efficiency	**Efficiency**
Transparent budget information Expenditure monitoring, evaluation and review Budget allocation decision support tools Data capture and analysis systems	Investment stocktake ($) Risk reduction ($)
Capacity and capability	**Capacity and capability**
Financial resources: Funding level and mechanisms, cost sharing arrangements	Financial resources: Investment ($)
Physical resources: Scale and quality of inspection, quarantine and laboratory facilities; quality of plant pest reference collections	Physical resources: Inspection, post-entry quarantine and laboratory facilities; plant pest reference collections
Human resources: resources available for normal operations and in emergency responses; emergency training and awareness; future skills forecasting	Human resources: Baseline and surge capacity
Organisational capability: Strategy and policy development Governance Partnerships Engagement and communications Data and information management, analysis and sharing Research and innovation Monitoring, evaluation and reporting	Organisational capability
Robustness and resilience	**Robustness and resilience**
Awareness Preparedness Resourcing Responsiveness Ability to adapt	Performance pre- and post-shock, including time taken to revert to normal operations
Sustainability	**Sustainability**
Forecasting of risk Sustainable funding base Human capability development Research and innovation Organisational capability	Forecast growth in the biosecurity task

Figure ES 5: Indicator framework for the efficiency, capacity and capability, robustness and resilience, and sustainability of the biosecurity system. The framework addresses KEQs 5-8

In the effectiveness indicator framework (Figure ES 4), both *quantitative* (green squares) and *qualitative* (purple circles) *indicators of direct outcomes* are proposed to evaluate the effectiveness of biosecurity activities. Overarching *quantitative indicators* of the four *system-level outcomes* (red stars) are proposed that measure the collective effectiveness of all activities that contribute to that outcome, as identified in the system description. *Activity measures* (blue triangles) for the outputs delivered by each component of the biosecurity system are also developed.

Indicators are also proposed under the framework for the other attributes of system health – efficiency, capability, resilience and sustainability (Figure ES 5). Emphasis is placed on qualitative indicators of performance, derived from the judgments of experts and stakeholders involved in the system. Where appropriate, quantitative measures are also proposed to define the scale of some relevant characteristics of the system. A total of 13 qualitative indicators, summarised in rubrics, are developed under this framework to answer KEQs associated with these attributes of health.

5. Develop performance benchmarks, targets or expectations, against which the performance of the system can be evaluated

Without clear statements of performance expectations, indicators are limited to information about the results of the system rather than real assessments of its performance – they do not of themselves define whether a system is healthy. An essential step to evaluating system performance is defining what a healthy system looks like. This can involve defining performance benchmarks or targets that are deemed healthy, as well as setting expectations of future performance. Targets and benchmarks might include minimum levels of performance required for the biosecurity system to be considered healthy, or thresholds required to be considered 'good practice'. The appropriate or desired level of system performance should be identified, through consultation, by system participants who have an understanding of the constraints around the operation of the system, including its financing. Performance benchmarks should be re-assessed based on the knowledge and experience gained over time.

6. Build the performance narrative through synthesising and integrating data and analysis, using quantitative and qualitative information

Using performance information to tell a meaningful performance story is an important part of the performance evaluation process. Reporting on outcomes involves presenting evidence that can be used to assess what has been achieved. It should allow those interested in the performance of the biosecurity system, including the parliament, ministers, participants, the public, to form a view, with sufficient confidence, of how healthy the system is and where improvements in performance can be made.

7. Use the information generated from the process to inform the future operation of the biosecurity system, as well as to refine future evaluations

Performance evaluation of Australia's biosecurity system using indicators can help identify, among the many components of the system, areas of strong performance relative to the agreed attributes of health, as well as areas of relative weakness. This can help support decisions about where to invest resources, as well as informing the strategic direction of the system and future system design. The use of a performance framework and performance indicators will necessarily evolve over time. Lessons learnt should be incorporated into future evaluations and the performance indicators and benchmarks re-assessed and refined as new information comes to hand.

Indicators of the effectiveness of the biosecurity system

Key Evaluation Questions 1-4

The following tables comprise the proposed indicators of the effectiveness of direct and system-level outcomes of each component of the biosecurity system. The table headings highlight the relationship between the indicators and the KEQs, and where relevant, the IGAB objectives. Rubrics for the effectiveness of the system are included in the main report, as are the activity measures against each component of the system.

Table ES 1: Performance indicators of the direct outcome of activities to anticipate biosecurity risk (KEQ 1a)

Direct outcome	Performance indicator	Rationale
The biosecurity risk profile is identified, assessed and prioritised	The proportion of pest/disease groups, import pathways or commodities that have been assessed as high priority that are the subject of a contemporary risk analysis or review. High is good.	Provides summary information about how well resources have been allocated to assessments of high priority risks, and encapsulates the steps preceding this to identify and prioritise these risks.
	Number of incidents of biosecurity risk material that are intercepted at the border that have not been subject to a risk review. Low is good.	Provides an indication of the number and scale of biosecurity risks that have not been identified and hence have not been analysed and prioritised.

Table ES 2: Performance indicator of the direct outcome of activities to prevent biosecurity risk material arriving at the border (KEQ 1b)

Direct outcome	Performance indicator	Rationale
The number of priority pests and diseases approaching the border is reduced	The approach rate – the amount of biosecurity risk material that actually reaches the border. Low is good.	Provides an indication of the success of offshore risk management measures as well as potential size of the border task.

Table ES 3: Performance indicator of the direct outcome of activities to screen entry pathways (KEQ 1c)

Direct outcome	Performance indicator	Rationale
The number of priority pests and diseases that enter Australia is reduced	The leakage rate – the amount or rate of biosecurity risk material that is not intercepted at the border. Low is good.	Provides an indication of the amount of biosecurity risk material that actually passes through border controls and has the potential to establish or spread onshore.

Table ES 4: Performance indicators of the system-level outcome for IGAB objective 1

System-level outcome	Performance indicator	Rationale
The likelihood of exotic pests and diseases entering, becoming established or spreading in Australia is reduced.	The leakage rate – the amount or rate of biosecurity risk material that is not intercepted at the border. Low is good. The amount of biosecurity risk material that is captured by the system. High is good.	Lower leakage rates reduce the possibility of exotic pests and diseases establishing and spreading in Australia. Higher capture rates reduce the possibility of exotic pests and diseases entering, establishing and spreading in Australia.

Table ES 5: Performance indicator of the direct outcome of activities to prepare for an incursion or outbreak of a pest or disease (KEQ 2a)

Direct outcome	Performance indicator	Rationale
Participants in the biosecurity system are ready to respond to priority pest and disease incursions and outbreaks	Number and proportion of critical gaps in preparedness, identified through emergency response simulation exercises and reviews (post incident or other), that are addressed in a timely and positive manner. High is good.	Simulation exercises and reviews identify critical gaps in all areas of response preparedness at national and jurisdictional levels. These gaps should be addressed in a timely manner to ensure effective response preparedness in the future.

Table ES 6: Performance indicators of the direct outcome of activities to detect pest and disease incursions and outbreaks (KEQ 2b)

Direct outcome	Performance indicator	Rationale
The time taken to detect incursions or outbreaks of priority pests and diseases is reduced	Number and proportion of incursions or outbreaks where priority pests and diseases are detected and reported in time to enable containment or eradication. High is good. Number and proportion of reports of early detection of pests and diseases by source, for example, targeted surveillance program or producer reports. High number of sources is good.	Early detection, when the extent of spread is small, maximises chances of containment or eradication. A broad range of sources contributing to early detection indicates that the overall surveillance system has good coverage and reduces the risk of missing an incursion or outbreak of a pest or disease.

Table ES 7: Performance indicators of the direct outcome of activities to respond to an incursion or outbreak of pests and diseases (KEQ 2c)

Direct outcome	Performance indicator	Rationale
The number of priority pests and diseases that establish and spread is reduced	Number and proportion of emergency responses that result in containment or eradication of an incursion or outbreak. High is good. Number and proportion of emergency responses that achieve their objective other than eradication and containment. High is good.	Containment or eradication is the desired outcome of a response. A higher proportion of successful responses indicates that response planning and implementation are effective. A higher proportion of response plans that achieve their objective indicates effective initial investigation, response planning and implementation.

Table ES 8: Performance indicator of the system-level outcome of IGAB objective 2

System-level outcome	Performance indicator	Rationale
There are effective responses to and management of exotic and emerging pests and diseases that enter, establish or spread in Australia.	Number and proportion of emergency responses that result in containment or eradication of an incursion or outbreak or otherwise achieve their objectives. High is good.	A higher proportion of successful responses indicates that preparation, detection and response planning and implementation are effective.

Table ES 9: Performance indicators of the direct outcome of activities to recover from an incursion or outbreak and adapt to new circumstances (KEQ 4a)

Direct outcome	Performance indicator	Rationale
The realised impact of pests and diseases on the economy, the environment and the community is reduced	Impact on the economy in AUD as determined in cost-benefit analysis as part of response planning for major incidents. Low is good. *Other examples*: Grain yield loss (in million $) because of established weeds (SoE, 2016b) Direct economic impact of vertebrate pests on agriculture in Australia (Gong *et al.*, 2009) Total expenditure by farmers on weed management (in billion $; ABS, 2008) Number of species that have become extinct since the first documented occurrence of a pest or disease (e.g. Chytridiomycosis, SoE, 2016a)	Cost-benefit analysis completed as part of the initial investigation for a response provides a measure of the impact of pests and diseases on the economy. The Australian State of the Environment website has information about the economic impacts of individual or groups of pests and diseases, however, there is no estimate of the cumulative impact of all pests and diseases on the economy. One-off studies can provide a snapshot in time but would need to be repeated to be useful for evaluation of economic impacts over time. For example, the Invasive Animals Cooperative Research Centre did a one-off study on the economic impact of four introduced invasive pest animals, and the Australian Bureau of Statistics did a Natural Resource Management survey in 2006-07 to estimate the cost of managing weeds.

Direct outcome	Performance indicator	Rationale
	Number of threatened mammal species that are under major threat from cane toads (SoE, 2016a) Area of native vegetation affected by root-rot in hectares (SoE, 2016a)	The Australian State of the Environment website has key findings for biodiversity, land, inland water and coasts that relate to invasive species and pests and diseases. However, linking the occurrence of pests and diseases to impacts on the environment is difficult. The narrative in the State of the Environment Report about invasive species and diseases contains little information.
Disruption to market access is minimised	Loss of value from market closures or disruptions, including tourism markets. Low is good.	Fewer market closures and quicker restoration of access minimises the impact of an outbreak on trade- and tourism-dependent industries and the Australian economy.

Table ES 10: Performance indicators of the system-level outcomes of IGAB objectives 3 and 4

System-level outcome	Performance measures	Rationale
Nationally significant pests and diseases already in Australia are contained, suppressed or managed by relevant stakeholders in order to enable international and domestic market access and tourism	Number and proportion of significant pests and diseases subject to long-term management where status has not changed. High is good. Number of outbreaks of endemic pests and diseases of biosecurity concern. Low is good.	Maintenance of pest and disease status indicates that long-term strategies are effective in containing, suppressing or otherwise managing the impacts of pests and diseases. A change in status that indicates further spread of a pest or disease is not favorable. If ongoing management is effective, the number of endemic pests and diseases of biosecurity concern should be low, thereby minimising the impact on the economy, including international trade and tourism, the environment and the community.

Indicators of the efficiency, capacity and capability, robustness and resilience, and sustainability of the biosecurity system

Indicators and measures of the performance of the system against the other attributes of health – efficiency, capacity and capability, robustness and resilience and sustainability – are largely qualitative in nature and derived from the judgments of experts or stakeholders in the system. Rubrics are developed for each attribute that define the evaluation criteria and the performance standards. Where appropriate, quantitative indicators are also proposed to define the scale of some relevant characteristics of the system.

Efficiency

Key Evaluation Question 5

Are the resources invested in the biosecurity system allocated across activities in a manner that maximises the efficiency of the system and delivers the highest return on investment?

The efficiency with which resources are deployed in the biosecurity system is defined in this project as one of the core attributes of a healthy system. An efficient biosecurity system is one that will, broadly speaking, allocate its limited resources across all components and activities in the system in a way that maximises biosecurity risk reduction. This is achieved where rates of return to investment on different biosecurity activities are equalised. Using a portfolio allocation approach to biosecurity investment can guide the efficient allocation of the system's resources. To date, a portfolio approach has been used only in limited contexts across a narrow range of biosecurity threats and control measures.

The project has considered whether there is sufficient information and capability available to implement a meaningful portfolio allocation approach to biosecurity investment at the system level. It concludes that this is currently infeasible. However, incremental steps can be taken by biosecurity agencies to build the basis for future applications of a portfolio approach. Taking this into account, the evaluation criteria posed to stakeholders in relation to KEQ 5 are designed to assess whether the biosecurity system is developing the information and capability to undertake meaningful evaluations of resource allocation efficiency.

Evaluation criteria for the efficiency of the biosecurity system

- The budget available for biosecurity is transparent
- Expenditure on biosecurity is routinely monitored, evaluated and reviewed to assess rates of return on activities and inform future resource allocation
- Decision-makers make use of available knowledge, tools and models to support budget allocation decisions
- Data capture and analysis systems are available to decision-makers, or under development, that support and inform a whole of portfolio approach to budget allocation. This includes capture and analysis of information on the rates of return to different activities in the system.

Capacity and capability

Key Evaluation Question 6

Does the biosecurity system have the appropriate capacity and capability, that is the quantity and quality of financial, physical, human and organisational resources, to meet its objectives?

One of the core attributes of a healthy biosecurity system identified in the project is its capacity and capability – or its ability to provide the appropriate quantity and quality of human, physical, financial and organisational resources to deliver the expected system outputs and outcomes (Figure ES 6). Capacity and capability are critical aspects of organisational and system performance and directly underpin other attributes of health. Without the appropriate capacity and capability, the biosecurity system cannot, for example, deliver effective and efficient outcomes, nor can it be resilient or sustainable over the long term.

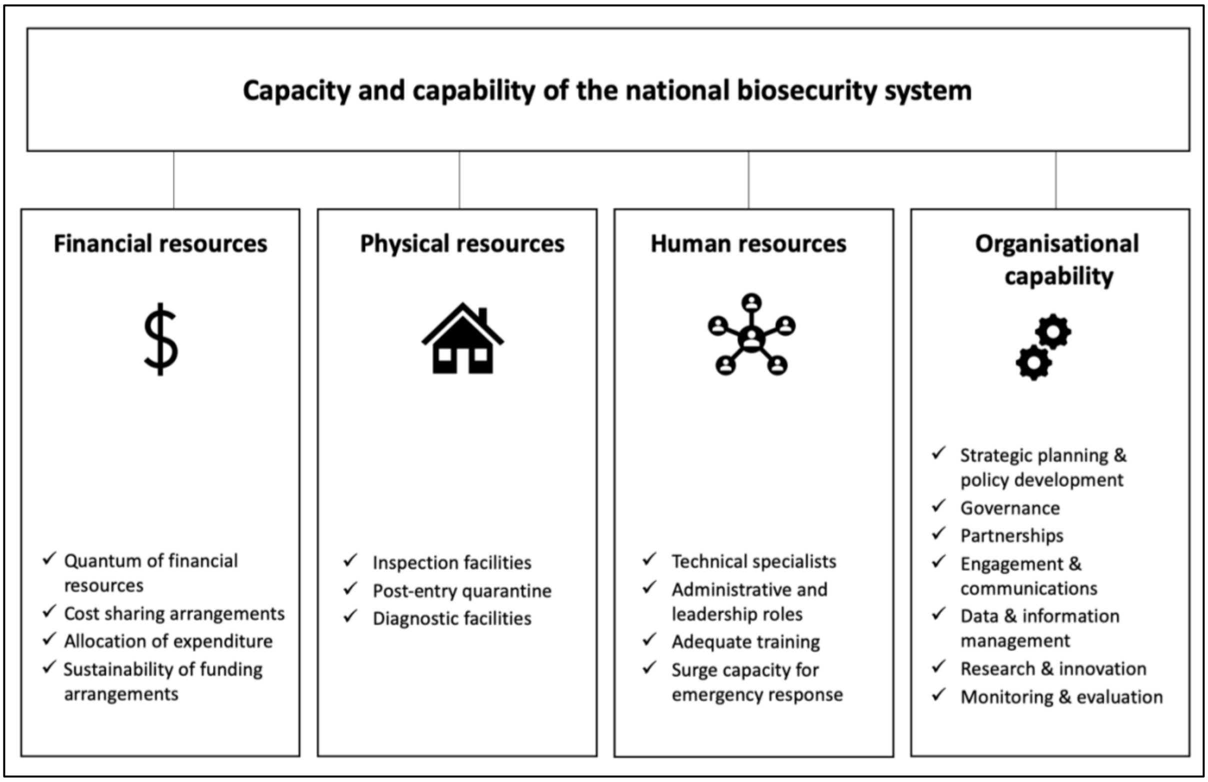

Figure ES 6: Capacity and capability of the national biosecurity system

Quantitative measures are proposed, where appropriate, to describe the three inputs to the biosecurity system – financial, physical and human resources. They are relevant because they provide insight into the scale of these inputs to the system. These measures are included in the main report.

Evaluation criteria are also posed to elicit qualitative assessments of performance against capacity and capability, including the seven components of organisational capability. Rubrics are then constructed to summarise and order these qualitative assessments in a structured and transparent manner.

Evaluation criteria for the capacity and capability of the biosecurity system

- Funding for the biosecurity system is adequate, equitable, efficient and sustainable
- Physical resource inputs to the biosecurity system – inspection facilities, post-entry quarantine facilities, laboratory infrastructure and plant pest reference collections – are of sufficient capacity and quality to manage biosecurity risk effectively in normal circumstances and in emergency responses
- The biosecurity system has access to sufficient qualified and trained personnel to manage biosecurity risk effectively in normal circumstances and in emergency responses
- There is a clearly articulated strategy for the biosecurity system that has the endorsement of all participants in the system, and provides the basis for consistent and harmonised biosecurity policy development by all levels of government and by industry and community participants
- There are clearly defined governance arrangements, including institutional, legislative and administrative structures, that support the operation of the biosecurity system
- There is a genuine partnership approach to national biosecurity in which all participants – government, industry and community – recognise and understand their roles and responsibilities, take ownership of appropriate activities in the system, and have opportunities to participate in strategy and policy design and the implementation of national biosecurity arrangements
- Engagement and communication activities in the national biosecurity system underpin the effective cooperation of all participants; support a partnerships approach to biosecurity management; increase stakeholder, including community, awareness of biosecurity; and enhance the effectiveness of biosecurity activities?
- Communication activities, in normal circumstances and in emergency responses, are targeted, timely and effective
- Biosecurity data and information is managed, that is, collected, collated, analysed, stored and shared, optimally to support risk management and the effectiveness of biosecurity operations?
- Advanced data analytics are used effectively to understand emerging biosecurity risks and to guide risk-related policy development and decision making
- The national biosecurity research and innovation (R&I) system is sustainably funded and based on clearly articulated national priorities, including cross-sectoral priorities?
- National coordination of R&I allocates investment funds according to priorities, contributes to current and emerging challenges in biosecurity and delivers positive rates of return?
- There is a commitment by all jurisdictions to develop and implement a performance monitoring and evaluation framework for the national biosecurity system

The detailed components of each of these rubrics is described in the main report.

Robustness and resilience

Key Evaluation Question 7

Is the biosecurity system sufficiently robust and resilient to reasonably withstand external shocks and disturbances without significant consequences, or to recover from shocks and disturbances in a reasonable time, and to adapt to changed circumstances?

Robustness and resilience are defined in this project as the ability of the biosecurity system to withstand the impacts of an external shock or disturbance, to respond effectively to the impacts of such a shock, and to recover from and adapt to changed circumstances. In the biosecurity context, the principal shock or disturbance is a pest or disease incursion or outbreak. Changed circumstances in the external environment that require adaptations in risk management can also test the system's robustness and resilience. Australia's recent experience with brown marmorated stink bugs is one such example.

The project has defined five characteristics that contribute to robustness and resilience in the biosecurity system. These are being aware, prepared, resourced, responsive and adaptive. Consistent with the methodology used elsewhere in this report, a robustness/resilience rubric is proposed to capture and measure the views of experts on each of these characteristics in a consistent and transparent manner.

Evaluation criteria for the robustness and resilience of the biosecurity system

- participants in the biosecurity system are aware – they understand the operational context of the system and use this to identify, assess and prioritise current and emerging risks on an ongoing basis
- the system is prepared – it has the appropriate plans, tools, agreements and arrangements in place to support biosecurity risk management in normal and emergency circumstances, including the capacity to detect pest and disease incursions through targeted and general surveillance activities
- the system is resourced – it has sufficient capability, including financial, physical and human resources, as well as organisational capability, to support biosecurity risk management in normal circumstances, as well as surge capacity to address emergency situations
- the system is responsive – it has the capacity to respond in a timely and effective manner to incursions of unwanted pests and diseases to increase the likelihood of eradication or containment; be able to deal with anomalous situations and disruptions to normal activities without cascading consequences
- the system is adaptive – it has the capacity to recover from or adapt to new circumstances that arise after a pest or disease incursion, including adaptation by producers, industries and communities, including by taking new actions and modifying behaviours, or applying existing resources to new roles; using monitoring and evaluation processes to identify system performance issues and ways to address them.

The project also considers quantitative approaches to observing robustness/resilience that model characteristics of the system before and after a shock, including the time taken to revert to normal operations. The project does not propose the development of any particular model. The choice of whether to pursue a quantitative assessment of robustness/resilience, and the form of model to use, is one for the evaluation organisation to make. This should be based on the estimated benefits that enhanced understanding of system robustness/resilience can deliver compared with the costs of developing and implementing a quantitative approach.

Sustainability

Key Evaluation Question 8

Is the biosecurity system sustainable? Does it have the appropriate structures and mechanisms in place to ensure its continued effective and efficient operation over the medium to longer term, taking into account pressures expected to arise from growth in system demands and complexity?

The sustainability of the biosecurity system is defined in this project as the ability of the system to meet its objectives over the medium to long term. Over time the pressures on the biosecurity system are expected to grow, with increasing volumes of trade and traveller movements and increasingly diverse import pathways. The global distribution of pests and diseases is also likely to shift in response to factors such as climate change and changes in market demand, while international supply chains are expected to become more complex over time. These contextual factors will have an impact on the biosecurity risk profile facing Australia and the volume of risk that needs to be managed.

A sustainable system will have the appropriate mechanisms in place to ensure that the objectives of the biosecurity system can continue to be met in the face of these pressures. These mechanisms will include the capacity to forecast changes in risk patterns over the medium to longer term, including the capacity to foresee disruptive events that might have sudden implications for risk management. Other mechanisms that underpin sustainability are sustainable funding processes to ensure the appropriate level of resourcing to the system and the efficient allocation of those resources; effective training processes to develop the human resource capability necessary to operate the system over the medium to long term; a targeted R&I effort to generate innovative and cost effective solutions to biosecurity problems; and organisational arrangements to ensure that the system as a whole is fit for the future.

The evaluation criteria posed to stakeholders in relation to KEQ 8 are designed to assess whether the biosecurity system has the appropriate structures and processes in place to support its future operations.

Evaluation criteria for the sustainability of the biosecurity system

- There is well-developed capacity to forecast changes in biosecurity risk over the medium to longer term
- There are appropriate mechanisms in place to provide a sustainable funding base that will support the biosecurity system into the future
- Training programs are implemented that address the human capability requirements of the biosecurity system
- Research and innovation supports biosecurity priorities and contributes to meeting emerging challenges
- The biosecurity system has the appropriate organisational capacity to achieve its objectives into the future under changing conditions

Implementation issues and strategy

Designing and implementing a performance evaluation framework for a complex system such as biosecurity is a non-trivial exercise. It is complicated by the large number of interrelated activities in the system, the multiple objectives the system seeks to achieve, and the range of participants that contribute to system outputs and outcomes. Cooperation between participants and other stakeholders will be critical to the success of an evaluation exercise at the national and system-wide level.

A number of issues will need to be addressed by an implementation team, some of which are discussed in this report. These include the level at which the evaluation should be undertaken. System participants require performance information that is relevant to the level and scale at which they operate and make decisions. The framework established in this report is able to be applied at different levels, with KEQs developed to reflect the objectives of particular components or activities within the biosecurity system.

Data issues will be important – developing a performance evaluation framework for a multi-part system such as biosecurity is necessarily data intensive. All the indicators of performance proposed in this project have been developed with the assistance of jurisdictional staff through workshops and follow-up meetings. Some assurance has been provided that data are available for the proposed indicators or could be collected or curated from existing data sources. However, this has not been validated in practice, with some limited exceptions. Implementation of a performance evaluation framework would require a rigorous data rehearsal, including testing of data availability, quality and accessibility. This needs to be conducted by each jurisdiction and may result in changes or refinements to the proposed indicators. Differences in data availability and quality between jurisdictions will have implications for implementation of the framework.

The collection of qualitative evidence of performance also raises issues, including being clear about the appropriate evaluation questions to ask and carefully framing the performance standards. The selection of experts to participate in the process of gathering qualitative evidence needs to be well considered. These should be drawn from a broad pool of those directly involved in the system as well as the users of system outputs and the beneficiaries of system activities. As with the selection of participants in performance benchmarking processes, transparency can help to reduce inherent biases.

Also important is that the indicators collected in an evaluation process can be used by policy or operational participants in the biosecurity system to improve system performance. Indicators may be scientifically sound and well-constructed in a technical sense but this provides no guarantee that they will be used in, or have an influence on, policy or operations. Usability is likely to be enhanced if a broad range of system participants is involved in the design and implementation of performance indicators.

Another key question is whether the performance evaluation framework can be implemented in its entirety or should be a staged process. Jurisdictions are at different stages of implementation readiness and a pragmatic approach may be to implement the framework initially in a progressive manner in which activities are undertaken by jurisdictions and other participants at a pace that is feasible. Where activities are undertaken principally by one jurisdiction, these could be progressed independently. Building a national, system-wide framework in a progressive manner will require coordination to ensure that activities are structured, consistent with the agreed framework, and can be integrated into an overarching view of system performance. The appropriate authority for this process could be provided by the National Biosecurity Committee.

Articulating the performance narrative is as important as developing and measuring the indicators of performance. The actual form of the final reporting will evolve as the performance evaluation process develops, particularly if implementation occurs in stages rather than as one integrated project. While telling the performance story can be achieved in different ways, it is important that all participants in the evaluation exercise are able to participate in the process and have ownership of the resulting narrative. There may be sensitivities among participants about the confidentiality of results and the level at which these should be reported. It will require trust, in particular, to disseminate poor results but explaining these with the relevant evidence is part of a transparent evaluation process designed to provide stakeholders with confidence in the performance of the system.

Managing stakeholder expectations about the performance evaluation system will be critical to its ongoing support. It is unrealistic to expect that an ideal set of performance indicators and related performance expectations will be identified at the first attempt and that a performance measurement system will be implemented in one step that endures unchanged over time. The process will be evolutionary and advances through trial and error.

Given this, the evolution of the performance evaluation system should occur in a deliberate manner, rather than as random trial and error. There should be visible built-in adjustment mechanisms that identify the strongest indicators and expectations, that is, those that are most useful to stakeholders for managing the system and reporting. An overarching coordination process under the authority of the National Biosecurity Committee will help achieve this and identify the most appropriate opportunities to further develop the system. This can reinforce the importance of deliberate learning based on past experience rather than simply reporting on the gap between expectations and actual performance.

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1 Introduction

1.1 Objectives

This is the final report of Centre of Excellence for Biosecurity Risk Analysis (CEBRA) Project 170714 Evaluating the Health of Australia's Biosecurity System. It represents the final phase of a three-year project commissioned by the Australian Government Department of Agriculture, Water and the Environment (the department). The primary objective of the project is to develop a rigorous method or framework that can be used repeatedly to evaluate and report on the health, or performance, of the national biosecurity system. This framework is designed to capture all components of the biosecurity system and all participants in the system; to articulate relevant attributes of system performance; and to establish appropriate performance indicators.

The capacity to articulate the health of the biosecurity system using sound evidence can provide a strong basis for identifying where system improvements can be made. This can be used to support decision-making in the system, including in relation to the quantity and allocation of investment. Governments at the national and state and territory levels will be beneficiaries of a performance evaluation framework as they seek to allocate their limited resources in the most cost-effective manner. The outcomes of performance evaluation can also contribute to governments' consideration, either individually or collectively, of the future strategic direction of the biosecurity system and to future system design. In an operational context, the evidence derived from a performance evaluation exercise can contribute to annual corporate reporting, budget processes and the development of policy and technical standards for the management of biosecurity risk.

Other participants in the biosecurity system are also likely to benefit from the implementation of a performance evaluation framework that identifies areas of greatest need. These include research and development agencies that aim to meet biosecurity challenges through new technologies and innovative practices; as well as industries and producers that seek guidance on the effectiveness of their biosecurity risk management practices and their role in the broader system.

1.2 Background

Australia's biosecurity system is complex, comprising multiple actions undertaken by many participants, including government, industry and the community, at different points along the biosecurity continuum – off-shore or pre-border, at the border, and on-shore or post-border. These actions are designed to achieve a number of broad objectives that have been defined collectively by Australia's Commonwealth and state and territory governments in the Intergovernmental Agreement on Biosecurity (IGAB) (COAG, 2019). These objectives are to:

(v) reduce the likelihood of exotic pests and diseases, which have the potential to cause significant harm to the economy, the environment and the community (people, animals and plants) from entering, becoming established or spreading in Australia;

(vi) prepare and allow for effective responses to, and management of, exotic and emerging pests and diseases that enter, establish or spread in Australia;

(vii) ensure that, where appropriate, nationally significant pests and diseases already in Australia are contained, supressed or managed by relevant stakeholders; and

(viii) enable international and domestic market access and tourism.

A characteristic of the biosecurity system is the array of complex interactions that occur between participants at different stages of biosecurity risk management. This reflects the varied relationships that exist between participants at all levels of the system and underpins the need for a collaborative partnerships approach to ensure the effective and efficient operation of the system.

Collectively, system participants invest significant resources in biosecurity risk management. In 2015-16, total investment in the system was $1 billion, comprising around $425 million by the Australian and state and territory governments and $575 million by industry participants through levies on production and fee-for-service payments (Craik *et al.*, 2017). Landholders and community groups also make substantial in-kind contributions. These investments are estimated to generate significant value for the Australian economy, environment and community (CEBRA Project 170713).

Over time, the scale of the biosecurity risks facing Australia is expected to increase with growing volumes of trade and traveller movements. From 2012-13 to 2032-33, for example, total containerised trade through Australian ports is forecast to grow by almost 270 per cent and non-containerised trade by 210 per cent (DIRD, 2014). Passenger arrivals by air are expected to double by 2030, and there is significant increase forecast in the movement of travellers by sea (DIRD, 2014). Further pressures on the biosecurity system will arise as international supply chains become more complex and the global distribution of pests and diseases shifts in response to factors such as a changing climate.

Given the important objectives of the national biosecurity system, the increasing risk management task and the significant investment involved it is important to evaluate the overall performance of the system. The Australian and state and territory governments have a strong focus on performance evaluation and require that performance frameworks are in place to assess the effectiveness and efficiency of their activities, including biosecurity. Performance evaluation underpins the accountability of agencies engaged in the biosecurity system and can be used to identify risks in the system and areas for improvement, as well as guiding evidenced-based investment decision making.

Evaluation of components of the national biosecurity system occurs on a regular basis. The Australian and state and territory governments, for example, articulate performance measures in corporate plans, annual reports and strategy documents, although their coverage and sophistication vary widely (Craik *et al.*, 2017). Jurisdictional auditors-general undertake reviews of aspects of the biosecurity system from time to time and have been influential in driving system reform in some jurisdictions, including Queensland and Victoria. The Australian Government's Inspector-General of Biosecurity also provides independent assessment of Australia's biosecurity arrangements.

In addition, several independent reports have provided 'one-off' overviews of the biosecurity system. These include the Nairn review (Nairn *et al.*, 1996), which established the principle of shared responsibility. The Beale review (Beale *et al.*, 2008) built on this principle, moved from consideration of quarantine to the broader concept of biosecurity, and underscored the importance of a risk-based management approach. In 2011, the Matthews review assessed Australia's preparedness for the threat of foot-and-mouth disease, including the capacity to prevent and respond to an outbreak (Matthews, 2011). And in 2017 an independent review was undertaken of the capacity of the national biosecurity system and its underpinning Intergovernmental Agreement (Craik *et al.,* 2017).

There has not, however, been a consistent, rigorous approach to evaluating the performance, or the health, of the biosecurity system at the national level. This gap was identified by the IGAB review, which noted that it is not possible to 'roll up' individual jurisdictional performance measures to capture the national system and assess national performance (Craik *et al.*, 2017). The review recommended the development of a performance framework and performance measures for the national biosecurity system. This report into the health of Australia's biosecurity system responds to that recommendation by proposing a performance evaluation framework and candidate indicators that can be used to assess performance of Australia's biosecurity system at the national level.

1.3 Structure of the report

The report comprises:

- an outline of the methods and approach adopted in the project and the rationale behind the choice of methods (chapter 2)
- a comprehensive description of the national biosecurity system (chapter 3)
- an overview of the evaluation framework adopted in the report (chapter 4)
- a proposed framework to assess the effectiveness of the national biosecurity system (chapter 5)
- proposed frameworks to assess the efficiency, capacity and capability, robustness and resilience, and sustainability of the system (chapters 6 to 9)
- a discussion of the issues around implementation of the proposed evaluation framework (chapter 10).

2 Methods

2.1 Introduction

This chapter describes the methods used to achieve the objectives of the project. The methods applied in the project consist principally of literature reviews covering key concepts and methodological approaches to performance evaluation, their application in different domains, followed by extensive stakeholder engagement. This chapter outlines the objectives of two literature reviews commissioned for the project and how their findings were used. This chapter provides a table detailing stakeholder engagement activities undertaken throughout the project and how stakeholder feedback influenced and confirmed the course of the project. The remainder of the chapter presents the selected evaluation method, including a rationale behind choices made, and an overview of key considerations when developing indicators for an evaluation.

2.2 Literature reviews

CEBRA commissioned two literature reviews to support the project work. The first literature review provided an overview of peer-reviewed literature on the evaluation and performance or 'health' of complex systems. The findings of this review informed decisions around the choice of evaluation method, the attributes of health and the development of performance indicators. The second review was contracted to Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES) to undertake a further and more detailed review of the experience of Australian and international evaluation approaches in the public sector, using examples from health, education and defence. The findings of the ABARES review are captured in this chapter.

2.3 Definitions

Definitions of key terms that are used throughout the project are provided in the glossary.

2.4 Stakeholder engagement

Engaging stakeholders in decision making was an important component of the methods used in this project. Evaluation research has shown that the degree of stakeholder involvement throughout an evaluation process, among other factors, substantially influences the uptake of evidence from an evaluation (Bossuyt *et al.*, 2014).

Nine workshops were held throughout the life of the project (Table 1, Appendix 1). These workshops had different objectives and outcomes but a common intention was to engage all principal stakeholders. The department project team selected invitees associated with different parts of the biosecurity system to provide the opportunity for broad input. This allowed involved parties to reach a common understanding of the approach taken and of decisions made.

Regular meetings were held with the project sponsor and senior executives in the department, both individually and through the Biosecurity Research Steering Committee. The suitability of the system description as the foundation of the evaluation framework was confirmed with these stakeholders (Table 1, ID 4 and 5).

Table 1: Stakeholder engagement

ID	Engagement details	Objectives and outcomes
1	**Joint scoping workshop** for CEBRA Health (1607B) and Value (1607A) projects 12 July 2016, Canberra	The objectives were to obtain: (i) key recommendations on project scope, deliverables and dependencies; and (ii) suggestions on collaborative partnerships and assistance, including the potential roles and responsibilities of the principal stakeholders and collaborators. The outcomes of this workshop helped refine the business case for the project.
2	**Technical workshop** 8 December 2016, Canberra	The objectives were to refine the project focus and discuss future steps for the project. CEBRA presented the findings of the CEBRA literature review, which included the proposed attributes of health for evaluating the performance of the biosecurity system. The outcomes of the workshop provided important direction for the CEBRA project team: it was agreed that the Australian biosecurity system should be treated as a complex system and be evaluated at a whole of system level; and that the evaluation approach should be based on program theory, logic modelling and systems thinking, and include the use of indicators and benchmarks.
3	**System description workshops** 2 & 4 May 2017, Melbourne	The objective of these two workshops was to develop a description of the Australian biosecurity system. The initial workshops were led by CEBRA and involved biosecurity experts, including the Chief Plant Health Officer of Agriculture Victoria. The outcome of these workshops was a draft system description using the protocol of a logic model.
4	**Senior executive feedback** 23 & 27 May 2017, Canberra	The draft system description was presented to the First Assistant Secretary and the Assistant Secretary of the Biosecurity Policy and Implementation Division for discussion at a meeting on 23 May 2017. A previous First Assistant Secretary of this Division provided objective advice on the document, and endorsed the approach of framing the description around the IGAB goal and objectives. In a subsequent meeting with CEBRA on 29 May 2017, the Deputy Secretary agreed that the description document was an appropriate description of the biosecurity system.

ID	Engagement details	Objectives and outcomes
5	**Biosecurity Research Steering Committee workshop** 11 August 2017, Canberra	The objective of this workshop was to discuss the system description and the associated narrative document with First Assistant Secretaries of biosecurity-related divisions. The outcome of this workshop was confirmation from participants that the system description is "well suited to its purpose as an underlying framework for the Value and Health projects and potentially to support future biosecurity policy and strategic outcomes". Constructive comments from workshop participants were used to revise the description and accompanying narrative.
6	**Draft final CEBRA report** Phase 1 5 September 2017	Submission of the draft final report for phase 1 of the project. The draft report was reviewed by the department project team and two CEBRA Scientific Advisory Committee (SAC) reviewers. Feedback on the evaluation principles presented in this report, including using a system description and attributes of health, was positive. Reviewer comments were addressed, and the final report was published on the CEBRA website in March 2018.
7	**Workshop 1** Anticipate and Prevent 8 November 2017, Canberra **Workshop 2** Screen 28 March 2018, Canberra **Workshop 3** Prepare, Detect, Respond and/or Adapt (Commonwealth) 27 September 2018, Canberra	**Workshops 1-3** were held with departmental representatives. The objectives of the workshops were to: (i) consider the range of activities under the relevant components of the biosecurity system to ensure their complete coverage; and (ii) develop appropriate indicators of performance for the components that link the activities, outputs and outcomes in the national biosecurity system. In addition to these objectives, workshop 3 tested proposed indicators with departmental representatives before they were circulated to jurisdictional representatives. Indicators included in workshop papers were for discussion purposes and did not represent CEBRA's preferred options.
8	**Draft final CEBRA report** Phase 2 31 May 2018	Submission of the draft final report for phase 2 of the project. The draft report was reviewed by the department project team and two CEBRA Scientific Advisory Committee (SAC) reviewers. Reviewers commented positively on the proposed evaluation framework, including the proposed attributes of health, the key evaluation questions (KEQ), and the use of rubrics for qualitative evaluation. The final report for phase 2 has not been published online. However, reviewer comments were addressed and incorporated into the draft final report for the last phase of this project.

ID	Engagement details	Objectives and outcomes
9	**Workshop 4** Prepare, Detect, Respond and/or Adapt (States and territories) 20 November 2018, Canberra	The objectives of **workshop 4** were, in discussion with representatives from states and territories, to: (i) consider the range of activities undertaken in the post-border components of the biosecurity system to ensure their complete coverage; and (ii) review proposed indicators of performance for these components that link the activities in the national biosecurity system to their intended outputs and outcomes. The outcomes of workshops 1-4 were used to guide the development and refinement of indicators for and the description of the components of the biosecurity system.
10	**NZ MPI consultation meeting** 28 March 2019	The New Zealand Ministry of Primary Industries was a collaborator in the project and represented at workshops. A consultation meeting with the New Zealand Ministry of Primary Industries updated the Ministry's evaluation team on project progress.

2.5 Selecting an evaluation method

This section describes the reasons for adopting a theory-driven evaluation approach in this project. This choice is based on the premise that indicators will be used in the evaluation of the performance of the biosecurity system. The review of Australian and international evaluation practises identified that evaluation frameworks generally measure system performance by defining a number of performance dimensions and grouping performance indicators and measures underneath.

Many frameworks can guide indicator development. In the area of environmental monitoring, the Organisation for Economic Co-operation and Development (OECD) developed the pressure-state-response (PSR) framework for identifying and structuring indicators (OECD, 1993). The PSR framework is deemed successful (Levrel *et al.*, 2009) and has been adapted by other organisations into, for example, the drivers-pressure-state-impact-response framework (EEA, 2003), the driving force-state-response framework (CSD, 2001) and the use-pressure-state-response-capacity framework (CBD, 2003). In Australia, the State of the Environment reporting builds on the drivers-pressure-state-impact-response framework, complementing it with topics such as resilience, emerging risks and environmental outlooks (SoE, 2016a).

The PSR framework is based on the idea that "human activities exert *pressures* on the environment and change its quality and the quantity of natural resources (the *state*). Society responds to these changes through environmental, general economic and sectoral policies (the *societal response*)" (OECD, 1993). Because the PSR framework tends to suggest linear relationships between human activities and the environment (OECD, 1993), researchers from disciplines such as sustainable development and environmental conservation have criticised it for oversimplifying constraints on anthropogenic pressures, environmental states and social responsibilities (Hukkinen, 2003; Levrel *et al.*, 2009), and for failing to capture important information about complex causal relationships and behaviour (Kelly, 1998; Wolfslehner & Vacik, 2008). The shortcomings of the model reduce its applicability for decision making and scenario analysis (Wolfslehner & Vacik, 2008).

While the PSR framework can be a useful tool for developing and selecting indicators in environmental contexts (e.g. Hughey *et al.*, 2004; Teillard *et al.*, 2016; Liu & Hao, 2017), it is not commonly used for evaluating the performance of programs or complex systems. Systems can be better evaluated using theory-driven approaches that are underpinned by conceptual frameworks (Chen, 1990; Gibert *et al.*, 2017). Theory-driven approaches can be applied across sectors. They are used in public sectors such as health (e.g. Marchal *et al.*, 2010; Petticrew *et al.*, 2013). The majority of evaluations performed by governmental and inter-governmental organisations such as the Canadian border services or the European Union use a theory-driven approach (EC, 2013; Agriculture and Agri-Food Canada, 2015). New Zealand ministries also use a theory-driven approach to evaluation in their annual reporting.

A theory-driven approach can be used in the evaluation of both complex and complicated systems. The biosecurity system is complex. The main characteristics of complex systems are that (i) they contain many components, (ii) there are interactions between components of the system, and (iii) they exhibit non-linearity, feedback loops and emergent behaviour (Shiell *et al.*, 2008; Ladyman *et al.*, 2013; Walton, 2014), which can result in unexpected outcomes at varying time scales. Therefore, evaluation procedures for complex systems typically require identifying all interactions that may exist within a system, between components within a system, and between the system and its context.

In a theory-driven approach, evaluators develop models that show how interventions are meant to work and use them as the conceptual basis for an evaluation (Vogel, 2012). These models are often described as *program theory*, *logic model*, *theory of change* or *results chain* without agreement on terms or meaning (Funnell & Rogers, 2011; James, 2011; Mayne, 2015). While there is no agreed definition in the literature of what the term *theory of change* means, the general understanding is that it is an articulation of how and why an intervention will lead to change (Stein & Valters, 2012). Similarly, Bickman (1987) defined *program theory* as ‘the construction of a plausible and sensible model of how a program is supposed to work’. A theory of change or program theory can be developed for any level of intervention – an event, a project, a programme, a policy, a strategy or an organisation (Peersman, 2014). Mayne (2015) does not consider an outcomes or impact pathway to represent a theory of change, only when assumptions are added to the causal links in a pathway model, it becomes a theory of change. Others also consider a theory of change to be more informative than an outcomes pathway and list the following as components of a good theory of change: a broad context, beneficiaries, actors and a narrative summary (James, 2011; Vogel, 2012). There is some agreement on what a logic model is. A logic model is viewed as the depiction of a program theory or a theory of change in diagrammatic format; different types of logic models exist (Funnell & Rogers, 2011; Mayne, 2015).

In this project, we applied a theory-based approach using logic modelling. However, there are other theory-based methods that could be used, such as *systems thinking*. The concept of systems thinking has been used for decades (Hammond, 2019), however only recently has the term been used in public health and by social sciences for advocating new approaches that explicitly consider complexity properties when evaluating complex systems (Glouberman & Zimmerman, 2002; Forss *et al.*, 2011; Patton, 2011; Westhorp, 2012; Lamont *et al.*, 2016). Systems thinking is defined as an approach to problem solving that views problems as part of a wider dynamic system. Systems thinking involves more than a reaction to present outcomes or events. It demands a deeper understanding of the linkages, relationships, interactions and behaviour among the elements that make up a system (WHO, 2009). Despite its recent popularity within the evaluation literature, systems thinking remains only peripheral in evaluation practice because of several barriers limiting its use (Walton, 2016). Because of the documented difficulty of translating complexity thinking into practical tools, this approach has not been adopted in this project.

2.6 Developing the biosecurity system description

The initial development of the description of the Australian biosecurity system was undertaken in two internal workshops (Table 1, ID 3) and further refined as described in section 2.4 (Table 1, ID 4 and 5). The system description was structured using the characteristic elements of a basic logic model.

The elements of a basic logic model consist of resources (inputs), activities, outputs, outcomes and impacts. Outputs are the direct and measurable products, results or services of program activities (W.K. Kellogg Foundation, 2004; McLaughlin & Jordan, 2015). Short-term, intermediate and long-term outcomes are the results of outputs over time. Impacts usually describe the results of outcomes on a higher level and over time (Mertens & Wilson, 2012). Logic models provide a useful guide for planning and designing an evaluation. They help with developing a conceptual idea of the attributes of interest and of the operational definition of how the associated data will be collected (Fitzpatrick *et al.*, 2012; Mertens & Wilson, 2012). A logic model also assists evaluators with the formulation of evaluation questions (McLaughlin & Jordan, 2015).

KEQs and attributes of health are not components of a logic model because they do not influence how interventions are meant to work but rather are essential components of an evaluation process. Key evaluation questions (KEQs) are derived from the purpose of the evaluation and linked to the attributes of health.

CEBRA complemented the system description with a comprehensive narrative of the national biosecurity system to provide the context needed for evaluating the performance of the system using different perspectives, briefly outlined in the following section on the attributes of health.

2.7 Attributes of health

For non-human systems, the term 'health' has an intuitive connection to human health and is commonly used as a metaphor to describe the state or condition of a system (Crawford, 2006; Gibert *et al.*, 2017). Defining the attributes of health is an important part of the evaluation framework as they specify the values that will be used in an evaluation (Peersman, 2014). They are the characteristics of the system that are considered critical and will contribute to achieving the desired objectives of the system. The selection and definition of attributes of health depend on the type and subject of the evaluation and is partly subjective – different stakeholders in the system might have different views about the key attributes of health or the weights that should be attached to each of them. The attributes of health used to evaluate the biosecurity system in this project were chosen on the basis of discussions and feedback with stakeholders (Table 1, ID 1, 2, 6 and 8) and the review of international literature.

The literature review identified attributes that are associated with healthy systems across sectors, including effectiveness, resilience, robustness and sustainability (Atkinson, 1999; Lauras *et al.*, 2010; Cao & Hoffman, 2011; Blondeau *et al.*, 2015). In Australia, common performance dimensions that are used to evaluate public health systems include capability, effectiveness, efficiency and sustainability (Arah *et al.*, 2006). Development agencies use standard criteria for evaluating development assistance, the OECD-DAC criteria. These criteria include relevance, effectiveness, efficiency, impact and sustainability (Peersman, 2014). In New Zealand, performance reporting in annual reports mainly focuses on effectiveness and efficiency.

2.8 Key evaluation questions

Evaluation of a program or system such as the biosecurity system should be focused around answering a small number of high-level KEQ that can be answered through a combination of evidence (Rogers, 2014). Answers to these questions provide high-level observations of the performance of the system overall. In this project, the high-level KEQs are designed to evaluate whether the system as a whole is meeting its overarching objectives, as described in the IGAB, as well as whether the other attributes of system health are being met. The program logic, the IGAB objectives and the attributes of health guided the development of high-level KEQs.

This level of question and evaluation is likely to satisfy the needs of some high-level stakeholders – these might include ministers, parliaments and biosecurity executives. Other stakeholders in the system, such as managers responsible for individual elements of the system or activities within those elements, or industry and community members affected by these activities, may require more detailed questions to be answered to satisfy their evaluation needs. The high-level KEQs can be unpacked to tackle these more detailed questions about performance of individual components or activities in the biosecurity system. The same framework that has been developed in this project can be applied at lower levels of the system to answer these questions. Synthesising the answers to lower level questions can also allow defensible judgments to be made that directly answer the higher level questions (Davidson, 2014).

The KEQs developed in this project were examined by departmental and independent reviewers (Table 1, ID 8) and included in the workshop material for the workshop with state and territory governments (Table 1, ID 9).

2.9 Indicators

This section provides a definition of the term 'indicator' and discusses the use of indicators in decision-making. It also explains different types of indicators and describes the characteristics of good indicators. Further, this section introduces rubrics, a tool for summarising qualitative information in an evaluation, and briefly touches on the issues related to successfully integrating indicators into policy decisions.

The term indicator used in this report is defined as:

> 'a measurable characteristic of a system that yields insights transcending its individual parts to answer specific questions relevant for decision-making in policy.'

This definition is based on examples in the scientific literature, including Ott (1978); Jackson *et al. (*2000); Riley (2001a; b; c); Meyer (2004); Bauler (2012); Bell & Morse (2013); Frederiksen *et al.* (2013); Dillon *et al.* (2014); Latruffe *et al.* (2016); de Olde *et al.* (2017).

The first step in indicator development involves conceptualising the characteristics and interactions of the subject of an evaluation. In this project indicator development was based on the description of the biosecurity system. Building a set of indicators that is based on an underlying conceptual framework ensures that the indicators are relevant and provide balanced coverage (Brown, 2009; McLaughlin & Jordan, 2015). Selecting indicators using an unstructured approach creates a risk of biased, or even unreflective assessment outcomes (e.g. Cairns *et al.*, 1993; Bell & Morse, 2008; Olsson *et al.*, 2009; Latruffe *et al.*, 2016; Lehtonen *et al.*, 2016).

Indicators are widely used in practical evaluation, including to support management decision-making and policymaking (Gudmundsson, 2003; Lehtonen *et al.*, 2016). Indicators have been used (i) to characterise current status, (ii) to track short and long-term progress, (iii) to predict change, (iv) for early warning and detection, (v) for monitoring of conditions, (vi) in communication and awareness raising, and (vii) to help devise resolutions for problems identified (Jackson *et al.*, 2000; Meyer, 2004; Bell & Morse, 2008; Bauler, 2012; Moeller *et al*., 2014; Lehtonen *et al.*, 2016;).

2.9.1 Quantitative and qualitative indicators

Indicators can be quantitative or qualitative (Meyer, 2004; ABS, 2013; Lehtonen *et al.*, 2016). Quantitative indicators are described by, or derived from, numerical variables defined by units of measurement and measured on metric scales. Examples of such measurements are counts, weights, and dollar amounts. Qualitative indicators are rooted in language description with no unit of measurement and measured on nominal (characteristics are assigned to categories e.g. pass or fail) and ordinal (characteristics are assigned to rank ordered categories e.g. agree, neutral, or disagree) scales.

Quantitative indicators may be easier to collect and interpret than qualitative indicators but they may tell only part of the performance story. Qualitative indicators provide complementary and valuable insights into the attitudes, perceptions and beliefs underlying the behaviour of participants in a system (DEPI, 2014). The emphasis is on narrative rather than numbers and aims to capture and interpret the characteristics of something. It typically involves tapping into the experiences and judgments of stakeholders or experts (DF, 2015).

Using a combination of quantitative and qualitative data can improve performance evaluation by ensuring that the limitations of one type of information are balanced by the strengths of another. This helps to ensure that understanding is improved by engaging different ‘ways of knowing’ (BetterEvaluation, 2019). A mixed methods approach is likely to result in better understanding of outcomes than either quantitative or qualitative evaluation alone (Adato, 2011).

The ABARES literature review investigated different approaches to system wide performance evaluation used by public sector agencies in defence, education, environment, finance, forestry, health, Indigenous and social justice, and science. It identified emerging trends in the way entities approach performance reporting in Australia, including the use of a confined set of targeted, high level (or core) indicators (e.g. PMC, 2017) and the use of a mix of quantitative and qualitative indicators to provide more complete and insightful information about performance. Agencies also supplement indicators with a range of other tools such as benchmarking, stakeholder surveys, peer review and comprehensive evaluations.

2.9.2 Characteristics of good indicators

The characteristics of good performance indicators vary according to the nature of the activities or system being evaluated, the purpose of the evaluation and the values of the organisation. The scientific literature offers many descriptions of quality indicators (e.g. Harger & Meyer, 1996; Jackson *et al.*, 2000; Dale & Beyeler, 2001; Meyer, 2004; Bell & Morse, 2008).

The management literature frequently cites variants of five SMART criteria – that indicators should be:

- **S**pecific: target a specific area for improvement;
- **M**easurable: quantify or at least suggest an indicator of progress;
- **A**ssignable: specify who will do it;
- **R**ealistic: state what results can realistically be achieved, given available resources; and
- **T**imely: specify when the result(s) can be achieved (Doran, 1981).

The European Commission (EC) Directorate-General for Regional and Urban Policy (2013) uses a similar framework but includes *relevance* – that an indicator should be directly related to the objective being measured; *understandable* – that the indicator can be readily interpreted; and *cost effective* – that collection of an indicator should provide a benefit commensurate with its cost. Reflecting the purpose of its activities, the United States Agency for International Development (USAID) requires that its performance indicators be, among other things, (i) *objective* – unambiguous about what is being measured and what data are being collected; (ii) *useful for management* – able to provide a meaningful measure of change over time for management decision making; and (iii) *able to be disaggregated* to the appropriate level, for example by age or gender – to manage for sustainable project impact (USAID, 2010).

There are many other examples of organisations defining the types of indicators useful for their specific purposes. Key considerations for all organisations are that the indicator set chosen should, when interpreted together, be capable of providing a more effective picture of the impacts of interventions than any individual indicator. The set of indicators should also reflect different points along the pathway to long term outcomes and impacts to provide an understanding of how results are linked to activities and identify areas that might require further investigation (Peersman, 2017).

In this context, indicators collected in an evaluation process should be usable by policy or operational participants in the biosecurity system to improve system performance. Indicators may be scientifically sound and well-constructed in a technical sense but this provides no guarantee that they will be used in, or have an influence on, policy or operations (Gudmundsson, 2003; Bauler, 2012; Gudmundsson & Sørensen, 2013). Usability is likely to be enhanced if a broad range of system participants is involved in the design and implementation of performance indicators.

Diverse sources of data and other information are required to assess the outcomes of activities. These can include reviews of reports, previous evaluations and audits (Lauras *et al.*, 2010; EC, 2015a; Wu *et al.*, 2016); statistical sources such as national and regional statistics; program and system monitoring data sets (Gupta & Dokania, 2014); experiments (Lyon *et al*., 2013; Susaeta *et al*. 2016); case studies (Wu *et al.*, 2016); interviews (Agriculture and Agri-Food Canada, 2015); surveys (EC, 2015b) and reviews of the academic literature or media (Agriculture and Agri-Food Canada, 2015). Indicators used by government or intergovernmental agencies were mainly based on data gathered from previous reports as well as from interviews and surveys (EC, 2013, 2015a; Agriculture and Agri-Food Canada, 2015; Canada Border Services Agency, 2016).

2.9.3 Rubrics

As not all aspects of biosecurity system performance can be quantified, the project has adopted a mixed methods approach to evaluation by including a method to measure qualitative information. Capturing qualitative information and presenting and interpreting it rigorously and transparently is important. Rubrics are proposed in this project as a means to achieving this in a practical manner. A rubric is a form of constructed scale that provides a transparent process for articulating the aspects of performance that are important (Oakden, 2013) and can help clarify the basis on which qualitative judgments about performance are made (King *et al.*, 2013).

A rubric is a tool that provides an evaluative description of what performance or quality ‘looks like’ at two or more defined levels (Davidson, 2005). At its simplest, a rubric can be presented as a table or matrix that describes different levels of performance against a set of evaluation criteria.

The conceptually similar term of constructed scale is used in the structured decision-making domain to estimate the anticipated consequence of management alternatives or to assess the performance of individuals or programs against specific criteria. Constructed scales allow the inclusion of hard-to-quantify things into an evaluation framework and, if well designed and described, bring consistency and minimal ambiguity to the assessment process (Gregory *et al.*, 2012). For example, the department uses constructed scales to report the magnitude of social and environmental impacts in the Risk Return Resource Allocation (RRRA) model and in import risk analyses, where they underlie pest risk assessments.

Rubrics have two main components: evaluation criteria and performance standards (Dickinson & Adams, 2017) as shown in Figure 1.

<table>
<tr><td colspan="2" rowspan="2">a. Criteria</td><td colspan="5">b. Standards
Organised on a spectrum by degree of goodness or level of performance</td></tr>
<tr><td>Standard 1</td><td>Standard 2</td><td>Standard 3</td><td>Standard 4</td><td>Standard 5</td></tr>
<tr><td>Criterion 1</td><td rowspan="5">Non-overlapping dimensions of quality</td><td colspan="5" rowspan="5">c. Descriptor
Cells outlining what evidence will look like for each level of performance for each quality dimension</td></tr>
<tr><td>Criterion 2</td></tr>
<tr><td>Criterion 3</td></tr>
<tr><td>Criterion 4</td></tr>
<tr><td>Criterion 5</td></tr>
</table>

Source: Martens (2018)

Figure 1: Elements of an evaluation-focused rubric

The evaluation criteria identify the dimensions of interest that are used to judge how well a program or system has performed in relation to particular interventions or outcomes. They should define a comprehensive set of dimensions that make up the performance. If these dimensions are not of equal importance in determining the performance of the program or system that is being evaluated, weights can be applied to reflect their relative merit.

The performance standards define different levels of performance in order to distinguish between, for example, advanced, good and inadequate performance. In a practical evaluation process, generic performance standards may not be appropriate, and the rubric may need to be refined to meet the specific needs of the performance evaluation exercise.

By defining the evaluation criteria rubrics explain what is considered important in the evaluation. They also help make transparent the judgments that are applied by experts when answering the KEQ. They can provide a structure for answering those questions that clarifies the basis on which judgments about performance are made. As a result, evidence can be interpreted on an agreed basis, clear judgments can be reached, supported by evidence and reasoning, and an accurate performance story can be told (Julian King and Associates, 2017).

An important consideration in designing a rubric is that the language used to describe performance against an evaluation criterion at a specified level should be as objective and transparent as possible. Linguistic ambiguity may generate unwanted bias in the judgments made but can be mitigated by discussion and feedback in the implementation process that clarifies the language used in the specific context. Given that the rubrics developed in this project are designed to elicit qualitative judgments rather than quantitative measures it is not possible to eliminate all ambiguity but awareness of the issue can help to reduce inherent biases.

3 Describing the biosecurity system

3.1 Introduction

The Australian biosecurity system is complex, comprising multiple actions undertaken by many participants at different points on the biosecurity continuum – off-shore or pre-border, at the border, and on-shore or post-border. The broad goal of the system is articulated in the IGAB, an agreement between the Australian and state and territory governments. The goal is to '*minimise adverse impacts of pests and diseases on Australia's economy, environment and the community while facilitating trade and the movement of plants, animals, people and products* (COAG, 2019).

Beneath this overarching goal the objectives of the biosecurity system are identified in the IGAB as being to provide arrangements, structures and frameworks involving governments, industry and community that:

- reduce the likelihood of exotic pests and diseases, which have the potential to cause significant harm to the economy, the environment and the community (people, animals and plants) from entering, becoming established or spreading in Australia;
- prepare and allow for effective responses to, and management of, exotic and emerging pests and diseases that enter, establish or spread in Australia;
- ensure that, where appropriate, nationally significant pests and diseases already in Australia are contained, suppressed or managed by relevant stakeholders; and
- enable international and domestic market access and tourism (COAG, 2019).

Through meeting these objectives, the biosecurity system helps to deliver some important outcomes for Australia's economy, environment and people. By reducing the adverse impacts of pests and diseases, an effective biosecurity system supports the sustainability, profitability and competitiveness of Australia's agriculture, fisheries and forestry industries, which, in turn, helps drive a stronger Australian economy. The reduction in pest and disease impacts contributes to the health of the environment through better functioning ecosystems. It supports a healthier population by reducing the incidence of mortality and morbidity arising from pests and diseases; and it underpins communities through its protection of social assets in natural and built environments and the amenity value they create.

3.2 The external context

The Australian biosecurity system does not operate in isolation – global and domestic factors define the context in which biosecurity activities take place. Changes in these factors affect the biosecurity risks facing Australia. The scale of biosecurity risks will increase with growing volumes of trade and passenger movements.

Pressures on the biosecurity system will also change as the origin and destination of trade and passenger movements shift, leading to increasingly diverse and potentially higher risk import pathways (Hulme, 2009; Dodd *et al.*, 2015). Similarly, international supply chains are expected to become more complex over time. Final goods will increasingly comprise components from multiple origins that may involve different risk profiles, while the growing use of online shopping will require new approaches to risk management. Other trends with implications for biosecurity risk are the intensification of agricultural industries and the expansion of monocultures that can concentrate the impacts of pests and diseases, and urbanisation that brings biosecurity risks closer to agriculturally sensitive areas (Craik *et al*., 2017). The global distribution of pests and diseases is also likely to shift in response to factors such as a changing climate. At the same time, technological advances are bringing new opportunities to manage biosecurity risk in innovative and cost-effective ways.

In the domestic context, there is much to protect. Australia's agriculture, fisheries and forestry industries generate significant value and have a reputation for quality and safety that supports their access to international markets. Australia also has a mega-diverse natural environment with many unique native animals and plants (Mittermeier *et al.*, 1997; Mittermeier *et al*., 2011). Together these characteristics contribute to a strong economy and high standard of living, including access to a rich natural environment. While the immediate impact of biosecurity management is to regulate imports to protect Australian primary industries from unwanted pests and diseases, it also directly underpins export market access and the quality of the environment.

Consistent with its international obligations under the World Trade Organization (WTO), Australia has defined its tolerance to biosecurity risk, or its Appropriate Level of Protection (ALOP), as being very low but not zero. This definition is included in the *Biosecurity Act 2015* and has been reached with the agreement of all states and territories. It recognises that a zero-risk stance is impractical because it would mean that Australia would have no tourists, no international travel and no imports. It also recognises the potential for pests and diseases to be introduced through natural processes such as wind. Australia's biosecurity risk management measures are designed to achieve the broad objective of ALOP.

3.3 Principles of the national biosecurity system

There are a number of principles that underpin the operation of the national biosecurity system that are outlined in the IGAB. These are that:

- biosecurity is a shared responsibility between all system participants;
- in practical terms, zero biosecurity risk is unattainable;
- biosecurity investment prioritises the allocation of resources to the areas of greatest return, in terms of risk mitigation and return on investment;
- biosecurity activities are undertaken according to a cost-effective, science-based and risk-managed approach;
- governments contribute to the cost of risk management measures in proportion to the public good accruing from them. Other system participants contribute in proportion to the risks created and/or benefits gained;
- system participants are involved in planning and decision making according to their roles, responsibilities and contributions;
- decisions governments make in further developing and operating the national biosecurity system should be clear and, wherever possible, made publicly available;

- the Australian community and its trading partners should be informed about the status, quality and performance of the national biosecurity system; and
- Australia's biosecurity arrangements comply with its international rights and obligations and with the principle of ecologically sustainable development (COAG, 2019).

These principles provide a guiding framework for the operation of the biosecurity system and strengthen the collaborative approach between the Australian, state and territory governments and other participants.

3.4 Participants in the biosecurity system – a partnership approach

Given the broad ranging objectives of the national biosecurity system, encompassing economic, environmental and social dimensions, there are many participants. These are, principally, the Australian, state, territory and local governments; industry, including representative groups; natural resource managers, users and custodians, including farmers; research providers; relevant non-government organisations (NGOs); and the general community. Each of these has different roles and, in some cases, formal responsibilities. While these can be articulated individually, it is the cooperation and relationships between these participants that underpin the national biosecurity system. The shared responsibility or partnership approach articulated in the IGAB is fundamental to the effective performance of the system.

Governments, as regulators, have prime responsibility for the development, implementation, monitoring and enforcement of the system (Beale *et al.*, 2008). The responsibilities of the Commonwealth and state and territory governments are articulated in the IGAB.

The Australian Government, through the department, is responsible largely for the pre-border and border components of the biosecurity system. These include assessing the potential risks associated with imported goods and conveyances, screening for exotic pests or diseases at the border, and developing and enforcing quarantine. It also conducts some specific post-border activities such as those under the Northern Australia Quarantine Strategy (NAQS) and shares funding with the states and industry for other pest and disease control and surveillance programs, including those conducted through Animal Health Australia (AHA) and Plant Health Australia (PHA). Australian Government biosecurity activities are supported by the Inspector-General of Biosecurity (IGB). This statutory position was established under the *Biosecurity Act 2015* to provide independent assessment of the effectiveness of Australia's biosecurity arrangements. The scope of the IGB is broad, encompassing all biosecurity risk management measures and systems across the biosecurity continuum.

At a higher level, the Commonwealth provides national leadership for strategic biosecurity issues, and legislative, capacity and capability support to states and territories to ensure the effective management of biosecurity risks. It also manages international government-to-government relations on biosecurity matters and monitors and reports Australia's pest and disease status to meet international obligations (COAG, 2019).

State and territory governments are responsible for animal and plant health within their borders, including sharing enforcement actions and regulatory interventions with the Commonwealth; managing eradication and containment programs; undertaking surveillance and diagnostics to support early detection and diagnosis; regulating the keeping and movement of plants and animals that pose significant risks; and monitoring pest and disease status, including to assist the Commonwealth meet domestic and international obligations (COAG, 2019). There are formal arrangements under the National Biosecurity Committee (NBC) and its subcommittees that provide a forum for Commonwealth and state and territory collaboration and decision making on priority biosecurity issues (Box 1).

Box 1: National Biosecurity Committee

The National Biosecurity Committee (NBC) provides advice to the Agriculture Senior Officials' Committee and the Agriculture Ministers' Forum (AGMIN) on national biosecurity and on progress on implementing the Intergovernmental Agreement on Biosecurity (IGAB). The NBC is also responsible for managing a national, strategic approach to biosecurity threats relating to animal and plant diseases and pests, marine pests and aquatics, and the impacts of these on agricultural production, the environment, community well-being and social amenity. A core objective of the committee is to promote cooperation, coordination, consistency and synergies across and between Australian Governments. The NBC is supported by four sectoral committees (Animal Health Committee, Plant Health Committee, Marine Pest Sectoral Committee and the Invasive Plants and Animals Committee) that provide policy, technical and scientific advice on matters affecting their sector. From time to time the NBC forms expert groups and short-term task specific-groups to provide advice and deliver key initiatives.

Local governments provide biosecurity-relevant services, including controls on domestic and feral animals, weeds and wildlife, and are essential participants in emergency responses to pest and disease incursions (Beale *et al.*, 2008). In some jurisdictions, local governments may have a regulatory role to direct landholders to control noxious weeds.

Farmers and industry groups manage biosecurity within their areas of operation, including developing biosecurity plans and adopting measures that reduce biosecurity risk. AHA and PHA are important partnerships between industry and governments that work to achieve biosecurity outcomes through a range of programs and projects (Box 2).

Box 2: Animal Health Australia and Plant Health Australia

Animal Health Australia (AHA) and Plant Health Australia (PHA) are not-for-profit companies that facilitate partnerships between the Commonwealth and state and territory governments and industry. AHA facilitates improvements in Australia's animal health policy and practice in partnership with the livestock industries, governments and other stakeholders; builds capacity to enhance emergency animal disease (EAD) preparedness; ensures that Australia's livestock health systems support productivity, competitive advantages and preferred market access; and contributes to the protection of human health, the environment and recreational activities (AHA, 2017). The purpose of PHA is for government and industry to have a strong biosecurity partnership that minimises pest impacts on Australia, enhances market access and contributes to industry and community sustainability (PHA, 2017a).

Other businesses and individuals participate in the biosecurity system. These include those directly engaged in biosecurity activities, such as those involved in importing goods to Australia, including importers, customs brokers, freight forwarders, managers of facilities under approved arrangements, retailers and others along the supply chain, as well as those in ancillary activities such as travel and shipping (Beale *et al.*, 2008). Other community members and groups, including NGOs, contribute to the biosecurity effort in diverse ways, including through coordinated or individual passive surveillance activities, and general awareness raising efforts.

The research community is another essential part of the biosecurity system and supports Australia's science- and risk-based approach to biosecurity risk management. Biosecurity-relevant research is delivered through a range of funding mechanisms and by multiple providers, including the Commonwealth Scientific and Industrial Research Organisation (CSIRO), universities, the Rural Research and Development Corporations (RDCs) and government agencies. Many organisations that are involved in biosecurity risk management, including AHA, PHA, the Invasive Plants and Animals Committee and Rural RDCs have developed R&I strategies. The NBC has endorsed overarching national biosecurity Research, Development and Extension priorities that are intended to provide a unified, strategic and nationally consistent guide to investment in high priority research activities (DA, 2019a).

The partnership approach across the many participants in the national biosecurity system has underpinned the system for some time and is a core principle of the IGAB. The definition of the partnership approach is articulated in the IGAB and the National Biosecurity Statement (DAWR, 2018c), stressing the cooperative relationships between the Australian and state territory governments with relevant industries, local governments, environmental groups and the broader community. This is underpinned by clear statements of the roles and responsibilities of system participants. In addition, state and territory biosecurity strategies consistently refer to partnerships as a fundamental principle (Box 3).

Box 3: Shared responsibility or the partnership approach to biosecurity

Biosecurity: a shared responsibility – Government, industry and people of NSW working together to protect the economy, environment and community from the negative impacts of animal and plant pests, diseases and weeds for the benefit of all people in NSW.

NSW Biosecurity Strategy 2013-2021 (NSW Department of Primary Industries 2013)

We need to work together to build a resilient system with common goals that deal effectively with the complexity of biosecurity. Our goal is a partnership approach that allows all partners to contribute meaningfully to our governance structure, system design and decision making.

Queensland Biosecurity Strategy 2018-2023 (Queensland Department of Agriculture and Fisheries 2018)

The Strategy is based on the principle of shared responsibility and recognises that land managers, government agencies, industry and the community are jointly responsible for pest and disease management.

Western Australian Biosecurity Strategy 2016-25 (Western Australia Department of Agriculture and Food 2016)

The Tasmanian Biosecurity System recognises that land managers, government agencies and the community are jointly responsible for pest and disease management.

Tasmanian Biosecurity Strategy 2013-17 (Tasmanian Department of Primary Industries, Parks, Water and Environment 2012)

All Territorians share the responsibility to minimise the threat and impact of plant and animal pests and diseases to the Northern Territory's economy, natural environment and community.

Northern Territory Biosecurity Strategy 2016-2026 (Northern Territory Department of Primary Industry and Resources 2016)

Australia's national biosecurity system relies on partnerships between the Australian and state, territory and local governments, industry, environmental bodies, land managers and the broader public.

National Biosecurity Statement (Australian Department of Agriculture and Water Resources 2019)

The Parties recognise that biosecurity is a responsibility shared by all Australians and that cooperation, investment and action with industry and community are essential for a strong national biosecurity system.

Intergovernmental Agreement on Biosecurity 2019 (COAG, 2019)

3.5 Resourcing the national biosecurity system

A diverse range of inputs is required to ensure the effective and efficient operation of the national biosecurity system. In financial terms, the system represents a significant investment by participants with expenditure of $1 billion in 2015-16 (Craik *et al.* 2017). In that year, the Australian, state and territory governments spent approximately $425 million on their biosecurity responsibilities. Industry participants contributed levies on production and fee for service payments of approximately $575 million. Industry, landholders and community groups also make substantial in-kind contributions (Craik *et al.,* 2017).

The most important resource in the biosecurity system is the human resource, encompassing both the number, or capacity, of people who work within the system, and their capability. A diverse range of skills is required to ensure the effective operation of the system. These include veterinary and plant sciences, taxonomy, diagnostics, epidemiology, and entomology. Advanced skills in statistics, data analytics and risk analysis are becoming increasingly important inputs to effective biosecurity risk management. The human resources in the biosecurity system also include government officers who perform leadership, policy, management and operational functions, in offices and in the field. Also critical are the skills of those participants in the system that provide in-kind support such as producers who manage on-farm biosecurity and community groups that undertake and report on passive surveillance activities. Training in skills development across all participants in the biosecurity system is an important activity.

There are also extensive physical resources that support the biosecurity system. These include inspection facilities at major points of entry to Australia – airports, sea ports and international mail centres; diagnostic facilities, including laboratories, equipment and taxonomic collections that support activities at the border and post border; post-entry quarantine facilities to screen high risk materials before they are cleared for entry to Australia; information technology (IT) systems that facilitate the collection, management and analysis of data generated by the biosecurity system; and extensive office facilities that accommodate staff involved in biosecurity activities. While many of these resources are managed and operated by the Australian and state and territory governments, industry also contributes physical resources, including approved premises for quarantine purposes and facilities and IT infrastructure operated by customs brokers and freight forwarders.

3.6 Biosecurity is a complex system

A characteristic of the biosecurity system is the complex interactions that occur between participants at different stages of biosecurity risk management. This reflects the relationships that exist between participants at different levels of the system and the need for a partnership approach to ensure the effective and efficient operation of the system.

The many components of the biosecurity system are interconnected and interdependent and can interact with each other in unpredictable ways such that outcomes of the system cannot necessarily be forecast on the basis of known components. Some interactions are non-linear in nature so that small changes in inputs, for example surveillance effort, can have large impacts on outcomes, such as detection of pests and diseases, and vice versa. There are also multiple feedback loops in the system that may not be readily apparent. These include, for example, that activities at the border to screen goods for biosecurity risk may have a positive impact on the compliance of importers and hence lead to reduced arrivals of biosecurity risk material. The outcomes of risk management interventions may be highly dependent on the context in which they are implemented – the same action may lead to different outcomes in different sets of circumstances.

Adding to the complexity of the system is that the external environment is dynamic and evolving rapidly over time. For example, the growth in new channels for trade such as e-commerce has been swift and has required the implementation of new rules and practices, including the development of new relationships, to manage the changing pathways of biosecurity risks. A further complicating factor is increasing incidents of deliberately non-compliant behaviour by importers, including those who are beneficiaries of the biosecurity system. Designing systems that incentivise compliant behaviour without imposing undue efficiency costs on system participants is an ongoing challenge.

The existence of complexity means that it is difficult to succinctly and clearly define the overall biosecurity system. Developing a framework for evaluating the performance of the system requires an appropriate balance between the detail inherent in the system and the practical requirements of implementing a meaningful evaluation framework. The following draws on the broad outline of the national biosecurity system in the IGAB, as well as the detailed descriptions contained in the RRRA model developed by the department. It describes the key inputs to the biosecurity system, the main activities that are performed and the outcomes that are derived from the operation of the system. Such a description allows the many participants in the system to identify where they 'fit' and how and where they contribute to overall system performance. This can be important in encouraging ownership of performance evaluation processes.

3.7 Activities in the biosecurity system

The Australian biosecurity system consists of sets of activities (Figure 2) that are designed to:

- **anticipate** biosecurity risk;
- **prevent** biosecurity risk material arriving at the border;
- **screen** entry pathways to detect non-compliance;
- **prepare** for an incursion or outbreak of pests and diseases;
- **detect** pest and disease incursions and outbreaks in Australia;
- **respond** to an incursion or outbreak of pests diseases; and
- **recover** from an incursion or outbreak and adapt to new circumstances.

These sets of activities are referred to throughout this report as the components of the biosecurity system. Associated with each of these components is a range of risk management interventions undertaken by various participants in the biosecurity system. These are outlined below.

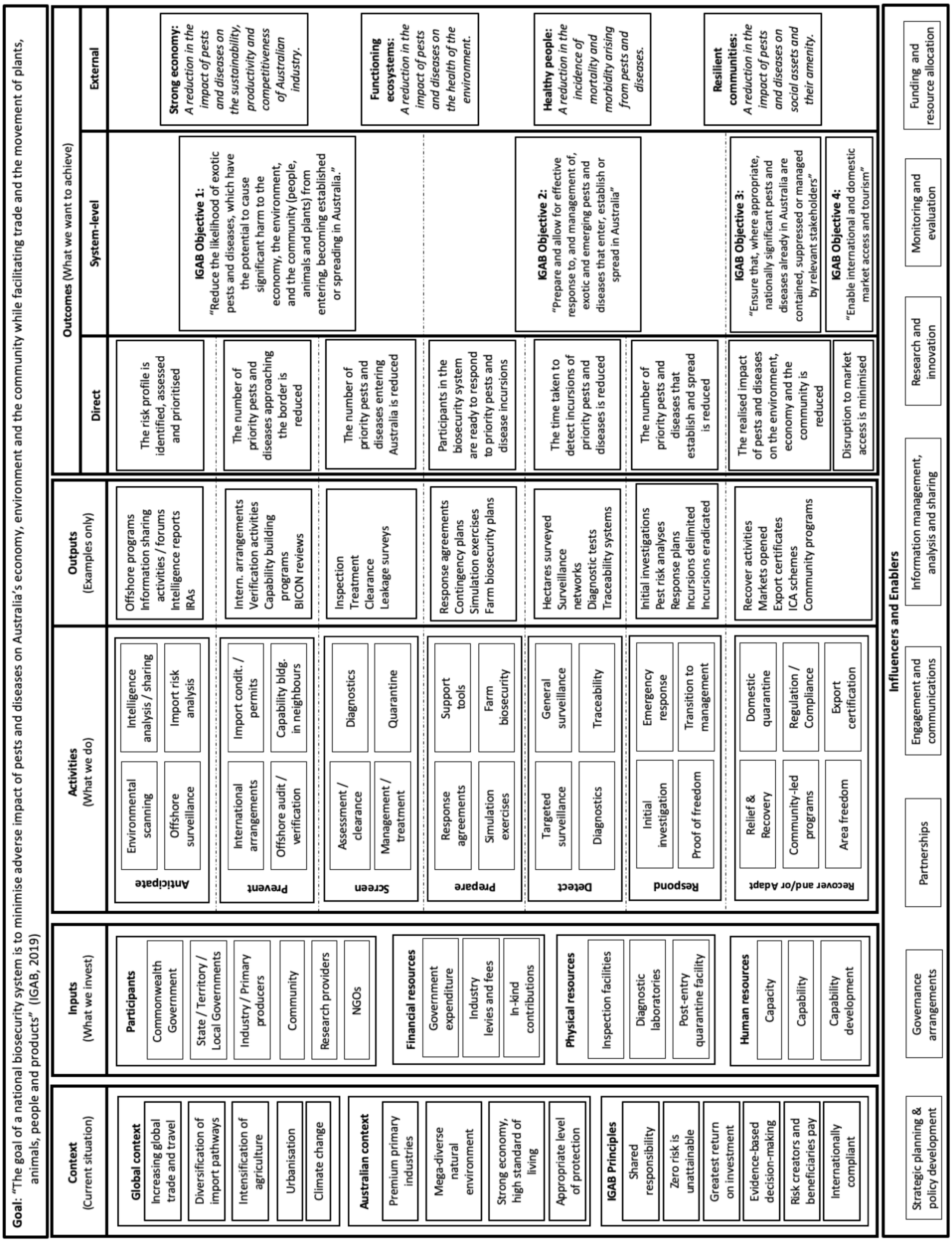


Figure 2: Description of the biosecurity system

3.7.1 Anticipate biosecurity risk

Understanding the context in which Australia's biosecurity system operates, including the offshore environment, is important because it helps us anticipate and identify biosecurity risk. Enhanced anticipation of these risks increases our capacity to prepare for and manage risk in a timely and cost effective manner.

A key activity that contributes to this component of the biosecurity system is environmental scanning that systematically examines the external environment and detects early signs of emerging biosecurity risks. Environmental scanning involves understanding trends in global production, trade and travel and the risks arising from these, including changes in risk pathways for high risk species. It also includes tracking of global pest and disease spread and increasing our understanding of the pest and disease status in neighbouring countries. Its purpose is to identify possible biosecurity risks early and systematically so that the potential threat can be assessed and prioritised against other risks.

The department, with CEBRA, has developed a world class early detection system – the International Biosecurity Intelligence System (IBIS) – that automatically scans the internet for information across the world for early identification of potential biosecurity risks. IBIS is most advanced in its capacity to scan for animal and aquatic disease risks; its use in the plant domain continues to be tested and implemented. IBIS generates reports on a daily basis in some areas of the department that are used for early identification of biosecurity trends and problems. These reports can be used by departmental officers to update their risk information and feed into risk prioritisation assessments. The success of the tool depends on the capacity of departmental staff and systems to convert the information generated by IBIS into actionable intelligence that helps inform risk identification, assessment and prioritisation (Lyon *et al.*, 2013).

The department uses other channels of information to support and complement IBIS. This includes participation in intelligence forums that contribute information and assessments of emerging risks. The Australian Government conducts this type of activity across functional areas to identify changes in the external environment that might lead to changes in risk profiles. One such forum is the Australasian Joint Agencies Scanning Network, which consists of representatives from government agencies and others in Australia and New Zealand that share an environment scanning service, including a database.

The department also derives information from its overseas officer network and the contacts they maintain. The department is represented in 16 countries in Asia, Europe, the Middle East and the United States of America. While the principal focus of overseas officers is to develop and maintain markets for Australia's agricultural exports, they can often be aware of early developments in the pest and disease status of Australia's trading partners and provide information to the relevant risk analysts in Australia. Other inputs to environmental scanning occur through the attendance of departmental officers at conferences, international meetings and similar fora that generate information through formal and informal means. These are not regular or systematic means of generating scanning information and their capacity to generate usable intelligence varies.

The capacity to anticipate biosecurity risk is also enhanced by active surveillance for risks in our near neighbours and trading partners. Understanding the pest and disease status in neighbouring countries contributes to identifying the potential for biosecurity risks to threaten Australia's animal and plant health. The department undertakes regular surveys of animal and plant health in Indonesia, Papua New Guinea and Timor Leste, in cooperation with the authorities in those countries. One objective of these activities is to build the skills required for surveillance in the host country.

These types of activities – environmental scanning, intelligence forums and offshore surveillance – generate considerable volumes of data and information. Ensuring that this translates to robust intelligence that can be used to manage risk effectively requires the capacity to analyse, report and provide timely access to the outputs of these activities to all relevant participants in the biosecurity system. To improve this capacity, the department is developing a Biosecurity Integrated Information System (BIIS) that will provide contemporary technical architecture to enable better data capture, storage, access and sharing, as well as predictive analytics to support improved and more timely decision making. Systematically sharing this information with other participants in the system maximises its value.

Using its understanding of the biosecurity risk context facing Australia, the department prioritises risks and undertakes biosecurity import risk analyses (BIRAs) or non-regulated risk analyses (Box 4). These assist the department to consider the level of biosecurity risk associated with the importation of goods into Australia. If the biosecurity risks exceed the tolerance level defined in the ALOP, then risk management measures are proposed to reduce the risks to an acceptable level. If the risks cannot be reduced to an acceptable level, the goods will not be imported into Australia until suitable measures are identified (DAWR, 2016a). The risk measures proposed in import risk analyses must comply with Australia's international trade and biosecurity obligations and apply Australia's ALOP in a consistent manner. Other forms of risk analysis undertaken by the department include the assessment of risk on particular pathways; originating in particular regions; relating to particular weeds; and associated with importer compliance behaviour.

Box 4: Biosecurity import risk analyses and non-regulated risk analyses

A biosecurity import risk analysis (BIRA) is generally undertaken in response to a new import proposal where risk management measures have not been established or where biosecurity risks could differ significantly from those associated with the import of similar goods. A BIRA is conducted through a regulated process under the *Biosecurity Act 2015* and Biosecurity Regulations. A non-regulated analysis is undertaken where the criteria for a BIRA are not met. It can include reviews of existing policies or import conditions or reviews of biosecurity measures in response to new scientific information.

The intended outcomes from the suite of activities that are designed to anticipate the biosecurity risks facing Australia are that the range and magnitude of risks are identified and understood, can be prioritised, and then analysed according to their priority. This increases the capacity to allocate investment across the biosecurity system more efficiently and to manage risk more effectively.

3.7.2 **Prevent** biosecurity risk material arriving at the border

Preventing pests and diseases from entering Australia is generally considered to be a cost-effective approach to managing biosecurity risk. Along with activities to anticipate risk, the returns on investment in prevention are believed to be higher than at other points on the biosecurity continuum (Biosecurity Victoria, 2009, 2010). The overarching aim of prevention activities is to manage biosecurity risk off-shore in order to prevent threats to Australia's animal and plant health reaching the border.

One of the key activities in this component of the biosecurity system is participation in international organisations, processes and arrangements that seek to guide, manage or underpin Australia's trade. These arrangements fulfil different purposes and Australia's role varies from being a signatory or member of an organisation or agreement to leading and influencing outcomes. These activities can be allocated to three broad categories:

- participation in international forums and processes that underpin trade;
- participation in international standards setting bodies; and
- participation in arrangements that mitigate biosecurity risk offshore, including undertaking offshore treatments of potential biosecurity threats.

Participation in international forums and processes that underpin trade

Australia is an active member of the WTO, which establishes the rules of trade between nations. A key WTO agreement relevant to biosecurity is the Agreement on the Application of Sanitary and Phytosanitary (SPS) Measures. SPS measures include quarantine and biosecurity arrangements designed to protect human, animal and plant life and health, while not inhibiting trade. Each WTO member is entitled to implement biosecurity measures that meets its ALOP. Australia is a signatory to the agreement and the department is responsible for setting and administering Australia's SPS measures. With the Department of Foreign Affairs and Trade (DFAT), it represents Australia's interests at SPS committee meetings.

Australia's participation in the International Laboratory Accreditation Cooperation (ILAC) forum supports biosecurity risk management and international trade by providing cross-border stakeholder confidence and acceptance of accredited laboratory data and inspection results. Australia's national accreditation body, the National Association of Testing Authorities (NATA), has signed the ILAC mutual recognition arrangement (ILAC MRA), covering calibration, testing and inspection. NATA is also a signatory to the Asia Pacific Laboratory Accreditation Cooperation mutual recognition arrangement and a member of the OECD Working Group on Good Laboratory Practice.

Participation in international standards setting bodies

Australia is an active participant in international standards setting bodies, including the World Organisation for Animal Health (OIE), the International Plant Protection Convention (IPPC) and its relevant regional organisations, and Codex Alimentarius. The common goal of these organisations is to develop science based standards, guidelines and codes of practice for the safe trade of animal, plant and food products that are consistent with the WTO's SPS Agreement.

Australia holds leadership positions in each of these organisations and their regional bodies. Through these positions, Australia's representatives work to influence the development of international standards that will minimise the likelihood of biosecurity risk material arriving at the border and that facilitate the capacity of Australia's agricultural industries to export their produce.

Australia is also a member of the International Maritime Organisation (IMO) and has ratified the International Convention for the Control and Management of Ships' Ballast Water and Sediments (the Ballast Water Management Convention). The Convention establishes global regulations to control the international transfer of potentially invasive marine species. The *Biosecurity Act 2015*, as amended, establishes national domestic ballast water requirements that are consistent with the Convention to reduce the risk of spreading marine pests that could establish in Australian seas.

Offshore risk mitigation arrangements

International arrangements, either between governments or between governments and importers, to agree offshore risk mitigation processes and measures are also effective mechanisms for managing biosecurity threats. The Australian Fumigation Accreditation Scheme (AFAS), the International Cargo Cooperative Biosecurity Arrangement (ICCBA) and the Quarantine Regulators' Meeting are examples of these mechanisms (Box 5).

Box 5: International risk mitigation arrangements

The Australian Fumigation Accreditation Scheme (AFAS) is a management system run by participating overseas government agencies to ensure compliance of fumigators with Australia's treatment requirements as well as a registration system for fumigation companies. The Quarantine Regulators' Meeting (QRM) is an annual forum that aims to connect government agencies responsible for, or involved in, biosecurity and border management. Its focus is to support a harmonised approach to biosecurity border management relating to cargo. The International Cargo Cooperative Biosecurity Arrangement (ICCBA) is a voluntary non-binding, multilateral arrangement that encourages international cooperation on the harmonisation and verification of international biosecurity activities and processes.

Import conditions and permits

A further approach to preventing biosecurity risks arriving at the Australian border is the development of import protocols that define the conditions under which material of biosecurity interest can be imported to Australia, and the issuing of permits. Import conditions are generally based on the BIRAs and non-regulated import risk analyses undertaken by the department. In many circumstances, import permits are issued to individual importers that specify the conditions under which a commodity is permitted to be imported. The department regularly reviews and adapts its import conditions according to identified changes in biosecurity risk.

The department develops and maintains the Biosecurity Import Conditions (BICON) system and database that identifies whether a commodity intended for import into Australia is permitted; is subject to import conditions; requires supporting documentation; requires treatment; or needs an import permit. Importers can apply for, track and manage import permits online using the BICON system.

BICON also includes non-commodities, including conveyances and packaging material, where specific import conditions may be imposed to manage biosecurity risk. The department uses BICON as a communications tool, informing industry about Australia's import conditions. BICON is focused on high risk imports and many commodities characterised by negligible or low biosecurity risk are not included in the system. The department is moving away from import permits for low-risk goods in favour of offshore certification for sourcing and treatments. The implementation of import protocols based on risk assessments is supported by the development of extensive technical and operational policies that guide the activities of the department's operational staff.

Audit of offshore risk mitigation processes

The department conducts off-shore audit activities to provide assurance that import conditions are met and that biosecurity risks are mitigated prior to goods or conveyances arriving at the border. This includes reviewing of industry-led offshore processes against specific standards and requirements. This does not amount to pre-clearance of imports but is designed to minimise clearance requirements on arrival in Australia.

An example of this type of activity is the department's audits of the AFAS. Offshore fumigation activities may be subject to facility audits or sample based verification on arrival. Other examples include periodic audits of pre-export quarantine facilities for horses and ornamental fish and of approved treatment facilities for imported plant material. Some audits of offshore processes and facilities are undertaken by the IGB. The department also certifies competent authorities in exporting countries to undertake some pre-export activities. In the case of live animal imports, the government veterinary service in the country of export may certify that the animal complies with the requirements described in the import permit. To support its offshore auditing work the department develops guidelines and training material for those involved.

Capability building in neighbouring countries

An additional measure that reduces the likelihood of biosecurity risk material arriving at the Australian border is work undertaken in neighbouring countries to build their capacity to manage biosecurity risks. There are multiple reasons for undertaking capacity building activities, including the insights they provide into the animal, plant and aquatic health in the region, the building of diagnostic networks, and the fostering of links between biosecurity agencies and experts. A key premise underpinning such work is that enhanced biosecurity risk management in the region will reduce the likelihood of biosecurity risks emerging and establishing in neighbouring countries; will contribute to safeguarding existing trade; and will create opportunities to expand markets.

The department supports a number of projects in Indonesia, Papua New Guinea and Timor-Leste on issues such as strengthening the capacity of government veterinary services, enhancing poultry biosecurity, and establishing surveillance systems that provide early warning of pests and diseases that could potentially enter Australia. Some state and territory governments and other institutions contribute to this area of activity.

Capacity building activities are often coordinated through regional bodies, such as the Association of Southeast Asian Nations or the Asia-Pacific Economic Cooperation (APEC) forum. Some activities are delivered with the assistance of funding from DFAT.

In addition to the activities outlined above, the department undertakes communication and engagement activities with those responsible for potential risk material arriving in Australia, including industry, customs brokers and travellers. This is designed to heighten awareness of biosecurity risks and to minimise the likelihood that risk material will arrive at Australia's borders.

Each of the activities described above share a similar goal, that is to conduct trade in a manner that reduces biosecurity risk by establishing rules for trade and by managing risk offshore to the maximum extent. This contributes to a reduction in the number of pests and diseases approaching Australia's borders.

3.7.3 Screen entry pathways to detect non-compliance

Investments by governments and other participants in the biosecurity system to anticipate and prevent risk material arriving at the border will not be completely effective. This is consistent with the setting of Australia's risk tolerance to a very low level but not to zero. As a result, the screening of travellers, cargo, plants, animals and mail at ports and airports and through mail centres to detect non-compliance with import conditions is an important risk management intervention. The screening of conveyances – vessels and aircraft – is a further activity of the biosecurity system designed to reduce the number of 'hitchhiker' pests entering Australia. These are pests attached to a container carrying goods, the packaging around the goods, or a vessel or aircraft.

Assessment/clearance

The Australian Government, through the department, is largely responsible for activities undertaken at the border. This includes the assessment of, travellers' personal effects, mail, cargo, vessels, live animals and plant material for biosecurity risk. Each year, millions of items are assessed at arrival ports. To better manage the task of protecting Australia from biosecurity risk material, the department adopts a risk-based approach to assessment. As a first step, cargo, travellers, mail and conveyances undergo classification, called profiling, which determines whether further biosecurity management intervention, such as inspection, is necessary. International travellers, for example, are the subject of automated profiling before they physically arrive at Australia's border. Passenger and mail profiling is based on statistical algorithms applied to datasets that are sourced from the Mail and Passenger System (MAPS) (and depending on the pathway, Home Affairs, Airports Coordination Australia or Australia Post). Commercial goods are classified before their arrival according to their tariff code as well as characteristics such as country of origin, supplier and importer.

Many imported goods are not of biosecurity concern. For those that are, clearance without inspection, using declarations and information provided by the importer, is common. Goods may be released from biosecurity control or directed for further assessment. This could include inspection, diagnostic testing and, where a biosecurity concern is identified, management such as treatment, export or destruction. Some goods are directed straight to treatment because of their import conditions, and some pathways require mandatory sampling and testing. The objective of assessment/clearance is to correctly direct travellers, mail, cargo and conveyances to the appropriate channel – release, inspection, diagnostics or management/treatment – so that non-compliance is detected and managed.

To reduce the burden of intervention on some pathways, the department has introduced risk-based inspection regimes that are based on sound science and statistics and targeted at highest priority risks. These include the compliance-based inspection scheme (CBIS) and the Maritime Arrivals Reporting System (MARS) for commercial vessels arriving in Australia. Both schemes reward compliance with Australia's biosecurity requirements with a reduced rate of physical inspection.

The department conducts random end-point surveys on some import pathways, including international travellers and mail, to determine leakage rates – the amount or rate of biosecurity risk material that is not intercepted at the border. The Cargo Compliance Verification Scheme (CCVS) performs the same function for commercial containerised sea cargo. Under this scheme some goods that would not typically be directed for inspection ('not-referred') are randomly selected for inspection, although at a very low rate. As a second point of verification, the CCVS randomly selects and inspects referred goods that were released on documentation (Figure 3). The CCVS can help determine whether risk profiling of incoming cargo results in goods being directed to the appropriate management channel.

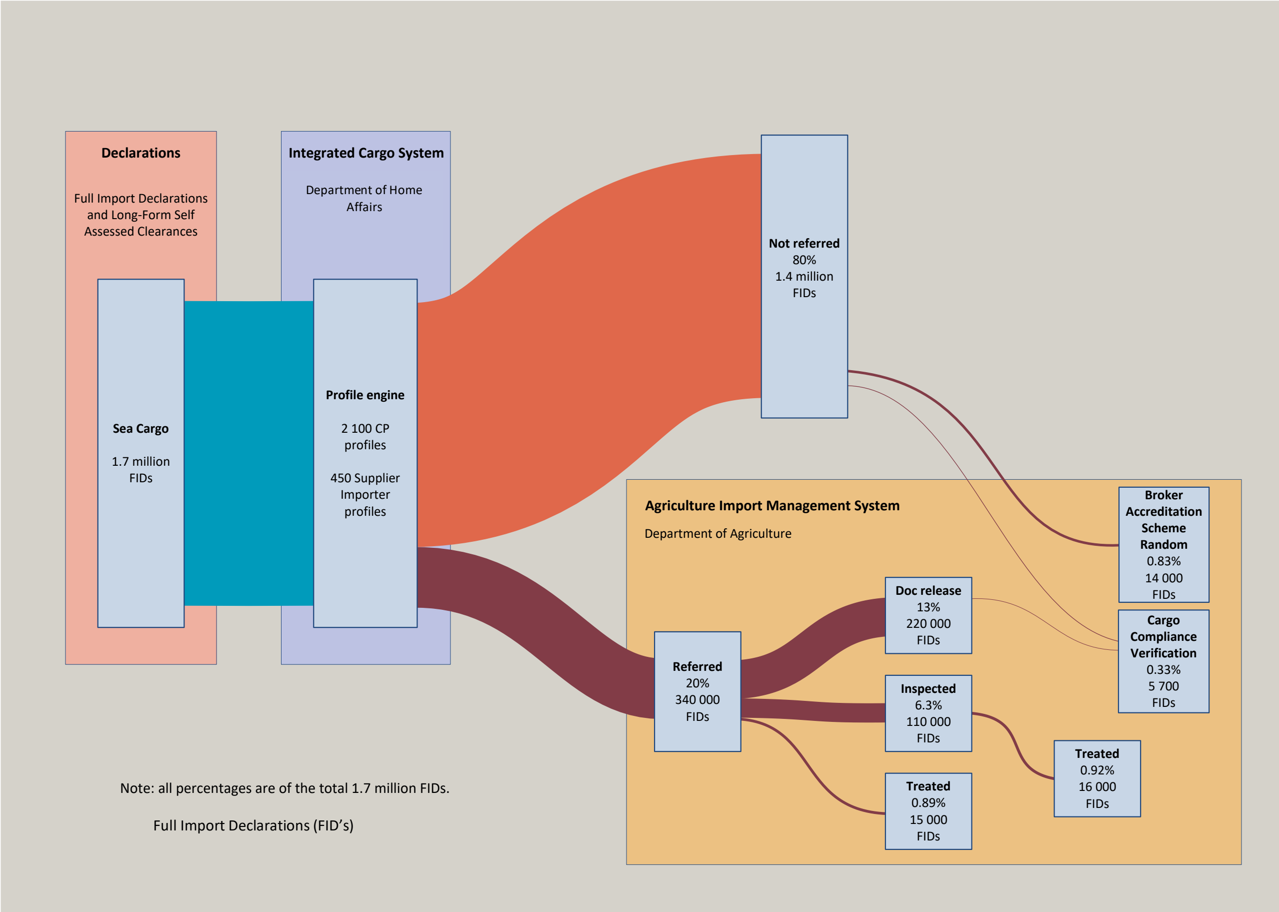


Figure 3: Cargo compliance verification

The department invests in maintenance of border infrastructure and trained staff that support assessment and clearance of travellers' personal effects, mail, cargo and conveyances at the border.

To manage disease vectors at the border the department conducts monitoring and surveillance within the biosecurity zone at all Australian international air and seaports, on behalf of the Department of Health. Activities to manage exotic mosquitoes, for example, include disinsection of international aircraft and vessels and the deployment and monitoring of surveillance traps at airports and seaports.

Diagnostics

Diagnostic testing is used to determine whether biosecurity risk material is present in submitted material. Its objective is to correctly identify samples and specimens in a timely manner to support management decisions. Biological specimens are identified to a certain taxonomic level and samples are subjected to analytical testing. The results of diagnostic analysis are reported back to border operations staff to support further management decisions. Based on diagnostic results, border staff may release goods to their intended recipients or, if a biosecurity risk is identified, direct them for further management or treatment.

The effectiveness of diagnostics facilities depends on the quality of analytical equipment, the adherence of diagnostic protocols and methods to specific standards, the competency of diagnosticians and the capacity of inspection staff to refer the right material. To maintain high quality services, investment in workforce training and review and improvement of diagnostic protocols and methods is required. The department runs pest awareness training events to ensure the appropriate number and quality of submissions to diagnostic facilities by border inspection staff. Too high a referral rate can result in a low proportion of positive tests, indicating a risk averse approach to testing, which contributes to reduced efficiency of the diagnostics system.

Management/Treatment

Following document assessment or diagnostic analysis, some goods or conveyances are directed to management or treatment to reduce detected biosecurity risk to an acceptable level. Import conditions specify mandatory treatments for some high risk pathways or commodities such as cut flowers. Where this information is not available, the department's biosecurity risk treatment guide provides direction for appropriate treatment. Treatments include cleaning, disinfection, and fumigation. If goods cannot be treated effectively, they must be otherwise managed to reduce the biosecurity risk to an acceptable level. In these cases, goods will be exported or destroyed. They may need to be isolated or contained before they can be exported.

Management at the border also involves measures for non-commodity risks, including hitchhiker pests. These risks are not specific to the imported goods but are facilitated through the movement of goods, people and conveyances.

Quarantine and approved arrangements

Live animals, fertile eggs and viable plant material are of high biosecurity risk to Australia. Import conditions require them to be quarantined in a post arrival quarantine facility, for specified periods of time. While in quarantine, animals, fertile eggs and plants are observed and tested to ensure they do not present a biosecurity risk on release. All Australian Government-operated post entry quarantine operations are undertaken in one facility at Mickleham, Victoria.

Legal entities, usually businesses, and people can apply voluntarily to operate an 'approved arrangement'. Approved arrangements permit authorised entities to perform specific activities with goods under biosecurity control without the supervision of biosecurity officers. This means that biosecurity industry participants covered by the approved arrangement can use their own premises, facilities, equipment and people to store, handle and/or treat goods. Each approved arrangement site is subject to periodic risk-based auditing.

The *Biosecurity Act 2015* provides for the approval, suspension or revocation of approved arrangements. When serious non-compliance with the operation of approved arrangements is detected, the department may consider the suspension or revocation of an arrangement. However, biosecurity industry participants have the opportunity to respond to adverse audit outcomes. If they fail to provide satisfactory responses, the department can suspend or revoke an arrangement, or part of it. Civil and criminal options are also available in the case of serious non-compliance.

The intended outcome of screen activities at the border is a reduction in the number of exotic pests and diseases that enter Australia. Post-arrival verification activities such as end-point surveys are designed to estimate the success of these intervention strategies.

Collectively, the activities undertaken to anticipate biosecurity risk, prevent risk material arriving at the Australian border and to screen travellers' personal effects, mail, cargo, plants and animals to ensure they comply with import conditions contribute to meeting the first objective of the IGAB, that is, to 'reduce the likelihood of exotic pests and diseases, which have the potential to cause significant harm to the economy, the environment and the community (people, animal and plants), from entering, becoming established and spreading in Australia'.

3.7.4 Prepare for an incursion or outbreak of pests and diseases

Given Australia's risk tolerance, it is not expected that pre-border and border activities will successfully intercept all threats to Australia's plant and animal health from exotic pests and diseases – some biosecurity risk material will inevitably cross the border. In February 2020, 18 outbreaks of pests and diseases were being managed across the country (www.outbreak.gov.au; 18 February 2020). An important part of post-border biosecurity is to ensure that Australia is well prepared to respond to incursions or outbreaks of unwanted pests and diseases. Similar to pre-border and border activities, the economic returns on investment in prepare activities are considered to be high because participants invest prior to the emergence of an incursion or outbreak (Biosecurity Victoria 2009, 2010). They underpin the effectiveness of other post-border activities (detection of incursions, response actions and activities to recover and/or adapt to the impacts of pests and diseases). They also have an impact on many of the capabilities that are necessary in a well-functioning biosecurity system.

While pre-border and border activities are largely the responsibility of the Commonwealth, post-border biosecurity activities are based on a partnerships approach, involving the Commonwealth, state and territory governments, industry, NGOs, producers and the general community. Coordination and collaboration between these participants, including effective information sharing, is fundamental to a healthy biosecurity system.

Prepare activities are broad in nature and can encompass both the establishment of infrastructure and tools to support preparedness and the implementation of these tools. For example, the establishment of the National Livestock Identification System (NLIS) could be considered a 'prepare' activity because it provides the infrastructure to trace animals in the case of an emergency disease. Similarly, the development of animal and plant laboratory and diagnostic services underpins the capacity to respond to a pest or disease incursion; and the establishment of a domestic quarantine system supports both respond and recover activities. In order to avoid duplication a decision has been made in this project to evaluate these three significant activities at the point of their implementation rather than as prepare activities.

Response agreements and plans

A major set of activities that helps participants in the biosecurity system prepare for an incursion or outbreak of a potentially harmful pest or disease is the development and maintenance of emergency response deeds and related agreements and contingency plans. These define the nationally agreed approach that will be taken in a response so that participants are able to respond quickly and effectively when one occurs. It is primarily the responsibility of states and territories to implement and coordinate response activities.

AHA is custodian of the Emergency Animal Disease Response Agreement (EADRA) and the Australian Veterinary Emergency Plan (AUSVETPLAN). The EADRA is a contractual agreement between the Commonwealth, state and territory governments and livestock industry groups to increase Australia's capacity to prepare collaboratively for and respond to Emergency Animal Disease (EAD) incursions or outbreaks. In particular, it defines how to manage the costs and responsibility for an emergency response to an animal disease outbreak. The EADRA is reviewed every five years. For each EAD listed in EADRA, there is an agreed initial approach to responding to an outbreak set out in AUSVETPLAN. This plan consists of a series of technical manuals and supporting documents that describe the proposed approach to an EAD incident, including roles, responsibilities and policy guidelines for agencies and organisations involved in the response (PIMC, 2008; AHA, 2018a). It includes detailed information on recommended quarantine and movement controls (AHA, 2018b).

The equivalent arrangements for emergency plant pest (EPP) incidents are the Emergency Plant Pest Response Deed (EPPRD) and Australian Emergency Plant Pest Response Plan (PLANTPLAN), both of which are managed by PHA (PHA, 2017a, 2020).

The Australian Aquatic Veterinary Emergency Plan (AQUAVETPLAN) and the Emergency Marine Pest Plan (EMPPLAN) set out the preferred approach to diseases that affect aquatic and marine animals, respectively. The department manages the development and maintenance of both plans. AQUAVETPLAN is a series of manuals that details Australia's approach to national disease preparedness and contains technical response and control strategies. EMPPLAN is a series of rapid response manuals for different marine pests and is adapted from both AUSVETPLAN and AQUAVETPLAN.

While the EADRA and EPPRD are primarily concerned with exotic pests and diseases, both have a subclause that allows endemic pests and diseases to be considered as an EAD or EPP and therefore be subjected to a response under AUSVETPLAN or PLANTPLAN. AQUAVETPLAN closely follows the format of AUSVETPLAN. EMPPLAN also considers methods for containment, control and/or eradication of established populations of marine pests. Endemic species that do not fall under the emergency response plans (ERP) are managed through other mechanisms, for example, the Draft National Fruit Fly Strategy.

The National Environmental Biosecurity Response Agreement (NEBRA) sets out emergency response arrangements, including cost sharing arrangements, for responses to nationally significant biosecurity incidents that primarily affect the environment and/or social amenity and where the response is for the public good. It is an agreement between the Commonwealth and all states and territories, delivered under the IGAB. The department is the custodian of the agreement. A NEBRA response is only implemented if the emergency response cannot proceed under pre-existing cost-sharing arrangements, such as the EADRA and EPPRD. Since 2012, the NEBRA has managed a number of nationally cost-shared eradication responses, including programs for red imported fire ant, browsing ant and Macao paper wasp incursions. The agreement was reviewed five years after its inception (KPMG, 2017).

Sitting underneath these overarching deeds and agreements are various strategic documents and plans that contribute to preparedness for pest and disease incursions. For example, at the national level, plant biosecurity is guided by the National Plant Biosecurity Strategy, developed in 2010 through PHA. It is supplemented by sub-strategies, including the National Plant Biosecurity Diagnostic Strategy (2012) and the National Plant Biosecurity Surveillance Strategy (2013). Another important strategic document is the Australian Weeds Strategy 2017-2027 that provides a national framework for addressing weed issues. Key strategies in the animal biosecurity sector developed through AHA are the Australian Pest Animal Strategy 2017-2027, the National Animal Health Surveillance and Diagnostics Business Plan 2016-2019, and the National Animal Biosecurity Research, Development and Extension Strategy 2017-2022. The environment and human communities are covered by the National Environment and Community Biosecurity Research, Development and Extension Strategy 2016-2019.

The NAQS (1989) is a Commonwealth government policy that spans plant and animal biosecurity. In addition, states and territories have their own biosecurity strategies that cover terrestrial, aquatic, marine and environmental pests and diseases, as well as weeds and pest animals.

Biosecurity plans exist at national, industry, regional and farm levels. AHA and PHA facilitate the development of sector-specific biosecurity plans. For example, the *Aquaculture farm biosecurity plan: generic guidelines and template* has formed the basis for developing biosecurity plans for the abalone and oyster industries.

Plant industry-specific biosecurity plans provide guidelines for risk assessments, which underpin the development of threat summary tables for the industry. These plans identify existing contingency arrangements and outline possible risk mitigation activities for industry and growers. Each PHA industry member is covered by a biosecurity plan that is funded by industry bodies, their relevant RDC and the Australian Government (PHA, 2018a). PHA also develops contingency plans for individual high priority pests, for example the brown marmorated stink bug. These pest-specific contingency plans assist responders with development and implementation of response plans should an incursion or outbreak occur.

Environment-specific biosecurity plans describe a national approach for dealing with pests and diseases that threaten Australia's biodiversity and social and economic wellbeing. The National Invasive Ant Biosecurity Plan 2018-2028, drafted by the Australian Government Department of the Environment and Energy, is one example.

In a different preparedness context, Australia is a member of the International Animal Health Emergency Reserve (IAHER) agreement with Canada, Ireland, New Zealand, the United Kingdom and the United States. The purpose of the agreement is to share personnel and resources in an EAD outbreak and support the effectiveness of a response.

Training and simulation exercises

Training activities help participants in the biosecurity system build their capability and readiness to respond to an incursion or outbreak of an exotic pest or disease. They support government and industry representatives, growers, private veterinary practitioners and other stakeholders to fulfill their responsibilities under the EADRA and the EPPRD. Training exercises are strengthened when they include assessment of participants against defined competencies for defined roles.

AHA and PHA deliver national EAD and plant pest training programs in different formats: online modules, face-to-face sessions and large-scale functional simulation exercises. Jurisdictions also conduct their own targeted training and simulation exercises and, in conjunction with stakeholders, produce technical support material for diagnosticians. The Australian Handbook for the Identification of Fruit Flies is an example. Diagnostic networks offer members training to address identified gaps in skills or capacity.

Formal qualifications in biosecurity emergency response are also available nationally as part of the Public Safety Training Package. These align with the emergency response training delivered by jurisdictions and puts biosecurity response personnel on the same footing as those in other emergency response areas, such as police and firefighters. Graduate and post-graduate studies in biosecurity are also offered by a number of universities across the country.

Emergency response simulation exercises test the capacity of the biosecurity system to respond to an incursion or outbreak. Exercise Odysseus, for example, was a series of more than 40 simulated field activities and discussions in each Australian state and territory held throughout 2014 and 2015. It was designed to focus on the first week of a hypothetical outbreak of foot-and-mouth disease (FMD) initially detected in Queensland (DAWR, 2015a). In 2017, exercises Icarus and Synergy focused on a hypothetical outbreak of highly pathogenic avian influenza. In the plant domain, exercise Decini 2017-18, dealt with a hypothetical exotic fruit fly incursion in production areas (PHA, 2017b) and exercise Bee Prepared aimed to prepare government and industry for a Varroa mite incursion (PHA, 2018a). In 2018, exercise Border Bridge simulated detection of Lumpy Skin Disease and Giant African Snail to test the cross jurisdictional response capacity of New South Wales and Queensland to two different and concurrent biosecurity emergencies (Cleary & Lavin, 2018).

Farm biosecurity

Good biosecurity practices at the farm level can be a powerful means of reducing the risk that an exotic pest or disease present in Australia can establish and spread. While farm biosecurity is the responsibility of land owners and managers, training and education programs are important for raising awareness and disseminating information about good biosecurity practices. The Farm Biosecurity Program is a joint initiative of AHA and PHA that provides information and on-line resources on a range of farm-level biosecurity issues. The program increases land owners' preparedness and also acts as an early detection surveillance system for EADs and EPPs. Producers are encouraged to have a formal biosecurity management plan to guide day-to-day farm practices and emergency responses. AHA and PHA undertake regular national producer surveys to track trends in attitudes to farm biosecurity and producer awareness of the program. Industry supports farm biosecurity by funding or co-funding initiatives such as the Grains Farm Biosecurity Program, the Livestock Biosecurity Network and Hort Innovation activities, all of which complement the Farm Biosecurity Program. While risk mitigation activities such as these provide protection from the impacts of pests and diseases at the farm level, they also have flow-on effects that support regional economies and market access.

Support tools

A range of activities is undertaken to provide the tools that support participants in the biosecurity system to be better prepared for incursions of pests and diseases. These encompass information gathering and sharing activities, communications initiatives, and other measures that support response actions in an emergency.

To support exchange of information among biosecurity participants, efforts have been made to develop, maintain and harmonise cost-effective systems and tools for collecting, storing, analysing and sharing data from different sources in relation to detection, response or long-term management. This includes pest databases, resource tracking systems and surveillance reporting tools. AUSPest Check is a national system managed by PHA to collect, analyse and display plant pest surveillance data. It uses data from both general and targeted surveillance and provides system users with real-time representations of pest numbers and spread. In 2017, it successfully mapped an outbreak of Russian wheat aphid (PHA, 2017b). In animal health, the National Animal Health Information System (NAHIS) is a national database managed by AHA that collates validated data from a range of government and non-government surveillance programs to support trade and meet international reporting obligations (DAWR, 2016b).

Biosecurity management agencies in all jurisdictions except New South Wales use MAX, a biosecurity case management platform developed by the Victorian Department of Economic Development, Jobs, Transport and Resources that can be used in emergency situations as well as for routine biosecurity operations. It can, for example, record plant and animal health surveillance data, trace information, phone enquiries, property status, visits and treatments. MAX has been used in responses to biosecurity incidents in Victoria, including giant pine scale, chestnut blight and anthrax. In Western Australia the system has been successfully tested for an FMD response and in South Australia it has been used for fruit fly trapping and Khapra beetle surveillance (DAWR, 2017a). New South Wales is developing a separate information management platform called BYTE that has integrated functions such as auditing and export certification (NSW DPI, 2017).

Awareness building and education of stakeholders is another important aspect of emergency preparedness. State and territory governments put considerable resources into communication to increase awareness of regulatory and technical requirements at the commercial, community and farm level (PHA, 2018a). This includes disseminating public information to raise awareness of biosecurity threats and managing education campaigns.

The Biosecurity Incident National Communication Network is involved in awareness building activities for issues that warrant a national approach to communication. The National Biosecurity Communication and Engagement Network (NBCEN) communicates preparedness activities for biosecurity incidents, including training exercises and maintenance of communication tools, guidelines and resources.

The National Biosecurity Response Team (NBRT) is a group of almost seventy government response personnel from all jurisdictions with expertise in emergency management. Funded by governments, the NBRT works across sectors and responds to animal, plant, aquatic animal and environmental biosecurity incidents. NBRT members can take up opportunities to participate in professional development activities and exercises relevant to their nominated function in the NBRT. The management and administration of the group is shared among the department, AHA, PHA and state/territory biosecurity agencies.

Also supporting preparedness for incursions are national scale modeling efforts that can capture complex disease epidemiology, regional variability in transmission, and different jurisdictional approaches to pest and disease control. The Australian Animal Disease Spread (AADIS) model has fulfilled this role since its development in 2015. Jurisdictional personnel were trained in the use of AADIS in 2017 to enable model outputs to inform biosecurity risk assessment and response planning activities. CEBRA is currently expanding AADIS to model the incursion and spread of National Priority Plant Pests.

Other preparedness tools include the funding of vaccine banks for FMD and anthrax (AHA, 2018a) that ensure immediate access to a stock of vaccines in the event of an emergency outbreak. In addition, the capacity of the Australian Pesticides and Veterinary Medicines Authority to issue emergency use permits for chemical products during an emergency supports primary producers' response options.

The intended outcome of activities that increase preparedness for an emergency pest or disease incursion or outbreak is that participants in the biosecurity system are ready to respond to incidents, with the appropriate arrangements, tools and training to maximise the effectiveness of the response action. In this way, the potential harm from detected pests and diseases is minimised.

3.7.5 Detect pest and disease incursions or outbreaks in Australia

Early detection of an incursion or outbreak can significantly improve the outcomes of subsequent activities in the biosecurity system, particularly response actions. The potential for early detection is strongly influenced by prepare activities as appropriate policy, capacity and capability need to be in place to enable the detection of unwanted pests and diseases. Early detection is also supported by the sharing of border interception data with the appropriate biosecurity agencies. This can be used to underpin efficient pathway risk analysis, and the identification and targeting of new post-border surveillance targets.

Targeted and general surveillance

Targeted (or active) and general (or passive) surveillance programs for timely detection of pests and diseases are important components of the biosecurity system. Effective surveillance requires cooperative partnerships between the Australian and state and territory governments, industry, producers and the community. State and territory governments run many surveillance programs that are expected to achieve national and state-specific surveillance targets. By underpinning Australia's claims to pest and disease freedom, surveillance activities facilitate access to international markets, as well as supporting the ongoing management of established pests and diseases. The department is responsible for reporting particular surveillance outcomes to the OIE and the IPPC.

Animal disease surveillance activities

In 2016, the Animal Health Committee endorsed the National Animal Health Surveillance and Diagnostics Business Plan 2016-2019 (DAWR, 2016b), developed collaboratively by the Australian, state and territory governments and livestock industries. Under this business plan, AHA coordinates several targeted and general national surveillance programs (Table 2).

Table 2: Targeted and general national surveillance programs managed by Animal Health Australia

Targeted/active surveillance	General/passive surveillance
National Arbovirus Monitoring Program	Surveillance activities for eradicated diseases
National Transmissible Spongiform Encephalopathies Freedom Assurance Program	Surveillance activities for new and emerging diseases
Screw-worm Fly Surveillance and Preparedness Program	National Sheep Health Monitoring Program
	National Significant Disease Investigation Program (by private veterinary practitioners)

Source: AHA, 2018a

Other national programs use targeted and general surveillance activities to provide early detection of diseases. Wildlife Health Australia (WHA), for example, manages the National Avian Influenza in Wild Birds Surveillance Program that has targeted and general surveillance components. Further WHA surveillance programs focus on bat diseases, Tasmanian devil facial tumour disease and other diseases of wildlife.

Because of its proximity to neighbouring countries, the department undertakes targeted surveillance activities in northern Australia, funded through the NAQS. Surveillance under this strategy concentrates on targeted animal diseases in coastal areas of northern Australia from Broome to Cairns.

At the state and territory level, animal disease surveillance activities are undertaken by jurisdictional veterinary authorities, private practitioners, industries and non-government organisations under a range of partnership agreements. Collectively, state and territory governments invest in more than 100 field veterinarians with district surveillance responsibilities, supported by seven government veterinary laboratories, veterinary pathology staff, abattoir veterinarians and inspectors and stock inspectors (Craik *et al.*, 2017).

Plant pest surveillance activities

Plant pest surveillance activities are, similarly, undertaken on a collaborative basis between the Australian, state and territory governments, industry and the community. Current surveillance activities are outlined in the National Plant Biosecurity Surveillance Strategy 2013-2020 (PHA, 2013). They include the National Plant Health Surveillance Program (NPHSP) coordinated by the department. The objective of the NPHSP is to develop and implement a nationally consistent, multi-jurisdictional approach to plant pest surveillance that incorporates pest surveillance activities in the vicinity of ports, as well as in urban areas that have a relatively high risk of pest presence based on pathway and host considerations. Its three main components are ports of entry trapping, multiple pest surveillance and surveillance information management (PHA, 2013).

The department currently coordinates the following targeted post-border surveillance programs for plant pests and diseases (PHA, 2018a):

- NAQS pest and disease surveys (targeting 157 high priority exotic pests);
- National Bee Pest Surveillance Program; and
- NAQS exotic fruit fly trapping.

Two further national surveillance programs are being developed by PHA in consultation with industry. The National Citrus Biosecurity Surveillance Strategy 2018-28 and the National Forest Biosecurity Surveillance Strategy 2018-23 aim to provide a framework for surveillance of national priority pests that pose a threat to these industries.

Surveillance in jurisdictions targets exotic pests and diseases but also includes extensive general surveillance activities. Community volunteers and industry are a vital part of the effort to detect pests and diseases early. Biosecurity officers recruit volunteers who check for exotic pests in their paddocks, silos and during field trials, while community based weed spotters are active in many states and report new weed detections in their areas (PHA, 2018a). Citizen science initiatives are another, highly effective, way to involve the community. The ‘2017 Pantry Blitz’ biosecurity surveillance campaign in Western Australia distributed free Khapra beetle attracting traps to participants in the community and received important presence and absence information from across the state.

By membership of two botanic gardens, Australia is involved in the International Plant Sentinel Network, a global surveillance initiative and network where members maintain plant species outside their natural range and monitor them for damage by pests and diseases that are not currently in their country of origin. Information from member countries can be used to provide an early warning system for new and emerging plant pests and diseases.

Diagnostics

Early detection of incursions or outbreaks of pests and diseases relies on having sound diagnostic capacity and capability to support cost-effective identification of pests and diseases. Diagnostic services underpin the identification of exotic, emerging and nationally significant endemic pests and diseases; assist in assessing the magnitude of an incursion or outbreak, which helps determine whether a pest or disease is eradicable; and provide evidence to support any claim that a pest or disease has been eradicated. They provide the necessary information to support pest and disease control programs and reporting requirements (Craik *et al.*, 2017).

Australia's animal disease diagnostic capacity is well developed. Facilities include the CSIRO-managed Australian Animal Health Laboratory (AAHL), state and territory government veterinary laboratories and university and private veterinary laboratories. AAHL provides diagnostic testing services for a number of national surveillance programs and includes a state-of-the-art high throughput testing laboratory, the Diagnostic Emergency Response Laboratory, which can switch its operations from routine to outbreak mode. AAHL is also the nominated national reference laboratory for priority animal diseases. In this capacity it is responsible for maintaining competence in identification/diagnosis and for the transfer of tests and technologies to state laboratories.

Institutional arrangements support the effective operation of the national animal diagnostic laboratory system. For example, the Laboratories for Emergency Animal Disease Diagnosis and Response (LEADDR) network plays an important role in ensuring quality assurance for targeted EADs through standardising or harmonising the relevant testing performance in all member laboratories. All government laboratories and the major private laboratories in Australia are accredited NATA for testing of various EAD. The Australian National Quality Assurance Program (ANQAP) provides proficiency testing for veterinary tests associated with disease control programs, quarantine and export health certification.

Plant pest diagnostic facilities are distributed across all states and territories, including in major agricultural and horticultural regions. Diagnostic services are delivered by a range of agencies, including the Australian Government, state and territory governments, the CSIRO, and third-party contractors, including private laboratories, universities, herbaria and museums. Services are provided on an ad hoc, commercial or nationally coordinated basis. Diagnostic operations are often performed as part of collaborative research activities that focus on specific pests of concern (PHA, 2017a).

The Subcommittee on Plant Health Diagnostics was established in 2004 by the Plant Health Committee to improve the quality and reliability of plant diagnostics in Australia. Its role includes to develop diagnostic policies, protocols and standards; develop strategies to address national capability and capacity issues; endorse national diagnostic protocols; and drive the development and uptake of accreditation and quality management systems for diagnostic laboratories. Unlike the animal system, not all plant diagnostic laboratories are accredited by NATA to the appropriate international standard. Not all priority plant pests are covered by nationally agreed diagnostic testing protocols.

The plant pest diagnostic system is underpinned by the National Plant Biosecurity Diagnostic Strategy (PHA, 2012) and a national network of diagnosticians, the National Plant Biosecurity Diagnostic Network (NPBDN). The latter supports the diagnosis of plant pests by facilitating communication between experts and sharing of diagnostic resources. Together, these initiatives are designed to build an integrated national network that can deliver services that adhere to agreed national diagnostic standards, including the provision of surge capacity during incursions or outbreaks (PHA, 2018a).

Traceability

Not all pest and disease incursions or outbreaks are initially identified at source. A diseased animal, for example, might have been moved from its property before identification occurs at a sale yard or abattoir, or an infected plant might have been sold from an importer to a retail chain before detection occurs. The capacity to trace back to the source of an incursion or outbreak is an important part of the detection component of the biosecurity system. Tracing forward from the source to identify the spread of a pest or disease is a critical part of initial investigations after notification of a detection. An essential prerequisite of an effective traceability system is a comprehensive property identification scheme.

Animal traceability systems in Australia are well developed under the NLIS. The NLIS was developed to meet the National Livestock Traceability Performance Standards (NLTPS), endorsed in 2004 by the former Primary Industries Ministerial Council (PIMC). The NLTPS outline the requirements and timeframes for livestock to be traced quickly and reliably if needed (ABARES, 2014). AHA undertakes regular audits of the NLTPS to allow continual improvement of the various programs under the NLIS.

Under the NLIS all cattle, goat, pig and sheep producers must identify their stock and record their movements onto and off properties in the NLIS database. All movements to and from sale yards and abattoirs must also be recorded. When fully implemented for a type of livestock, NLIS is a permanent, whole-of-life system that allows animals to be identified – individually or by mob – and tracked from property of birth to slaughter, for the purposes of food safety, product integrity and market access (AHA, 2018a). State and territory governments are responsible for the legislation governing animal movements, the implementation of NLIS and monitoring and enforcement of its requirements throughout the livestock supply chain. NLIS Limited administers the NLIS database on behalf of industry and government stakeholders (AHA, 2017). The information stored in the NLIS database can be used by other systems to support animal disease response planning. NSW, for example, has developed Live Trace, a software application that rapidly traces and maps movements of cattle, sheep and goats by using information from the NLIS database.

Tracing the source of a plant pest incursion or outbreak is a more ad-hoc process than in the animal system, partly because plant pests move independently of their hosts. Hence there is no feasible equivalent of the NLIS and tracing activities are conducted on a case-by-case basis. For example, following detections, ongoing tracing is being undertaken for Khapra beetle and chestnut blight. The capacity to implement a successful tracing exercise relies on sound relationships between participants in the biosecurity system, the willingness of all participants to contribute to the tracing effort and effective communication.

Sharing of information is an important part of collaboration and coordination between participants in the national biosecurity system. Tracking and tracing of pests and diseases to the source of an incursion or outbreak can assist in profiling risk pre-border and at the border. Knowing how and where a pest or disease crossed the border can help in setting the appropriate import conditions as well as in evaluating and adapting management actions.

The intended outcome of detect activities is that the time taken to detect incursions or outbreaks of priority pests and diseases is reduced. This contributes to minimising the costs of response actions and to maximising the effectiveness of eradication or containment efforts.

3.7.6 Respond to an incursion or outbreak of pests and diseases

Following the detection of an exotic pest or disease, response actions are implemented collaboratively between governments, industry and other stakeholders. A strong, rapid and well-coordinated response to an exotic or endemic pest or disease can reduce or contain harmful impacts on the economy, the environment and the community and limit the need for recovery and adaptation activities. Time is an important factor in this context but its impact on the success of an emergency response depends on the spread characteristics of the pest or disease.

Following the detection of a pest or disease, response actions are implemented collaboratively between governments, industry and other stakeholders. Broad response actions are outlined in the response agreements and contingency plans discussed above – EADRA and AUSVETPLAN; EPPRD and PLANTPLAN; and EMPPLAN and AQUAVETPLAN, and NEBRA. These are supported by detailed industry specific or pest/disease specific response plans. The agreements and plans are designed to ensure rapid and effective responses to detections and to provide certainty regarding the management and funding of the response.

Coordination of response activities is enhanced by the use of established management groups and consultative committees. The National Management Group (NMG) is responsible for making the key decisions in a response to an emergency pest or disease incursion. It is formed in response to a detection and comprises representatives from the Australian and state and territory governments, AHA/PHA, and affected industries. The NMG is responsible for approving a response plan, including the budget and resources, if it is agreed that eradication is technically feasible and cost beneficial. The NMG is advised on technical matters by the relevant Consultative Committee (CC). Both bodies can at any stage during an incident request a formal cost-benefit analysis about the impacts on the economy, the environment and the community of a pest or disease establishing (PHA, 2017a).

The CC comprises the Australian Chief Plant Protection Officer/Chief Veterinary Officer, their state and territory counterparts, AHA/PHA, and industry representatives. It assesses the grounds for eradication and provides technical advice on which the NMG can base decisions. Operational responsibility for the response to an emergency incursion lies with the relevant state or territory – jurisdictions deploy staff to response activities. However, when a detected pest or disease is exotic to Australia or found in more than one state or territory, the department coordinates the national response. It also assists jurisdictions with access to NBRT members for interstate deployment.

The Biosecurity Incident Management System (BIMS) guides biosecurity incident responses and initial recovery operations. Its structure is based on the Australasian Inter-service Incident Management System that is used by other Australian emergency response service agencies. Incident Management Teams are formed and guided by the BIMS framework. The BIMS is scalable and takes an 'all hazards' approach, covering responses to pests and diseases affecting animals, plants and the environment.

Once a detection has been advised to a government party, the deeds require that the relevant government advises the CC within 24 hours. Sequential phases of response activities follow, as outlined in the relevant deeds. These are:

i) The incident definition phase where an *initial investigation* is undertaken by the relevant government authority. The notifying party undertakes risk assessments to inform the decision about whether an emergency response should be activated. Risk assessments consider the potential economic, environmental and social amenity impacts of the pest or disease. Already completed risk assessments may be available for plant and animal pests and diseases, especially for priority pests and diseases, but for environmental pests they may not. If a risk assessment is not available, it will be undertaken in the incident definition phase. In addition to a risk assessment, the notifying party needs to provide a technical feasibility analysis and a cost-benefit analysis for the NMG to consider in its decision to activate an ERP. The incident definition phase continues until a response plan is agreed by the NMG, on advice from the CC, or the NMG determines that the incident does not relate to an emergency pest or disease, or that eradication (or containment in the case of an EAD) is not feasible.

ii) The *emergency response phase* is the period during which the ERP is implemented. The risk mitigation measures employed in the ERP may evolve as new information about the outbreak becomes available. Delimiting surveys are conducted to determine the extent of the incursion or outbreak of pests or diseases. In the case of an EPP, this phase continues until the NMG, on advice from the CC, determines that the emergency response should enter a proof of freedom phase, or that eradication is not feasible and the emergency response should come to an end or enter a transition to management phase. In the case of an EAD, the emergency response phase continues until the NMG, on advice from the CC, determines that the EAD has been contained or eradicated or cannot be contained or eradicated.

iii) *The proof of freedom phase* commences if the CC determines that the emergency response activities set out in the response plan have been completed successfully. In the case of an EPP, the aim of the proof of freedom phase is to undertake activities to confirm if the EPP has been eradicated. In the case of an EAD, the NMG determines if the disease has been contained or eradicated. This phase may include research and/or surveillance activities. When the NMG determines that a plant pest has been eradicated or an animal disease has been contained or eradicated, activities under the response plan and any restrictions imposed by the plan, such as movement restrictions and livestock standstills, come to an end.

iv) In the case of plant pests, where eradication is not feasible, a *transition to management phase* may be determined by the NMG where it considers that transition to ongoing management of the plant pest is achievable within a reasonable timeframe, not exceeding 12 months. Transition to management refers to the transitioning of the management of an EPP from seeking to achieve eradication of the EPP during an emergency response phase to management of the EPP outside the Deed.

After the NMG has declared a pest or disease as contained or eradicated, new outbreaks will be treated as a new incident and phase one will commence. In the small number of cases where a pest or disease affects an industry that is not covered by a deed, the state or territory where the incident occurs is accountable for the response plan and for negotiating funding arrangements. Currently, more than 90 per cent of the value of Australia's agricultural production is covered by the relevant deeds.

Response deeds mandate at least one trigger point for mid-term reviews of response plans. The mandatory trigger point requires a review of the response activities if expenditure reaches a specific limit. Other trigger points relate to additional detections, operational matters and program management performance indicators (PHA, 2017a). The NMG may also appoint an external Efficiency Auditor to assess the efficiency and effectiveness of a response plan.

Response plans usually detail the spatial extent of declared restricted areas (biosecurity zones) and the level of movement controls imposed on vehicles, equipment and host material (plant and animal) to prevent the spread of a pest or disease from the restricted area. Movement or handling of host material is only allowed under a permit issued by a biosecurity inspector.

Jurisdictions collect and collate data during a response to support decision making. Information generated in a response is usually uploaded into an information management system and made available to all staff involved in a response. If systems integrate and share information so that data can be represented spatially and used by reporting systems, decisions can be made in real time. Data can also be used to monitor and evaluate the progress of an emergency response while it is underway.

In the event of an outbreak or incursion, the NBCEN produces nationally consistent information for affected producers/growers and their local communities, trading partners, media, the general public and other stakeholders such as exporters. The core network is chaired by the department and consists of communication managers from governments (including the Local Government Association and the Australian Government Department of Health), as well as PHA, AHA and AAHL. The NBCEN does not have sole responsibility for information communication and engagement with stakeholders during an incident but is the main coordinating body at the national level. Jurisdictions also provide communication around incursions and outbreaks to stakeholders, including their Ministers. The BIMS identifies roles that are responsible for managing communication throughout a response.

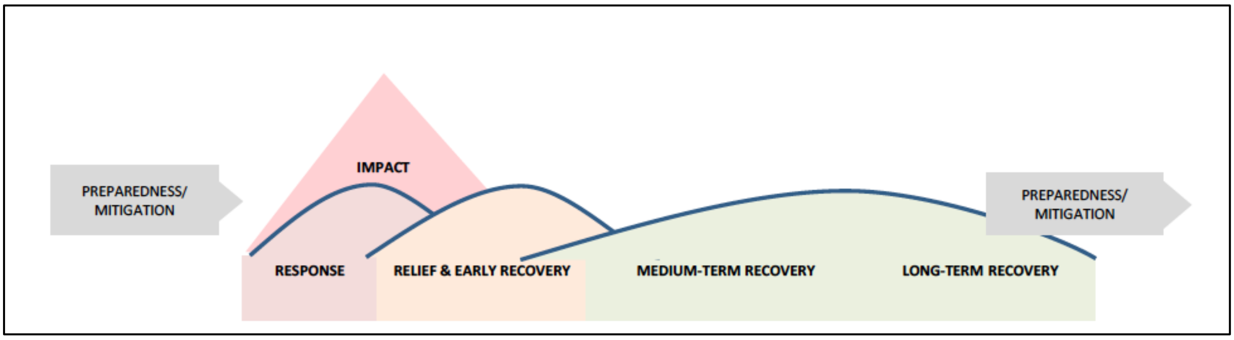
Changes in pest and disease status resulting from biosecurity incidents should be reported to the OIE or the IPPC. The OIE maintains a single list of notifiable terrestrial and aquatic animal diseases that OIE members are obliged to report. The OIE also provides a voluntary process for official recognition of animal disease status in relation to specific animal diseases (FMD, bovine spongiform encephalopathy, African horse sickness, classical swine fever, contagious bovine pleuropneumonia, peste des petits ruminants and rinderpest) to demonstrate pest-free status. OIE members can also self-declare their entire territory or a zone within that as free from OIE listed diseases other than those officially recognised. In the case of plant pests, National Plant Protection Organisations (NPPOs) are responsible for collecting information and reporting the occurrence, outbreak or spread of plant pests and diseases to the IPPC. The same reporting procedure can be used to report successful eradications or the establishment of plant pest and disease-free areas.

Having mechanisms in place that support rapid and effective responses to pest and disease incursions, including decisions about eradication and containment, ensures that the number of priority pests and diseases that establish and spread in Australia is reduced.

Collectively, the activities undertaken to prepare for an incursion, detect an incursion post-border and respond to an incursion once detected contribute to meeting the second objective of the IGAB, that is, to 'prepare and allow for effective response to, and management of, exotic and emerging pests and diseases that enter, establish or spread in Australia'.

3.7.7 **Recover** from an incursion or outbreak and **Adapt** to new circumstances

Incursions or outbreaks of pests and diseases usually have some impact on economic, environmental and/or social assets. The intensity and extent of the impact depends, among other factors, on the type of pest or disease and on the success of the emergency response. Following an emergency event, biosecurity participants implement activities to recover from and adapt to the impacts of an incursion or outbreak. These activities may change over time. They include short term actions that occur during and immediately after an incident as part of the relief and early recovery strategy, as well as medium to long term activities that help the system adapt to changed circumstances (Figure 4). Relief, recovery and adaptation activities are undertaken by a range of participants, including the Australian, state, territory and local governments, producers, industry and community groups.



Source: (EMV, 2018)

Figure 4: Emergency relief and recovery activities over time

Relief and recovery

Relief and early recovery from a pest or disease incursion or outbreak includes the provision of information and support to affected parties to facilitate their financial and non-financial recovery. These activities are provided by a range of agencies, both in and outside the biosecurity system. Whole of government cooperation and collaboration is generally required to Relief and recovery activities can be subject to agreements already in place, for example under the EADRA and the EPPRD. States and territories may also have their own jurisdiction-wide emergency relief and recovery plans. These short term efforts also include communication and engagement strategies to inform those affected of the changed circumstances resulting from pest and disease incursions and their potential implications for ongoing biosecurity risk management.

Long term management of established pests and diseases

Not all pests and diseases that enter Australia will be successfully eradicated. This might be because the pest or disease was not detected early or because it is technically infeasible to eradicate. Containment of pests and diseases to specific areas or regions can be used to minimise their negative impacts. In the case of plants, pests can be contained at a local, regional or state level, depending on their current distribution and the ability to implement cost beneficial measures for containment (PHA, 2017a).

To facilitate containment of pests and diseases that have entered Australia, all states and territories have established *domestic biosecurity* or *quarantine* zones. The domestic interstate quarantine system restricts movement of high risk material between these zones. It manages domestic imports and exports into and out of jurisdictions and is implemented under state and territory legislation to limit the spread of pests nationally. In the plant context, the Interstate Certification Assurance Scheme (ICAS) allows market access for producers who want to sell their produce across state boundaries. It is administered by all states and territories and enables accredited businesses to issue certificates for their produce. Accredited businesses are responsible for treating and/or inspecting produce before issuing a certificate of plant health. Jurisdictions develop and document treatment procedures under the scheme to be used by accredited businesses. Jurisdictional biosecurity authorities perform audits to ensure ongoing conformity with obligations. Once a pest is declared eradicated, all intra and interstate quarantine arrangements should be lifted.

A key issue with the implementation of domestic biosecurity or quarantine regulations is to ensure that they do not impose unnecessary costs on industries, businesses and individuals, as well as enforcement agencies. This can include the costs of businesses being denied access to traditional markets or to new genetic strains. Effective domestic biosecurity or quarantine regulations should balance the full costs of such restrictions against the benefits they generate. This is reflected in the IGAB, which states, inter alia, that interstate biosecurity measures will only be applied to the extent necessary to mitigate risks and will be the least trade restrictive as possible (COAG, 2019, clause 36).

In some cases, long-term management strategies will be implemented that seek to reduce the adverse impacts of an established pest or disease. These strategies might include changes in regional or local biosecurity practices to reduce the chance of a pest or disease spreading. The Draft National Fruit Fly Strategy is an example of a coordinated approach to managing the impacts of endemic fruit fly species on productivity and market access through the strategic use of containment, exclusion and other local management practices (PHA, 2008). The Australian Pest Animal Strategy 2017-2027 and the Australian Weeds Strategy 2017-2027 are policy frameworks underpinning efforts across jurisdictions that guide and inform biosecurity participants in relation to the management of invasive vertebrate animals (terrestrial and freshwater, but not marine) and invasive plant species. Their principles, goals and priorities cover prevention, eradication, containment and asset protection activities. In contrast, the 2016 'National framework for the management of established pests and diseases of national significance' focuses on asset protection only.

Management activities on public land complement and support the ongoing management of established pests or diseases because the economic and recreational benefit of such land, including natural parks, is significant. Tourism relies, in part, on environmentally healthy parks and waterways, but pests and diseases can put pressure on local biodiversity, water quality, soil stability and vegetation cover (VAG, 2010).

Because the management of established pests and diseases is a shared responsibility, long-term activities also include *community-led programs*. These programs coordinate actions and target established plant and animal pests where collective action has a social benefit. Examples are the Victorian Serrated Tussock Working Party and Western Australia's Recognised Biosecurity Groups. Agriculture sector participants also invest in surveillance, either directly or through the purchase of services from private or government providers, primarily to manage established pests on an ongoing basis (PHA, 2013).

Substantial effort at the state and territory level is directed at ensuring a high level of *compliance with biosecurity regulations* by participants in the biosecurity system. A common example is the targeting of enforcement activities at landowners and producers who fail to control noxious weeds on their property, as regulated by state and territory legislation. In Victoria, for example, a Directions Notice or a Land Management Notice are commonly used regulatory mechanisms to ensure control of noxious weeds and pest animals on private properties.

Re-opening of international markets is also an important recovery strategy for trade dependent industries and requires certification by the department. *Export certification* is a departmental requirement for live animals and animal and plant products to verify that goods for export are compliant with importing country requirements.

Export certification, as well as the ICAS, is frequently underpinned by evidence of the absence of a pest or disease. These *area freedom claims* are based on surveillance activities and surveys undertaken for a specific time, or activities maintained to demonstrate ongoing freedom from pests and diseases. For example, Australia uses a general surveillance approach for a range of eradicated animal diseases, such as equine influenza, virulent Newcastle disease and highly pathogenic avian influenza. Area freedom surveillance differs from proof of freedom surveillance because it assumes that a pest or disease is not present or has not been present for a period of time, in contrast to proof of freedom surveillance where an incursion or outbreak is known to have occurred in the recent past.

Part of recovering from and adapting to pest or disease incursions is evaluating outcomes of emergency response activities, including eradication and containment actions. Evaluation processes are used to update response tools, plans and procedures and to encourage the application of best practice across biosecurity sectors nationally.

The intended outcomes of activities in the national biosecurity system to recover from and adapt to incursions or outbreaks of pests and diseases is that the realised impact on the economy, environment and community of pests and diseases that establish and spread in Australia is reduced and that disruptions to international market access are minimised. These contribute directly to meeting the third and fourth IGAB objectives to 'ensure that, where appropriate, significant pests and diseases already in Australia are contained, suppressed or otherwise managed' and to 'enable international and domestic market access and tourism'.

3.8 Influencers and Enablers

In addition to the specific components of the biosecurity system outlined above, there are activities undertaken as part of the system that are fundamental to system performance and the value it creates. These activities – referred to here as influencers and enablers – underpin some, or all, of the biosecurity system's components.

An overarching *strategy* for the biosecurity system can provide a clear and coherent vision, goals and desired outcomes for its activities and can be a powerful tool for gaining the collective support of system participants. A strategy that has the endorsement of participants can also provide the basis for consistent and harmonised biosecurity policy at all levels of government and provide guidance on prioritisation and decision making. It can also provide a foundation for prioritising biosecurity research and innovation efforts.

Governance arrangements in the national biosecurity system provide a framework for the leadership and management of the system – they define how each participant in the system will behave, including the relationships between participants. Governance arrangements encompass the institutional structures that underpin the operation of the system, as well as the legislative, regulatory and administrative arrangements that support system strategy and operations at the national and state and territory levels. At the highest level, each jurisdiction has implemented biosecurity legislation that provides the overarching framework for the operation of the system. Key inter-governmental governance arrangements in the national biosecurity system are the IGAB and the NBC and its sub-committees and working groups. These arrangements support the development of national policy on key biosecurity issues. Other important governance settings are provided in the emergency response deeds managed by AHA, PHA and the department.

A key characteristic of the biosecurity system that underpins its performance at the national level is the partnerships approach that strengthens relationships between its participants. It reflects the fact that the national biosecurity system does not exist as a single physical or legal entity (Craik *et al.,* 2017) but is built on a complex set of relationships and interactions that link multiple participants. It is the effective cooperation and collaboration between these participants that helps ensure that the biosecurity system is more than the sum of its individual components.

Because of the many participants in the biosecurity system, the complex nature of their interactions, and the rapidly evolving nature of the system, effective *engagement* and *communications* are important to achieve outcomes. The partnerships approach relies on effective engagement of all participants in the system so that they understand the objectives of the system as well as their roles and responsibilities and those of other participants. Effective communication with biosecurity participants is designed to ensure that all stakeholders have access to essential information, including in emergency responses. Communication encompasses general strategies to inform and educate those who play a direct role in the biosecurity system such as producers and other landholders, as well as those subject to biosecurity regulation such as travellers and traders. Communication between governments and industry is critical in an emergency response situation and can be central to building community resilience in the period following an outbreak.

There are many communication mechanisms in place in the Australian biosecurity system that facilitate communication at different levels. These include the Farm Biosecurity program operated by AHA and PHA to raise awareness of producers about on-farm biosecurity and prevention of animal diseases and plant pests. The department coordinates an annual Biosecurity Roundtable that provides biosecurity stakeholders and government agencies with a forum to exchange perspectives on priority biosecurity issues. The department also has a dedicated communications section that coordinates communication between governments and industry during biosecurity incidents. The Biosecurity Incident National Communication Network produces nationally consistent public information in response to pest and disease outbreaks. It has members from the Australian and state and territory governments and from AHA and PHA. The department also produces a bi-monthly newsletter, *Biosecurity Matters*, as well as brochures on travel, biosecurity and citizens' awareness.

Also critical to operations across the entire biosecurity system is the capacity for *information management and analysis*. Ready access to comprehensive and reliable data and information is essential for anticipating, responding to and managing national biosecurity risks, substantiating Australia's claims to pest and disease free status, and for decision making, policy development, and performance measurement (Craik *et al*., 2017). All jurisdictions, industries and relevant NGOs hold data of relevance to the national biosecurity system. Many of these are based on manual systems, are not integrated, are not efficient and do not support assessments of biosecurity risks or changes in pest and disease status. However, recent developments across jurisdictions are addressing these issues. For example, nationally consistent minimum dataset specifications and standards have been agreed through the National Biosecurity Information Governance Expert Group. Interoperable technology platforms are also being developed to manage the collection, collation and analysis of biosecurity data. These include the software platform, MAX, developed by the Victorian government and used by a further five jurisdictions for routine and emergency biosecurity activities. PHA's AUSPestCheck is capable of providing and receiving national surveillance information on weeds and plant pests from a wide range of stakeholders. And the department is investing significantly in sophisticated data capture, use and analysis through the BIIS.

Because Australia's biosecurity system is based on sound science, *research and innovation* (R&I) is a critical driver of change. R&I can inform decisions made by governments and industry; help to improve the efficiency of biosecurity operations; maintain Australia's favourable pest and disease status through the development and application of new risk management measures; and ensure adequate scientific and technical capacity is maintained (Craik *et al.,* 2017). Biosecurity relevant research and innovation is funded principally by the Australian and state and territory governments and the rural RDCs, the latter of which in turn receive funding from both government and industry. Research is delivered by multiple providers, including the CSIRO, state and territory research agencies and universities.

The allocation of investment in research and innovation is guided by several strategies that are framed within the national research priorities outlined in the National Science and Research Priorities and the National Rural Research, Development and Extension Priorities. The National Biosecurity Research, Development and Extension Priorities were endorsed by the NBC in 2017 and are designed to provide a unified, strategic and nationally consistent focus to biosecurity research and to improve national biosecurity outcomes (DA, 2019a). They align with existing jurisdictional strategies. Sitting beneath these national level priorities are a number of strategies and frameworks relevant to biosecurity research in the animal and plant domains. It has been noted that the range of strategies at this level has resulted in the lack of a unified, national approach to coordination and delivery of biosecurity research and has limited their overall impact and effectiveness (Craik *et al.,* 2017).

A further important component of the biosecurity system is the capacity to undertake *monitoring and evaluation* of its performance. This provides a basis on which all participants can identify what improvements in investment allocation can be made, either individually or on a collective, system-wide basis. Although evaluation of components of the national biosecurity system occurs on a regular basis there is no current framework for monitoring or evaluating the performance of the system at the national level. This gap has been identified by the review into the IGAB, which notes that it is not possible to 'roll up' individual jurisdictional performance measures to capture the national system and assess national performance (Craik *et al.*, 2017).

4 Evaluation framework

4.1 Introduction

Based on the literature reviews and stakeholder engagement processes discussed in chapter 2, seven principles have been derived that inform the analytical approach taken in this project. This chapter outlines these principles below, and in Figure 5. It then explains each step in the evaluation framework in more detail. This chapter also includes a table that summarises the total number of indicators and measures that are proposed under each KEQ.

The seven principles of the evaluation framework are:

1) use a system description that describes how the biosecurity system is intended to work as the basis for the evaluation framework;
2) develop the attributes of health against which the performance of the system will be assessed;
3) define the KEQs that address the objectives that the system or component of the system is seeking to achieve;
4) select existing or develop new performance indicators that link activities undertaken in the biosecurity system to the outputs and outcomes they are designed to achieve, as described in the system description; and collect, analyse and interpret indicator data;
5) develop performance benchmarks, targets or expectations, against which the performance of the system can be evaluated;
6) build the performance narrative through synthesising and integrating data and analysis, using quantitative and qualitative information; and
7) use the information generated from the process to inform the future operation of the biosecurity system, as well as to refine future evaluations.

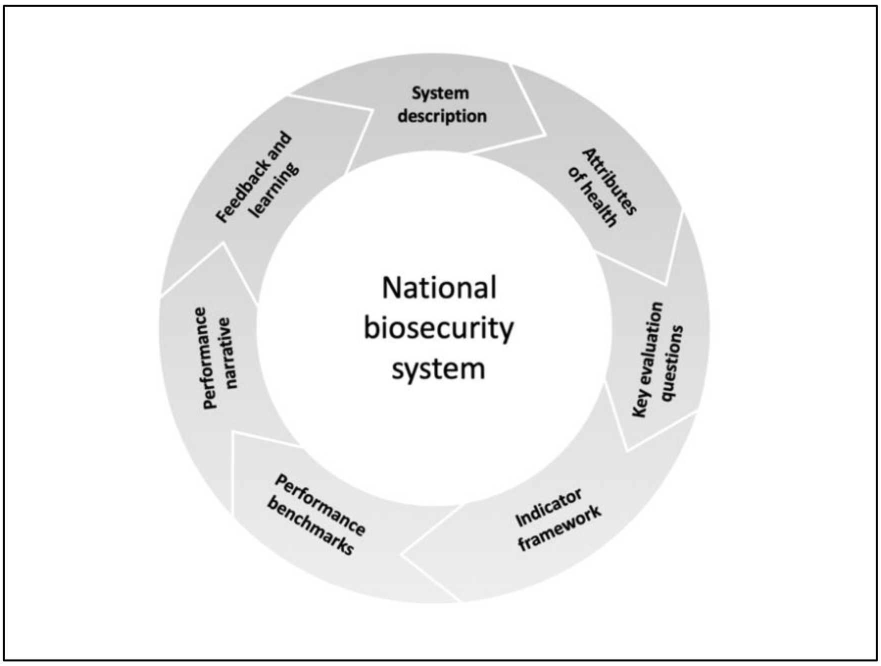


Figure 5: Framework for evaluating the performance of the national biosecurity system

The first four parts of this approach are the subject of this report. Parts 5 to 7 are described in this chapter and will be undertaken as part of the implementation of the performance evaluation framework.

4.2 System description

The project uses a conceptual basis for the evaluation that sits between an outcomes pathway and a theory of change. The conceptual basis is more than a simple outcomes pathway, which only describes the links between activities and desired results. While the conceptual basis developed in the project does not explicitly describe causal mechanisms, it provides comprehensive context in the form of a narrative description of the biosecurity system (chapter 3). For a complex system such as the Australian biosecurity system it would be difficult to identify all possible causal mechanisms behind the links in an outcomes pathway. The identification of causality is easier to achieve at a program or project level which is the basis of the majority of the evaluation literature. Liu *et al.* (2014) highlight a key challenge with system wide and/or long-term evaluations of complex systems which is the difficulty in establishing causality between the outcome and changes in the system components. This is because the strength of inferred causal relationships decreases with: (i) the scale of the evaluation (i.e., from action to system); and (ii) the time between implementation and evaluation of an action/system (Liu *et al.,* 2014).

The system description helps to provide clarity about the individual components of the Australian biosecurity system (chapter 3, Figure 2). These consist of activities to anticipate risk and prevent biosecurity risk material arriving at the Australian border; to screen entry pathways to detect non-compliance; to prepare for and detect any incursions of exotic pests and diseases; and to respond to, recover from and adapt to pests and diseases that establish and spread in Australia (DA, 2019b).

The description of the biosecurity system articulates the links between the resources, or inputs, that are invested in the system, the activities that are undertaken and the outputs that are delivered, as well as the immediate and longer term outcomes to which investments in the biosecurity system contribute. This structure provides a framework for explicitly linking activities to outputs and outcomes that allows us to assess the effectiveness of investments at different points in the system. It also clearly articulates the objectives of the biosecurity system, which are described in the IGAB.

The system description can be used to demonstrate that biosecurity risk management is a sequential and cumulative, process, such that activities under one component of the system have an impact on outcomes of subsequent components. For example, activities to better anticipate biosecurity risk will also contribute to preventing risk material arriving at the Australian border. The system description is also a communications tool that allows the many participants in the system to identify where they ‘fit’ and how and where they contribute to overall system performance. This can be important in encouraging ownership of performance evaluation processes and results.

4.3 Attributes of health

In this project, five broad attributes of a healthy biosecurity system are used to inform the evaluation framework (Box 6). These are (1) the effectiveness of the system, (2) its efficiency, (3) its capacity and capability, (4) its robustness and resilience to external stress, and (5) its sustainability over time. Not each of these attributes of health will be relevant to each component of the biosecurity system.

Box 6: Nominated attributes of system health

Effectiveness
The system or intervention achieves its objectives.

Efficiency
Productive efficiency is maximised when the goals of the system or intervention are achieved at the lowest possible cost. A system that maximises productive efficiency uses the least costly combination of inputs to produce the desired output. *Allocative* efficiency is maximised when resources are invested across the system such that it achieves the best overall outcome from scarce resource.

Capacity and capability
The extent to which the system has the appropriate quantity and quality of financial, physical, human and organisational resources to meet its objectives, that is, its expected outputs and outcomes.

Robustness and resilience
The system's ability to withstand the impacts of an external shock or disturbance, to respond to and recover from the impacts of such a shock or disturbance, and to adapt to changed circumstances.

Sustainability
How well the system performs through time – its ability to meet its objectives over the medium to long term taking into account pressures expected to arise from growth in system demands and complexity.

4.3.1 Effectiveness of the biosecurity system

The *effectiveness* of the biosecurity system is an overarching measure of its health and seeks to address whether the investments and interventions in the system are delivering appropriate outputs and achieving their intended outcomes. Effectiveness is the most important attribute of health because it describes the extent to which the purpose of the system is fulfilled and provides its intended benefits (DF, 2015). Effectiveness can be measured for each component of the system and for the system as a whole. It can also be measured at different levels – at the output level and at the direct, system-wide and external outcomes levels. It is conceptually easier to link the effectiveness of activities to outputs or direct outcomes than it is to higher level outcomes. For example, relatively direct links can be made between the activities designed to anticipate biosecurity risk and the outputs defined in the description of the biosecurity system such as the number of intelligence reports generated and the number of import risk assessments that are reviewed. It is also reasonably straightforward to link activities to the direct outcome that the risk profile is identified, assessed and prioritised. It is more difficult to attribute causality between activities undertaken and the system level objective to reduce the likelihood of exotic pests and diseases entering, establishing or spreading in Australia. The difficulty is amplified when seeking to link activities to the external outcomes of a stronger economy, functioning ecosystems, healthy people and resilient communities. This is because there are many more influences on the higher level outcomes than the activities undertaken to anticipate biosecurity risk.

4.3.2 Efficiency of the biosecurity system

The *efficiency* of the biosecurity system is a measure of how well the inputs to the system are used to deliver outputs and outcomes. It is an important attribute of health because biosecurity agencies and others involved in the system have limited resources to address risk and are concerned to ensure they are used efficiently. An efficient biosecurity system is one that will, broadly speaking, allocate its limited resources across all components of the system in a way that maximises biosecurity risk reduction.

Linking the total resource inputs in a system to a measure of outputs and outcomes provides an indication of the productive, or technical, efficiency of the system. Productive efficiency is achieved when output is produced at the lowest possible cost. In the context of the biosecurity system, productive efficiency is interpreted to mean the amount of biosecurity risk reduction – the output provided by the biosecurity system – that is achieved per unit of investment in the system, measured across all inputs identified in the description of the biosecurity system. Subject to the availability of appropriate data, productive efficiency can be calculated at any point in the biosecurity system from an individual activity or component to whole of system.

Resources in the biosecurity system can be used in many different ways, for example, they can be allocated to different components of the system and to different activities in each component. Some of these activities yield better returns on investment than others. A biosecurity system with the maximum allocative efficiency will distribute all of the resources invested in the system in a manner that maximises the reduction in biosecurity risk. This is achieved where rates of return to investment on different biosecurity activities are equalised. Measurement of allocative efficiency should be conducted at the whole of system level. Measures of allocative efficiency across more limited sets of activities can also provide insights into the efficiency of the system.

4.3.3 Capacity and capability of the biosecurity system

A further attribute is the *capacity* and *capability* of the biosecurity system – or its ability to provide the appropriate quantity and quality of financial, physical, human and organisational resources to deliver its expected outputs and outcomes. The resources required to support biosecurity activities are diverse, encompassing the direct financial investments in the system, the number and skills of people who work within the system and the extensive physical resources that support the system, including inspection facilities, laboratories, post-entry quarantine facilities and information technology and data analysis systems. Also important are the system's core organisational capabilities, including its governance arrangements, the R&I that underpins biosecurity innovation, and the ability to manage engagement and communications activities with all participants in the system. An important consideration for system performance is whether there is sufficient surge capacity and capability in the system to meet demand in an emergency situation. Surge capacity and capability can be met through inbuilt redundancy in the system or through partnering arrangements that share resources and expertise to support emergency responses. The capacity and capability of the system can be measured for different inputs, for example, diagnostic facilities or veterinary resources. Because we are interested in the national biosecurity system it is desirable to develop an aggregate measure of capacity at the whole of system level.

4.3.4 Robustness and resilience of the biosecurity system

The *robustness and resilience* of the biosecurity system refers to the ability of the system to withstand the impacts of an external shock or disturbance, to respond to and recover from the impacts of such a shock or disturbance, and to adapt to changed circumstances. For example, pest and disease incursions create stress in the biosecurity system – they require resources to be diverted from their usual activities to address the stress and they may require additional resources to be made available to cope with the new circumstances. A robust and resilient system will absorb these perturbations with minimal impact on other essential components of the system and will revert to normal activity in the shortest time possible after the stress has been resolved. It will also learn from the experience and adapt to any changed circumstances created by the stress event. Assessing the robustness and resilience of the biosecurity system can be conducted on the basis of observation of the system after a period of stress. The nature of the observed stress will determine at what level of the system the performance evaluation should be conducted. In the absence of a specific shock or stress, it is also desirable to evaluate the characteristics of the system that are likely to have an impact on its robustness and resilience.

4.3.5 Sustainability of the biosecurity system

The *sustainability* of the biosecurity system refers to its ability to meet its objectives over the medium to long term. Over time the pressures on the biosecurity system are expected to grow with increasing volumes of trade and traveller movements and increasingly diverse import pathways. The global distribution of pests and diseases is also likely to change in response to factors such as climate, while international supply chains are expected to become more complex over time. These contextual factors will have an impact on the biosecurity risk profile facing Australia and the volume of risk that needs to be managed. A sustainable system will have the appropriate mechanisms in place to ensure that the objectives of the biosecurity system can continue to be met in the face of these pressures. These mechanisms will include, among others, sustainable funding processes to ensure the appropriate allocation of resources to the system, effective training processes to develop the human resource capability necessary to operate the system, governance arrangements to ensure that changes in biosecurity risk management are appropriately implemented, and the R&I effort to generate innovative and cost effective solutions to biosecurity problems. The sustainability of the system can be assessed for different components of the system as well as at the whole of system level.

4.4 Key evaluation questions

The eight proposed high level or system level KEQs addressed in this project are outlined below. The first four questions correspond to the *effectiveness* with which the system delivers against the four IGAB objectives. The remaining four cover the other four attributes of health, namely: efficiency, capacity and capability, robustness and resilience, and sustainability.

1. How effectively does the national biosecurity system reduce the likelihood of exotic pests and diseases, which have the capacity to cause significant harm to the economy, environment and community, from entering, becoming established or spreading in Australia? (IGAB objective 1)
    a. How effectively do activities to anticipate biosecurity risk contribute to the direct outcome that the risk profile is identified, assessed and prioritised?
    b. How effectively do activities to prevent biosecurity risk material arriving at the border contribute to the direct outcome that the number of priority pests and diseases approaching the border is reduced?
    c. How effectively do activities to screen entry pathways to detect non-compliance contribute to the direct outcome that the number of priority pests and diseases entering Australia is reduced?

2. How effective is the national biosecurity system's preparation for and capacity to respond to and manage exotic and emerging pests and diseases that enter, establish or spread in Australia? (IGAB objective 2)
    a. How effectively do activities to prepare for an incursion or outbreak of pests and diseases contribute to the direct outcome that participants in the biosecurity system are ready to respond to priority pest and disease incursions or outbreaks?
    b. How effectively do activities to detect incursions or outbreaks of pests and diseases contribute to the direct outcome that the time taken to detect incursions or outbreaks of priority pests and diseases is reduced?
    c. How effectively do activities to respond to an incursion or outbreak of pests and diseases contribute to the direct outcome that the number of priority pests and diseases that establish and spread is reduced?

3. How effectively does the national biosecurity system ensure that, where appropriate, nationally significant pests and diseases already in Australia are contained, suppressed or managed by relevant stakeholders? (IGAB Objective 3)

4. How effectively does the national biosecurity system enable international and domestic market access and tourism? (IGAB objective 4)
    a. How effectively do activities to recover from an incursion or outbreak and adapt to new circumstances contribute to the direct outcomes that the realised impact on the economy, environment and community of pests and diseases that establish in Australia is reduced and that international and domestic market access and tourism are enabled?

5. Are the resources invested in the biosecurity system allocated across activities in a manner that maximises the efficiency of the system and delivers the highest return on investment?

6. Does the system have the appropriate capacity and capability, that is the quantity and quality of financial, physical, human and organisational resources, to meet its objectives?

7. Does the biosecurity system have the resilience to reasonably withstand external shocks and disturbances without significant consequences, or to recover from shocks and disturbances in a reasonable time, and to adapt to changed circumstances?

8. Is the biosecurity system sustainable? Does it have the appropriate structures and mechanisms in place to ensure its continued effective and efficient operation over the medium to longer term, taking into account pressures expected to arise from growth in system demands and complexity?

It is possible to pose KEQs at lower levels of the biosecurity system. KEQs could be developed for each activity outlined in the description of the biosecurity system, for example, environmental scanning under anticipate activities or diagnostics under screen. This would provide additional information to managers of those programs that can help identify challenges and allow corrective action to be taken in a timely manner. Further, synthesising the answers to lower level questions can allow defensible judgments to be made that directly answer the higher level questions (Davidson, 2014).

4.5 Indicator framework

A key part of the performance evaluation framework is the selection of existing or development of new indicators and associated measures of biosecurity system performance that link changes in activities undertaken in the system with the achievement of outputs and outcomes. The selection or development of appropriate indicators depends on the attributes of health and the key evaluation questions, as outlined in Figure 6.

Evaluating the effectiveness of the biosecurity system is about asking whether the system is achieving its objectives, as defined in the IGAB. As a result, the indicator framework for effectiveness is based on the structure of the system description, which describes the pathway from activities to outputs and outcomes.

Unlike effectiveness, there is no direct and measurable link between the other attributes of health (efficiency, capacity and capability, robustness and resilience, and sustainability) and system outputs and outcomes. Efficiency and capacity/capability are attributes that influence all activities in the system and have an impact on all outputs and outcomes. This is why they fall outside or ‘below the line' in the description of the biosecurity system (chapter 3, Figure 2). The resilience and sustainability attributes are derived largely from other characteristics of the system. For example, as discussed in chapter 8, robustness and resilience depend on the effectiveness of the system to anticipate risk, prepare for, respond to and recover from emergency situations, as well as the general capabilities of the system.

Separate frameworks are developed for indicators of effectiveness and for indicators of the other attributes of health. This is because effectiveness indicators are linked to each component of the biosecurity system, while indicators of the other attributes apply across the system as a whole. All indicators proposed in this report are candidates only and may be refined with further consideration by stakeholders in the system or an implementation team.

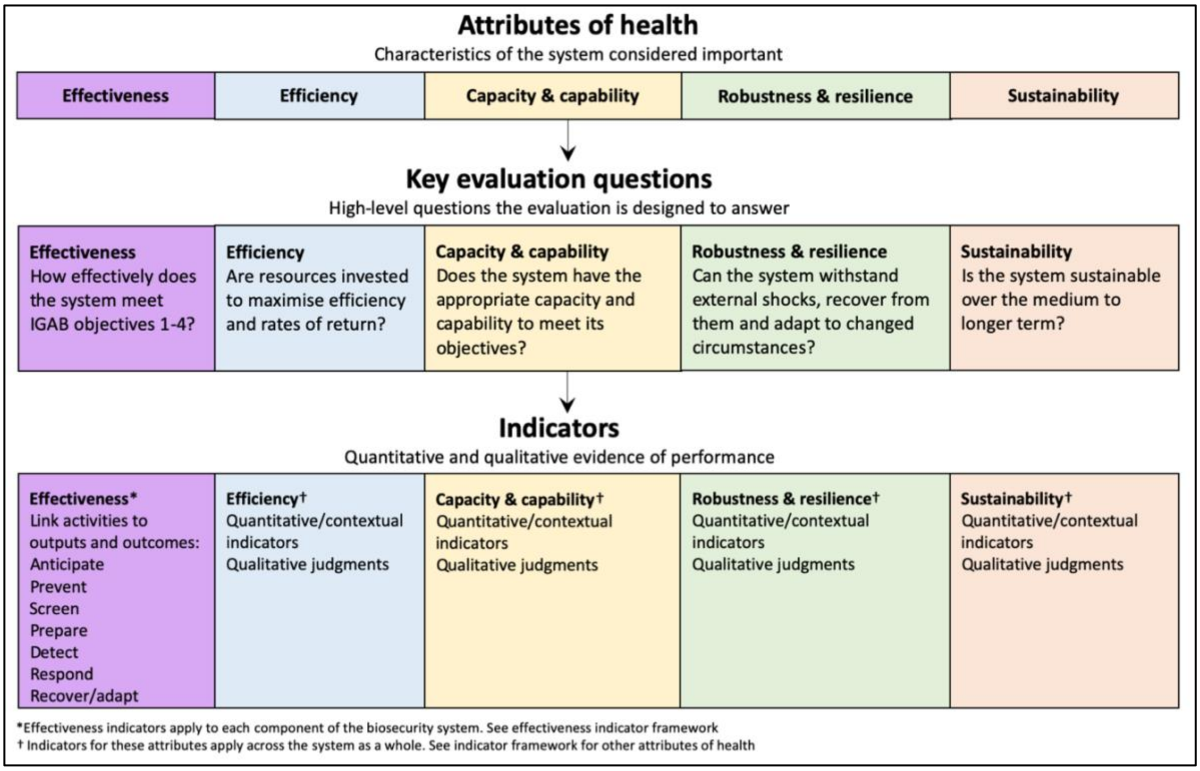


Figure 6: The sequence of indicator development

Figure 6 provides an overview of the set of indicators developed in the project, grouped by the attributes of health and linked to the KEQs. The shaded area shows how the effectiveness indicators are related to the KEQs and the components of the biosecurity system. In summary, across the two indicator frameworks, a total of 13 quantitative indicators and 20 qualitative indicators are proposed.

In addition, a total of 84 activity measures are developed across each component of the system (Table 3). These are relevant because they assess the scope and scale of activities undertaken in the system. They provide context for the performance indicators and rubrics as well as material to support the performance narrative. They are not of themselves indicators of the performance of the biosecurity system.

Table 3: Summary of proposed indicators and measures

Attributes of health	Key evaluation question	Quantitative indicators	Qualitative indicators	Activity measures
Effectiveness	1-4	13	7	84
Anticipate	*1a*	*2*	*1*	*10*
Prevent	*1b*	*1*	*1*	*19*
Screen	*1c*	*1*	*1*	*24*
Prepare	*2a*	*1*	*1*	*9*
Detect	*2b*	*2*	*1*	*9*
Respond	*2c*	*2*	*1*	*6*
Recover/adapt	*3,4a*	*4*	*1*	*7*
Efficiency	5	-	1	-
Capacity/capability	6	-	10	-
Robustness/resilience	7	-	1	-
Sustainability	8	-	1	-
Total		13	20	84

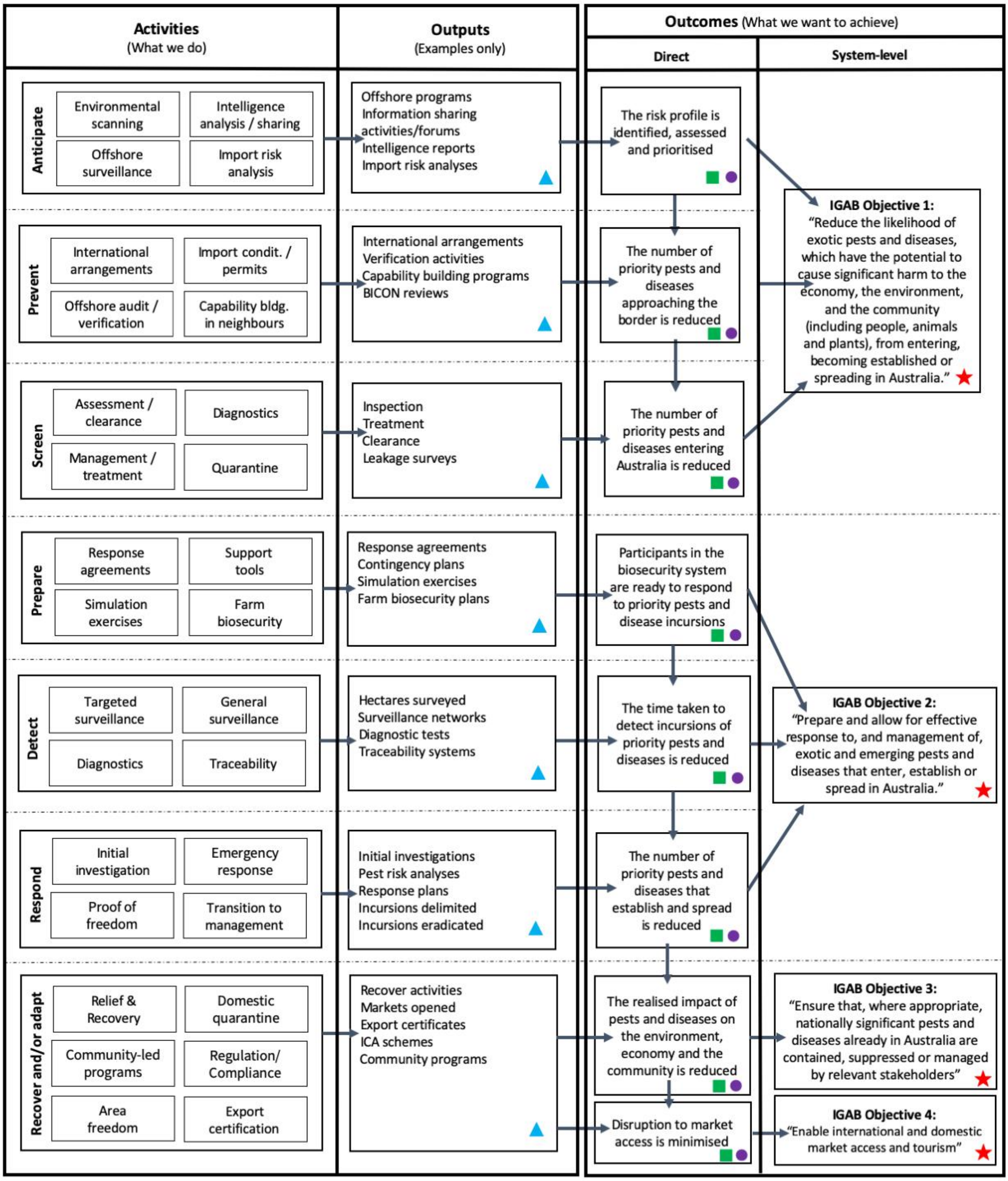
4.5.1 Effectiveness indicator framework

In the case of the effectiveness of the biosecurity system, a set of performance indicators and activity measures is proposed for each component of the system, based on the description of the biosecurity system (Figure 7). The effectiveness indicator framework comprises:

- *20 Indicators (13 quantitative, 7 qualitative)* – these link activities and outputs to the direct and system-level outcomes. Direct outcomes are the immediate consequences of the type and quantity of outputs in the biosecurity system (Box 7). System-level outcomes are the higher level and longer-term consequences of system activities and outputs. The effectiveness indicator framework consists of quantitative and qualitative indicators for each of the components of the biosecurity system. The symbols in Figure 7 indicate at what point in the system activity measures or indicators are developed.

- *84 Activity measures* – these link activities to outputs (the direct products and services produced by these activities). Quantitative measures are proposed at the output level. Activity measures are descriptive in nature and do not address how effective these activities are in achieving the objectives of the system.

Given the sequential and cumulative nature of activities in the biosecurity system, activities under one component of the system have an impact on outcomes of subsequent components. For example, the indicator of the direct outcome of prevent activities also captures the impacts of anticipate activities. And the measure of the direct outcome of screen activities captures the cumulative impacts of anticipate and prevent activities.



- ▲ Activity measure
- ■ Quantitative indicator of direct outcomes
- ● Qualitative indicator of direct outcomes
- ★ Quantitative indicator of system-level outcomes

Figure 7: Effectiveness indicator framework, addressing KEQs 1-4

Box 7: Direct outcomes of biosecurity activities and outputs

Anticipate	The risk profile is identified, assessed and prioritised
Prevent	The number of priority pests and diseases approaching the border is reduced
Screen	The number of priority pests and diseases entering Australia is reduced
Prepare	Participants in the biosecurity system are ready to respond to priority pest and disease incursions
Detect	The time taken to detect incursions of priority pests and diseases is reduced
Respond	The number of priority pests and diseases that establish and spread is reduced
Recover and/or Adapt	The realised impact of pests and diseases on the environment, economy and the community is reduced
	Disruption to market access is minimised

In the effectiveness indicator framework, as shown in Figure 7, both *quantitative* (green squares) and *qualitative* (purple circles) *indicators of direct outcomes* are proposed to evaluate the effectiveness of the biosecurity activities. Overarching *quantitative indicators* of the four *system-level outcomes* (red stars) are proposed that measure the collective effectiveness of all activities that contribute to that outcome, as identified in the system description. *Activity measures* (blue triangles) for the outputs delivered by each component of the biosecurity system are also developed.

Qualitative indicators of direct outcomes are selected or developed through a two-step process:

- the first involves posing KEQs and developing evaluation criteria that are designed to elicit the effectiveness of biosecurity activities in achieving the desired direct outcomes.
- the second step involves answering these questions to determine a measure of the effectiveness of these activities. Different methods can be used to undertake this measurement, all of which rely on tapping into the opinions and judgments of stakeholders and other experts. This can be achieved through mechanisms such as peer-reviews, surveys, interviews or focus groups, or the use of expert elicitation techniques. The outcomes of these methods can be a 'rubric' or 'constructed scale' that summarises qualitative information and judgments in a consistent manner and reduces ambiguity. Rubrics can encompass both qualitative and quantitative data in order to answer KEQs. In this step of the project rubrics are used specifically to summarise and order qualitative information.

The development and use of rubrics or constructed scales in performance evaluation is discussed in the methods chapter (chapter 2). A method for synthesising results from rubrics is presented in Appendix 2.

The performance standards used in the rubrics are outlined below:

Advanced	Performance is clearly very strong or exemplary in relation to the question. Any gaps or weaknesses are not significant and are managed effectively.
Good	Performance is generally strong in relation to the question. No significant gaps or weaknesses, and less significant gaps or weaknesses are mostly managed effectively.
Developing	Performance is inconsistent in relation to the question. Some gaps and weaknesses. Meets minimum expectations/requirements as far as can be determined.
Inadequate	Performance is unacceptably weak in relation to the question. Does not meet minimum expectations/requirements.
Insufficient Evidence	Evidence is unavailable or of insufficient quality to determine performance.

Rubrics are developed under both indicator frameworks to answer KEQs associated with each attribute of health. For effectiveness, the views of experts and stakeholders on the performance of the system can supplement and enrich the evidence derived from quantitative indicators. For the other attributes of health, which are less amenable to meaningful quantitative evaluation, qualitative information forms the dominant source of performance information. The evaluation criteria and the performance standards related to each of the rubrics are outlined in subsequent chapters.

It is conceptually and practically easier to link activities to outputs and direct outcomes than it is to higher level outcomes because there are many more influences on the higher level outcomes than the activities undertaken to manage biosecurity risk. It is increasingly difficult to present convincing evidence that links biosecurity activities to these outcomes. This is particularly relevant in the case of the final or external outcomes defined in the description of the biosecurity system – a strong economy, functioning ecosystems, healthy people and resilient communities. For this reason, only very broad conclusions can be drawn about the contribution of biosecurity activities to the achievement of these objectives of the system.

4.5.2 Indicator framework for the other attributes of health

Indicators are also proposed for the other attributes of system health – efficiency, capacity and capability, robustness and resilience, and sustainability (Figure 8). For these attributes of health, emphasis is placed on qualitative indicators of performance, derived from the judgments of experts and stakeholders involved in the system. One or more rubrics are developed for each attribute of health. Where appropriate, quantitative measures are also proposed to define the scale of some relevant characteristics of the system.

INDICATOR FRAMEWORK

Qualitative indicators	Quantitative measures
Efficiency	**Efficiency**
Transparent budget information Expenditure monitoring, evaluation and review Budget allocation decision support tools Data capture and analysis systems	Investment stocktake ($) Risk reduction ($)
Capacity and capability	**Capacity and capability**
Financial resources: Funding level and mechanisms, cost sharing arrangements	Financial resources: Investment ($)
Physical resources: Scale and quality of inspection, quarantine and laboratory facilities; quality of plant pest reference collections	Physical resources: Inspection, post-entry quarantine and laboratory facilities; plant pest reference collections
Human resources: resources available for normal operations and in emergency responses; emergency training and awareness; future skills forecasting	Human resources: Baseline and surge capacity
Organisational capability: Strategy and policy development Governance Partnerships Engagement and communications Data and information management, analysis and sharing Research and innovation Monitoring, evaluation and reporting	Organisational capability
Robustness and resilience	**Robustness and resilience**
Awareness Preparedness Resourcing Responsiveness Ability to adapt	Performance pre- and post-shock, including time taken to revert to normal operations
Sustainability	**Sustainability**
Forecasting of risk Sustainable funding base Human capability development Research and innovation Organisational capability	Forecast growth in the biosecurity task

Figure 8: Indicator framework for the efficiency, capacity and capability, robustness and resilience, and sustainability of the biosecurity system (KEQs 5-8)

4.6 Performance benchmarks

Without clear statements of performance expectations, indicators are limited to information about the results of the system rather than real assessments of its performance – they do not of themselves define whether a system is healthy. An essential step towards evaluating system performance is defining what a healthy system looks like. This can involve defining performance targets, or benchmarks, that are deemed healthy, as well as setting expectations of future performance. These targets and benchmarks might include minimum levels of performance required for a system to be considered healthy, or thresholds required to be considered good practice.

Different approaches can be taken to defining performance targets and benchmarks (Mayne, 2004). These include:

- identifying benchmarks from other similar programs or other jurisdictions
- measuring performance for a period to establish a baseline
- basing expectations on past performance
- setting the direction of expectations first, measuring progress and then establishing a reasonable performance expectation
- consulting with stakeholders on reasonable expectations.

Benchmarks can be established on the basis of industry agreed standards, for example those developed by the International Organization for Standardization (ISO).

Given the complexity of the biosecurity system and the number of participants, an external organisation such as CEBRA is not well placed to define performance targets and benchmarks, nor would it be appropriate to do so. The appropriate or desired level of system performance should be defined by system participants and stakeholders who have an understanding of the constraints around the operation of the system, including its financing. Different participants may have different initial views regarding target performance and appropriate benchmarks in a healthy system. It is important that, through consultation, they are accepted as valid by the broad stakeholder community and regularly re-assessed based on knowledge and experience gained over time. Consultation on targets and benchmarks should be undertaken as part of the implementation of a performance evaluation system.

4.7 Performance narrative

Using performance information to tell a meaningful performance story is an important part of the performance evaluation process. Reporting on outcomes involves presenting evidence that can be used to assess what has been achieved in relation to the expectations of the system. It should allow those interested in the performance of the biosecurity system, including the parliament, ministers, participants, the public, to form a view, with sufficient confidence, of how healthy the system is and where improvements in performance can be made. The performance story should address the different attributes of health that have been defined as important for the biosecurity system. In relation to effectiveness, for example, the performance story should answer the following questions:

- what was done and how much – what were the outputs of the system
- how well was it done – how effective was the system
- what changed as a result – what were the outcomes of the system.

Additional questions might be whether the right management activities were done and whether these were on a large enough scale to make a difference.

The Department of Finance provides guidance on how to use performance information to tell a meaningful performance story that is targeted to the appropriate audience. The performance story should provide a clear and transparent account using a coherent set of indicators. A small set of relevant and high quality performance measures is preferred over large amounts of less focused performance information (DF, 2015). A variety of data and information – both quantitative and qualitative – is needed to develop the performance story. This information can be presented through a combination of graphics, tabulation and narrative descriptions. Different layers of information are needed. For example, detailed quantitative information on system outputs will be collected at the activity level while more aggregated information will be generated to assess performance against outcomes. These may be presented in different ways with detailed data in appendices for reference and higher level information encapsulated in dashboards. All levels of information will be used to enrich the performance narrative and to facilitate data use for decision making.

4.8 Feedback and learning

When implemented effectively, an evaluation of the performance of the national biosecurity system can help identify, among the many components of the system, areas of strong performance relative to the agreed attributes of health, as well as areas of relative weakness. This can help support decisions about where to invest resources in the system in order to achieve its multi-layered objectives. The lessons derived from performance evaluation can also support consideration of the strategic direction of the biosecurity system and inform future system design.

It is unrealistic to expect that an ideal set of indicators and related performance expectations will be identified at the first attempt and that a performance measurement system will be implemented in one step that endures unchanged over time. The process is often evolutionary and advances through trial and error . The environment within which the biosecurity system operates is constantly changing, and hence ongoing planning and consequent revisions to indicators and expectations will be needed. The performance evaluation system should be seen as an evolving construct – it becomes firmer with stronger and better understood links based on evidence; acquires stronger, more meaningful measures of key results; and develops more concrete expectations (Mayne, 2004).

The evolution of the performance evaluation system should occur in a deliberate manner, rather than as random trial and error. There should be visible built-in adjustment mechanisms that identify the strongest indicators and expectations, that is, those that are most useful to stakeholders for managing the system and reporting. This reinforces the importance of deliberate learning based on past experience rather than simply reporting on the gap between expectations and actual performance (Mayne, 2004).

5 Evaluating the effectiveness of the biosecurity system

5.1 Introduction

This chapter proposes indicators of performance for the effectiveness of the biosecurity system. It considers each component of the system – anticipate, prevent, screen, prepare, detect, respond, recover/adapt – individually. Performance indicators are proposed for the direct outcome associated with each of these components of the system, as identified in the system description (chapter 3, Figure 2). Performance indicators are also proposed for each of the system level outcomes. The direct and system-level outcomes correspond with the KEQs articulated in chapter 4. The system-level outcomes are also aligned with the IGAB objectives, as outlined in the system description (chapter 3, Figure 2).

The chapter also presents a rubric for each component of the system that can be used to elicit the judgments of experts and stakeholders on the effectiveness of the biosecurity system. Chapter 2 outlines the purpose and structure of rubrics and how they can be implemented. Judgements about the effectiveness of the system complement the information obtained through the performance indicators referred to above.

The chapter also provides measures of the activities undertaken in each component of the system. These activities are described in chapter 3. The activity measures are relevant because they assess the scope and scale of activities undertaken in the biosecurity system. They provide context for the performance indicators and rubrics as well as material to support the performance narrative. They are not of themselves indicators of the performance of the biosecurity system.

5.2 Anticipate biosecurity risk

5.2.1 Activity measures

Measures of the activities undertaken to anticipate biosecurity risk are proposed below (Table 4).

Table 4: Activity measures: anticipate biosecurity risk

Activity		Activity measure
Environmental scanning	Environmental scanning is undertaken to understand the external risk environment	Number of actionable intelligence briefings generated for decision makers and entered to the risk register as a result of environmental scanning activities (IBIS, intelligence forums, overseas network finding)
Intelligence analysis and sharing	Information generated by scanning and related activities is stored, curated and analysed to produce actionable intelligence	Number of actionable risk issues identified to decision makers and entered to the risk register through department processes, including the BIIS

		Number of actionable risk issues communicated to participants in the biosecurity system, including other jurisdictions
Offshore surveillance	Surveillance measures are in place to monitor off-shore pest and disease status	Number of surveys undertaken in a given year (by country) using best practice survey design and collection and analysis techniques – animal, aquatic, plant
		Number of priority pests and diseases detected by surveillance activities in a given year (by country) – animal, aquatic, plant
		Number of sentinel herds and pest traps operational in a given year (by country) based on best practice statistical design, collection and analysis techniques – animal, plant
		Number of surveillance related capacity building programs implemented in neighbouring countries
Biosecurity risk analysis	Regulated or non-regulated risk analyses are undertaken and updated to understand the risk profile and propose risk management measures	Number and types of risk analyses and reviews undertaken in accordance with the regulations and using best available science and advice
		Proportion of significant pest/disease groups, import pathways or commodities covered by contemporary risk analyses (for example proportion of commodity types imported, based on lines in AIMS, that have undergone a pathway risk analysis in a previous specified time period such as the past five, ten years)
	Risks are prioritised as a basis for resource allocation	Existence of an evidence based prioritisation process for risk analysis, for example, through evidence of pest and disease prioritisation lists and processes for consideration of risk prioritisation

5.2.2 Performance indicators for Key Evaluation Question 1a

Question 1a: How effectively do activities to anticipate biosecurity risk contribute to the direct outcome that the biosecurity risk profile is identified, assessed and prioritised?

The direct outcome of activities to anticipate risk is: *the biosecurity risk profile is identified, assessed and prioritised*. Two performance indicators are proposed that seek to capture the effectiveness of anticipate activities (Table 5):

- The proportion of pest/disease groups, import pathways or commodities that have been assessed as high priority that are the subject of a contemporary risk analysis or review.
- This measure provides summary information about how well resources have been allocated to assessments of high priority risks, and encapsulates the steps preceding this to identify and prioritise these risks. The intention of the system should be that all biosecurity risks identified as high priority are the subject of an up-to-date risk analysis or review based on contemporary science. The measure should be calculated for animal, aquatic and plant risks. It could also be calculated for weeds, high risk import pathways or commodities.
- This measure does not provide confirmation of whether all risks have been identified – there may be new and emerging risks that have not been identified through intelligence or other sources and that may present an unacceptable level of risk if they present at the border. The following measure seeks to capture that possibility.
- Number of incidents of biosecurity risk material that are intercepted at the border that have not been subject to a risk review.
- This measure provides an indication of the number and scale of biosecurity risks that have not been identified and hence have not been analysed and prioritised. This could be measured across major import groups – animal, aquatic, plant – or could be presented as an aggregate number. If anticipate activities are effective, the number should be very low or zero.

Table 5: Performance indicators for Key Evaluation Question 1a

Question 1a: How effectively do activities to anticipate biosecurity risk contribute to the direct outcome that the biosecurity risk profile is identified, assessed and prioritised?

Direct outcome	Performance indicator	Rationale
The biosecurity risk profile is identified, assessed and prioritised	The proportion of pest/disease groups, import pathways or commodities that have been assessed as high priority that are the subject of a contemporary risk analysis or review	This measure provides summary information about how well resources have been allocated to assessments of high priority risks, and encapsulates the steps preceding this to identify and prioritise these risks
	Number of incidents of biosecurity risk material that are intercepted at the border	This measure provides an indication of the number and scale of biosecurity risks that

	that have not been subject to a risk review	have not been identified and hence have not been analysed and prioritised

5.2.3 Qualitative indicators of the direct outcome of anticipate activities

In relation to the anticipate component of the biosecurity system, the overarching question posed to stakeholders and experts is:

How effectively do activities to anticipate biosecurity risk contribute to the direct outcome that the biosecurity risk profile is identified, assessed and prioritised?

The evaluation criteria, or things that are important when answering this question, can encompass the following:

- Environmental scanning is used systematically and rigorously across all risk areas – animal, plant, aquatic – and is based on contemporary, best practice techniques.
- There is adequate coverage of priority pests and diseases in off-shore surveillance activities, including sentinel herds and pest traps – we survey the right things.
- Off-shore pest and disease surveillance activities are based on contemporary, best practice survey and sampling design and statistical techniques and are undertaken by skilled personnel – we do it well.
- Off-shore capacity building activities are well targeted and enhance the skills required for surveillance activities in host countries.
- Information generated from all sources – environmental scanning, international networks, intelligence forums, the BIIS, surveillance and sentinel activities – is converted into actionable intelligence and applied to understanding, assessing and prioritising risk.
- The information and intelligence generated by these activities are systematically shared with the appropriate potential users.
- Current biosecurity risk analyses provide good coverage of high risk pests and diseases, import pathways and commodities and provide confidence that risks are being managed appropriately.
- There is evidence that the department prioritises risk in the effective and efficient allocation of resources to areas of high priority risk.

Table 6 outlines a rubric for this high-level evaluation question.

Table 6: Rubric for Key Evaluation Question 1a

Question 1a: How effectively do activities to anticipate biosecurity risk contribute to the direct outcome that the biosecurity risk profile is identified, assessed and prioritised?

	Performance standards				
	Advanced	Good	Developing	Inadequate	Insufficient evidence
	Performance is clearly very strong or exemplary in relation to the question. Any gaps or weaknesses are not significant and are managed effectively	Performance is generally strong in relation to the question. No significant gaps or weaknesses, and less significant gaps or weaknesses are mostly managed effectively	Performance is inconsistent in relation to the question. Some gaps and weaknesses. Does not always meet minimum expectations or requirements	Performance is unacceptably weak in relation to the question. Does not meet minimum expectations or requirements	Evidence is unavailable or of insufficient quality to determine performance
Evaluation criteria*					
Environmental scanning	Environmental scanning is used systematically and rigorously across all risk areas – animal, plant, aquatic – and is based on best practice techniques.	Environmental scanning is used systematically across most risk areas – animal, plant, aquatic – but there is less effective coverage in at least one area. Techniques employed are best practice.	Environmental scanning is used across at least one risk area and may use best practice techniques.	Environmental scanning is undertaken on an ad hoc basis, does not cover all risk areas, and does not use contemporary, best practice techniques.	Evidence is unavailable or of insufficient quality to determine performance
Offshore surveillance coverage, including sentinel herds and traps	There is excellent coverage of priority pests and diseases in offshore surveillance and sentinel activities that provides a very high level of confidence that off-shore risks are identified.	There is good coverage of priority pests and diseases in offshore surveillance and sentinel activities. Confidence that off-shore risks are identified is high.	There is incomplete coverage of priority pests and diseases in offshore surveillance and sentinel activities. Confidence that off-shore risks are identified is limited.	There is insufficient coverage of priority pests and diseases in off-shore surveillance and sentinel activities to provide confidence that offshore risks are identified.	Evidence is unavailable or of insufficient quality to determine performance
Offshore surveillance design and techniques	Offshore pest and disease surveillance and sentinel activities are virtually always based on contemporary, best practice survey design and statistical techniques and undertaken by highly skilled personnel.	Offshore pest and disease surveillance and sentinel activities are mostly based on contemporary, best practice survey design and statistical techniques and are undertaken by skilled personnel.	Some offshore pest and disease surveillance and sentinel activities are based on contemporary, best practice survey design and statistical techniques and are undertaken by skilled personnel.	Offshore pest and disease surveillance and sentinel activities are generally not based on contemporary, best practice survey design and statistical techniques and are not necessarily undertaken by skilled personnel.	Evidence is unavailable or of insufficient quality to determine performance

	Performance standards				
	Advanced	Good	Developing	Inadequate	Insufficient evidence
Capacity building	Offshore capacity building activities are virtually always well targeted, and successfully build the skills required for surveillance activities and related areas of risk management in the host country. They are systematically and rigorously evaluated to determine if outcomes meet the program objectives and to guide future program design.	Offshore capacity building activities are mostly well targeted and enhance relevant risk management skills in the host country. Evaluation of outcomes is usually undertaken and can help guide future program design.	Some offshore capacity building activities are undertaken and may contribute to the skills base in the host country. Evaluation of activities is sometimes undertaken and may provide guidance for future program design.	Offshore capacity building activities are not often undertaken and are usually not well targeted or designed to build risk management skills in the host country. There is no systematic evaluation of program outcomes.	Evidence is unavailable or of insufficient quality to determine performance
Development and application of intelligence	Information generated from all sources – environmental scanning, international networks, intelligence forums, the BIIS, surveillance and sentinel activities – is virtually always successfully converted into valuable intelligence and applied to understanding, assessing and prioritising risk.	Information generated from a range of sources is mostly converted into useful intelligence and applied to understanding, assessing and prioritising risk.	Information generated from a range of sources is sometimes converted into useful intelligence and applied to understanding, assessing and prioritising risk.	Information generated from different sources is not systematically harnessed or converted into useful intelligence that can be applied to understanding, assessing and prioritising risk.	Evidence is unavailable or of insufficient quality to determine performance
Sharing of information and intelligence	Protocols and processes are applied to ensure that information and intelligence is virtually always shared with the appropriate potential users to maximise its value.	Protocols and processes are applied to support the sharing of information and intelligence with the appropriate potential users. Information and intelligence is mostly shared appropriately and its value is mostly realised.	The approach to information and intelligence sharing is developing. Some material is shared with the appropriate potential users but its value is not fully realised.	There are no protocols or processes to guide information and intelligence sharing. Sharing that occurs is on an ad hoc basis and fails to deliver value.	Evidence is unavailable or of insufficient quality to determine performance

	Performance standards				
	Advanced	Good	Developing	Inadequate	Insufficient evidence
Coverage of risk analyses	Current biosecurity risk analyses provide excellent coverage of high risk pests and diseases, import pathways and commodities and provide very high levels of confidence that risks are managed appropriately.	Current biosecurity risk analyses provide good coverage of high risk pests and diseases, import pathways and commodities and provide high levels of confidence that risks are managed appropriately.	Current biosecurity risk analyses provide limited coverage of high risk pests and diseases, import pathways and commodities. There are some gaps in coverage and timeliness of risk analyses that limit confidence that risks are managed appropriately.	Current biosecurity risk analyses provide poor coverage of high risk pests and diseases, import pathways and commodities. There are significant gaps in coverage and timeliness of risk analyses and there is little confidence that risks are managed appropriately.	Evidence is unavailable or of insufficient quality to determine performance
Risk prioritisation processes	There is strong evidence that DA has processes in place to rigorously and transparently prioritise risk as a basis for resource allocation.	There is good evidence that DA has processes in place to rigorously and transparently prioritise risk as a basis for resource allocation.	There is limited evidence that DA has processes in place to rigorously and transparently prioritise risk as a basis for resource allocation.	There is no evidence that DA has processes in place to rigorously and transparently prioritise risk as a basis for resource allocation.	Evidence is unavailable or of insufficient quality to determine performance

*Refer to text for description of the evaluation criteria

5.3 Prevent biosecurity risk material arriving at the border

5.3.1 Activity measures

Measures of the activities undertaken to prevent the arrival of biosecurity risk material at the Australian border are proposed below (Table 7).

Table 7: Activity measures: prevent biosecurity risk material arriving at the border

Activity		**Activity measure**
International arrangements	Australia participates actively in international trade forums and processes that underpin the rules of international trade	Number of relevant international bodies to which Australia is accredited and an active participant
	Australia participates actively in standards setting bodies on trade in animal, plant and food products	Number of relevant standards setting bodies in which Australia participates
		Number of leadership positions held by Australia in standards setting bodies
		Number of standards or policies influenced by Australian interventions

	Australia leads or participates in arrangements to manage biosecurity risk offshore	Number of offshore risk mitigation arrangements in place
		Number of accredited offshore biosecurity treatment providers
		Proportion of plant imports treated offshore by accredited treatment providers
Import conditions and permits	Risk based import conditions are developed and import permits issued where required	Number of import permits issued, by animal, plant, aquatic
		Proportion of high and medium risk commodities, as identified in contemporary risk analyses, included in BICON (weighted by volume of imports). That is, does BICON include everything it should?
		Proportion of BICON cases that are based on contemporary risk analyses (weighted by volume of imports). That is, are there many out of date cases in BICON?
		Proportion of imports arriving at the border without the appropriate import permit or that do not meet import conditions. That is, how effective is BICON as a tool for communicating with importers about import conditions and permits.
Offshore audit and verification	Audits by the Australian government are undertaken to provide assurance about offshore risk management activities	Number of audits of pre-export quarantine facilities by risk category and as a proportion of all pre-export quarantine facilities
		Number of offshore audits of risk mitigation processes by risk category
	Competent authorities in exporting countries are certified to undertake pre-export activities	Number of arrangements with competent authorities in exporting countries
	Independent audits by the IGB are undertaken to assess	Number of IGB audits by risk category

	the effectiveness of Australia's offshore biosecurity arrangements	
	Audit recommendations are addressed	Proportion of audit recommendations addressed
Capacity building in neighbouring countries	Capacity building activities are undertaken in neighbouring countries to enhance their capacity to manage biosecurity risks	Number of capacity building programs funded or supported in kind, by country
		Number of evaluations of capacity building programs/projects conducted by external parties, by country
		Outcomes of specific capacity building programs on a case study basis, for example, proportion of clean containers from PNG following Sea Container Hygiene Scheme training and capacity building; or number of cases of Newcastle disease in Timor-Leste following implementation of the Village Poultry Health and Biosecurity Program

5.3.2 Performance indicators for Key Evaluation Question 1b

Question 1b: How effectively do activities to prevent biosecurity risk material arriving at the border contribute to the direct outcome that the number of priority pests and diseases approaching the border is reduced?

The direct outcome of activities to prevent the entry of exotic pests and diseases is articulated in the system description as: *the number of priority pests and diseases approaching the border is reduced.*

Evidence that these activities are undertaken effectively might include (i) Australia's extensive and active participation in international organisations that establish the rules and standards for trade, including through leadership positions; (ii) the implementation of arrangements that mitigate biosecurity risk offshore; (iii) the development of import protocols and the issuing of import permits that define the conditions under which material of biosecurity interest can be imported to Australia; (iv) the undertaking of offshore audit activities that provide assurance that import conditions are met and that biosecurity risks are mitigated prior to goods or conveyances arriving at the border; and (v) the undertaking of activities in neighbouring countries that build their capacity to manage biosecurity risk. Activities undertaken to anticipate biosecurity risk also contribute to meeting this outcome.

Because the impacts of activities in the biosecurity system are cumulative, activities to anticipate risk will also have an impact on the direct outcome of prevent activities. The key measure proposed to capture the collective impact of anticipate and prevent activities is referred to in this report as the *approach rate*. This is defined as the rate of non-compliance with biosecurity import conditions before interaction with or intervention by biosecurity officers at the border, that is, the amount of biosecurity risk material that actually reaches the Australian border (Table 8).

Table 8: Performance indicators for Key Evaluation Question 1b

Question 1b: How effectively do activities to prevent biosecurity risk material arriving at the border contribute to the direct outcome that the number of priority pests and diseases approaching the border is reduced?

Direct outcome	**Performance indicator**	**Rationale**
The number of priority pests and diseases approaching the border is reduced	The approach rate – the amount of biosecurity risk material that actually reaches the border	Provides an indication of the success of offshore risk management measures as well as potential size of the border task

CEBRA has proposed indicators of the approach rate (previously termed *before intervention compliance* and *approaching compliance*) in earlier reports (Robinson *et al*., 2013; Hoffmann *et al.*, 2016). These indicators have been implemented by the department on some pathways to monitor pathway risk management. The indicator of the approach rate proposed in this report develops the existing indicators in order to increase confidence in the estimates and to allow the monitoring of pathway performance between time periods. It is explained in detail in Lane *et al*. (2018).

If all goods arriving on a pathway were inspected, then the approach rate could be observed from raw data about the number or rate of interceptions of biosecurity risk material on that pathway. In many cases, however, there is less than 100 per cent inspection – inspection rates are based on profiling and risk assessment, or the absence of suitable documentation for the consignment. To calculate the approach rate for portions of the pathway that are not inspected, and in case inspection is imperfect, it is necessary to have a measure of the leakage rate, or the amount or rate of biosecurity risk material that is not intercepted at the border. Leakage rates are observed by use of end-point surveys that test material that has been cleared at the border. The calculation and use of the leakage rate are discussed further in section 5.4.

The data requirements to estimate the approach rate are intensive. Sufficient data are available in the Mail and Passenger Systems (MAPS) database to calculate the approach rate on these two pathways. Data also exist for the commercial cargo pathway that are sufficient to calculate an approach rate. For other pathways, in the absence of end-point surveys there is no means of estimating an approach rate or leakage rate on these pathways. An alternative means of approximating these measures on these pathways is discussed in chapter 10 (section 10.5).

The approach rate indicator can be used to assess performance at different levels, or aggregations, of the biosecurity system. The mail pathway, for example, can be monitored as a single pathway to provide a high-level view of performance. It can also be disaggregated by the geographic location of the mail centre (Sydney, Melbourne, Brisbane, Perth) and by the class of mail (Express Mail Service, ordinary articles and parcels), each of which may be characterised by different levels of biosecurity risk. This might be important for individual managers to monitor the performance of the part of the system for which they are responsible. The measure of the approach rate proposed in this report is sufficiently flexible to report at the detailed level and to aggregate to a smaller number of key headline indicators.

5.3.3 Qualitative indicators of the direct outcome of prevent activities

The overarching evaluation question posed to stakeholders and experts in relation to this set of activities is:

How effectively do activities to prevent biosecurity risk material arriving at the border contribute to the direct outcome that the number of priority pests and diseases approaching the border is reduced?

The evaluation criteria, or things that are important when answering this question can be defined as follows:

- Australia's participation in international trade forums and processes (for example WTO, ILAC) contributes to effective international rules for trade and supporting systems that help deliver lower biosecurity risk.
- Australia's participation in international standards setting bodies (OIE, IPPC, Codex Alimentarius), and the IMO, including through its leadership positions, contributes to the development of appropriate science based standards, guidelines and codes of practice for the safe trade of animal, plant and food products that are consistent with the WTO's SPS Agreement, and to the establishment of global regulations to control the international transfer of potentially invasive marine species.
- The international arrangements and agreements in which Australia participates (AFAS, ICCBA, QRM) are effective mechanisms for managing biosecurity risk offshore.
- Commodity and non-commodity coverage in BICON is comprehensive and risk based; BICON cases are up to date and based on the latest available risk analyses; and BICON is a clear and effective tool for communicating with industry about import conditions and permit requirements.
- Offshore audits of commodities, risk mitigation processes and competent authorities undertaken by DA and the IGB are comprehensive, risk focused and timely; the findings or recommendations from audit activities are implemented to improve offshore risk mitigation.
- Evidence from evaluation programs shows that offshore capacity building programs deliver improved biosecurity risk management in our neighbourhood, including through enhancing networks with regional biosecurity agencies and experts.

Table 9 outlines a rubric for this evaluation question.

Table 9: Rubric for Key Evaluation Question 1b

Question 1b: How effectively do activities to prevent biosecurity risk material arriving at the border contribute to the direct outcome that the number of priority pests and diseases approaching the border is reduced?

	Performance standards				
	Advanced	Good	Developing	Inadequate	Insufficient evidence
	Performance is clearly very strong or exemplary in relation to the question. Any gaps or weaknesses are not significant and are managed effectively	Performance is generally strong in relation to the question. No significant gaps or weaknesses, and less significant gaps or weaknesses are mostly managed effectively	Performance is inconsistent in relation to the question. Some gaps and weaknesses. Does not always meet minimum expectations or requirements	Performance is unacceptably weak in relation to the question. Does not meet minimum expectations or requirements	Evidence is unavailable or of insufficient quality to determine performance
Evaluation criteria*					
Participation in trade forums and processes	Australia's participation in international trade forums and processes (WTO, ILAC, APEC) virtually always contributes to effective international rules for trade and supporting systems that help deliver lower biosecurity risk.	Australia's participation in international trade forums and processes (WTO, ILAC, APEC) usually contributes to effective international rules for trade and supporting systems that help deliver lower biosecurity risk.	Australia's participation in international trade forums and processes (WTO, ILAC, APEC) sometimes contributes to effective international rules for trade and supporting systems that help deliver lower biosecurity risk.	Australia's participation in international trade forums and processes (WTO, ILAC, APEC) rarely makes a contribution to effective international rules for trade and supporting systems that help deliver lower biosecurity risk.	Evidence is unavailable or of insufficient quality to determine performance

	Performance standards				
	Advanced	Good	Developing	Inadequate	Insufficient evidence
Participation in standards setting bodies	Australia's participation in international standards setting bodies (OIE, IPPC, Codex Alimentarius, IMO), including through its leadership positions, virtually always contributes to the development of appropriate science based standards, guidelines and codes of practice for the safe trade of animal, plant and food products that are consistent with the Word Trade Organisation's Agreement on the Application of Sanitary and Phytosanitary Measures.	Australia's participation in international standards setting bodies (OIE, IPPC, Codex Alimentarius), including through its leadership positions, usually contributes to the development of appropriate science based standards, guidelines and codes of practice for the safe trade of animal, plant and food products that are consistent with the Word Trade Organisation's Agreement on the Application of Sanitary and Phytosanitary Measures.	Australia's participation in international standards setting bodies (OIE, IPPC, Codex Alimentarius), including through its leadership positions, sometimes contributes to the development of appropriate science based standards, guidelines and codes of practice for the safe trade of animal, plant and food products that are consistent with the Word Trade Organisation's Agreement on the Application of Sanitary and Phytosanitary Measures.	Australia's participation in international standards setting bodies (OIE, IPPC, Codex Alimentarius), including through its leadership positions, rarely makes a contribution to the development of appropriate science based standards, guidelines and codes of practice for the safe trade of animal, plant and food products that are consistent with the Word Trade Organisation's Agreement on the Application of Sanitary and Phytosanitary Measures.	Evidence is unavailable or of insufficient quality to determine performance
International arrangements and agreements	The international arrangements and agreements in which Australia participates (for example, AFAS, ICCBA, QRM) are highly effective mechanisms for managing biosecurity risk offshore.	The international arrangements and agreements in which Australia participates (for example, AFAS, ICCBA, QRM) are effective mechanisms for managing biosecurity risk offshore.	The international arrangements and agreements in which Australia participates (for example, AFAS, ICCBA, QRM) are adequate mechanisms for managing biosecurity risk offshore.	The international arrangements and agreements in which Australia participates (for example, AFAS, ICCBA, QRM) are ineffective mechanisms for managing biosecurity risk offshore.	Evidence is unavailable or of insufficient quality to determine performance
BICON	Commodity and non-commodity coverage in BICON is extremely comprehensive and risk based; virtually all cases are up to date and based on the latest available risk analyses; it provides a highly effective platform for administration of permit applications and a highly effective tool for communicating with industry about import conditions and permit requirements.	Commodity and non-commodity coverage in BICON is comprehensive and risk based; most cases are up to date and based on the latest available risk analyses; it provides an effective platform for administration of permit applications and a good tool for communicating with industry about import conditions and permit requirements.	Commodity and non-commodity coverage in BICON is generally adequate but there are notable gaps in the use of up to date risk analyses and timeliness. These gaps limit its usefulness as a platform for permit administration and for communicating with industry about import conditions and permit requirements.	Commodity and non-commodity coverage in BICON is generally not comprehensive or risk based, and there are significant gaps in the use of up to date risk analyses and timeliness. It is not an effective platform for permit administration or for communicating with industry about import conditions and permit requirements.	Evidence is unavailable or of insufficient quality to determine performance

	Performance standards				
	Advanced	Good	Developing	Inadequate	Insufficient evidence
Offshore audit activities	Offshore audits of commodities, risk mitigation processes and competent authorities undertaken by DA and the IGB are virtually always comprehensive, risk focused and timely. The findings or recommendations from audit activities are virtually always implemented to improve offshore risk mitigation.	Offshore audits of commodities, risk mitigation processes and competent authorities undertaken by DA and the IGB are usually comprehensive, risk focused and timely. The findings or recommendations from audit activities are usually implemented to improve offshore risk mitigation.	There are gaps in offshore audits of commodities, risk mitigation processes and competent authorities undertaken by DA and the IGB. There are also gaps in the implementation of audit findings or recommendations.	Offshore audits of commodities, risk mitigation processes and competent authorities undertaken by DA and the IGB are generally not comprehensive, risk focused or timely. There are significant gaps in the implementation of audit findings or recommendations.	Evidence is unavailable or of insufficient quality to determine performance
Offshore capacity building programs	Offshore capacity building programs are virtually always focused on areas of highest risk. Evidence from evaluation programs shows that offshore capacity building programs virtually always deliver improved biosecurity risk management in our neighbourhood.	Offshore capacity building programs are mostly focused on areas of highest risk. Evidence from evaluation programs shows that offshore capacity building programs usually deliver improved biosecurity risk management in our neighbourhood.	Some offshore capacity building programs are focused on areas of highest risk. There is limited evidence from evaluation programs that offshore capacity building programs deliver improved biosecurity risk management in our neighbourhood.	Offshore capacity building programs are ad hoc in nature and not risk focused. There is little evidence to show that offshore capacity building programs deliver improved biosecurity risk management in our neighbourhood.	Evidence is unavailable or of insufficient quality to determine performance

*Refer to text for description of the evaluation criteria

5.4 Screen entry pathways to detect non-compliance

5.4.1 Activity measures

Measures of the activities undertaken at the border to screen goods, people and conveyances for non-compliance with biosecurity regulations are proposed in Table 10.

Table 10: Activity measures: screen entry pathways to detect non-compliance

Activity		Activity measure
Assessment/clearance	Incoming travellers, mail, cargo and conveyances are profiled according to risk	Size of the import task, for example number of travellers, mail articles, cargo inspections (from DA Annual Report)
		Number and proportion of pathways subject to profiling
		Number of risk profiles reviewed and outcomes implemented annually

Activity		Activity measure
	Incoming cargo, travellers, mail, conveyances are assessed for risk and directed to appropriate channel	Proportion of consignments not referred or referred and released on documents
		Proportion of consignments inspected
		Proportion of consignments directed to diagnostics or management/treatment
		Number of actions as a response to non-compliance (changes to operations, sanctions, directions)
		Number of reviews and updates of inspection protocols
	Random end-point surveys are conducted to estimate leakage rates	Number and proportion of pathways subject to end-point surveys using best practice survey design
	Border workforce and infrastructure are maintained	Number of trained and verified staff, dogs, x-ray machines, training events, internal review processes
		Staff retention rate and turnover
	Pest and disease vectors, for example mosquitoes, are monitored across pathways	Number of vector monitoring and surveillance activities (for example exotic mosquitoes) by pathway and facility
Diagnostic services	Submitted samples and specimens are analysed and support management decisions	Number of submissions to diagnostic services
		Proportion of non-actionable submissions (indicating potentially poor quality or unnecessary submissions)
		Proportion of diagnostic tests that meet accepted laboratory standards for sensitivity and specificity

Activity		Activity measure
	Diagnostic facilities are operated effectively	Proportion of diagnostic facilities that meet departmental quality benchmarks, including timeliness
		Number of trained diagnostic staff at the border
Management/Treatment	Goods, containers and conveyances are treated and managed effectively to reduce detected biosecurity risk to an acceptable level	Proportion of imported goods, containers and conveyances directed for treatment
		Proportion of goods, containers and conveyances that are treated effectively the first time
		Proportion of goods that are exported or destroyed
Quarantine and approved arrangements	The post entry quarantine facility contains high biosecurity risk material effectively	Live animal imports and plant material processed at post-entry quarantine facilities
		Number of pest and disease incidents from imported live animals and plant material, contained and not contained
	Approved arrangements contain biosecurity risk material effectively	Compliance rate of approved arrangements' facilities – proportion of failed audits (by class of facility, critical/major non-compliance category, by announced/unannounced audit)
		Audit rate (proportion of facilities audited within a specified time period)

5.4.2 Performance indicators for Key Evaluation Question 1c

Question 1c: How effectively do activities to screen entry pathways to detect non-compliance contribute to the direct outcome that the number of priority pests and diseases entering Australia is reduced?

The system description describes the direct outcome of activities to screen entry pathways to detect non-compliance as: the number of priority pests and diseases entering Australia is reduced.

Evidence of the effectiveness of these activities would be supported by (i) best practice profiling based on data analysis and feedback; (ii) comprehensive end-point surveys that accurately test the performance of assessment practices; (iii) state of the art diagnostic facilities and capabilities; (iv) implementation of management/treatment options that mitigate risk effectively; and (v) approved arrangements and quarantine processes that contain risk appropriately.

Because the impacts of activities in the biosecurity system are cumulative, activities to anticipate risk and to prevent biosecurity risk material arriving at Australia's borders will also have an impact on the direct outcome of screen activities. A key indicator that can be used to assess the overarching effectiveness of these activities is the leakage rate, defined as the amount or rate of biosecurity risk material that is not intercepted at the border (Table 11). Leakage rates are observed through end-point surveys that inspect material that has been cleared at the border, following document assessment, screening or inspection. The department conducts end-point surveys on the traveller and mail pathways. It also implements the cargo compliance verification scheme, which is the equivalent of an endpoint survey on commercial containerised cargo. As with the approach rate, the possible estimation of leakage rates on pathways that lack end-point surveys are conducted is discussed in chapter 10.

Table 11: Performance indicators for Key Evaluation Question 1c

Question 1c: How effectively do activities to screen entry pathways to detect non-compliance contribute to the direct outcome that the number of priority pests and diseases entering Australia is reduced?

Direct outcome	**Performance indicator**	**Rationale**
The number of priority pests and diseases entering Australia is reduced	The leakage rate – the amount or rate of biosecurity risk material that is not intercepted at the border	Provides an indication of the amount of biosecurity risk material that actually passes through border controls and has the potential to establish or spread onshore

The approach adopted in this project is to model the leakage rate on a pathway rather than to use the raw leakage data from end-point surveys. This is because end-point surveys are based on a small sample of material that crosses the border rather than all such material. The model developed in this project uses plausible assumptions that enable us to generalise from the behaviour of the sample to the behaviour of the whole pathway and provides a tool that can be used to measure and monitor pathway performance. Lane *et al.* (2018) provide technical detail about the leakage rate model developed in this project.

Some of the key points of the modelling approach adopted here are:

- Where data are sparse, the model can smooth the available data across pathways, borrowing strength from neighbouring observations. For example, if an end-point survey has not been undertaken on a particular pathway in a

particular year the model can predict the leakage rate using data from previous years and from other pathways;
- Estimates of leakage rates at higher levels of aggregation can be aggregated from lower levels by volume weights;
- Variability resulting from the estimation of leakage rates can be accounted for at any level of aggregation, and for any derived indicator, including the approach rate, providing for more informed decision making by pathway managers;
- Probability intervals can be calculated for the leakage rate at any level of the system that enhance clarity about the direction and magnitude of change in performance on a pathway.

As indicated in the second point above, the leakage rate indicator can be used to measure performance at different levels, or aggregations, of the biosecurity system, as is the case with the approach rate. For example, at the lowest level of aggregation, the international mail pathway could be monitored at a single geographic location, for a single class of mail, cleared by a single intervention type, or any combination of these. A leakage rate can be measured, for example, for ordinary mail articles coming through the Sydney Mail Gateway Facility that have been inspected by detector dogs; for all ordinary mail articles coming through the Sydney mail exchange inspected by any means; or for the aggregate mail pathway – all geographic locations, all types of mail and all inspection types.

Also outlined in Lane *et al.* (2018) is an approach to developing performance benchmarks, targets or expectations for the leakage rate indicator to assist in using the indicator as a tool for managing the performance of a pathway. Chapter 2 of the report notes that an essential step towards evaluating the performance of the biosecurity system is to define what a 'healthy' system looks like. This can involve defining benchmarks that are deemed healthy, as well as setting expectations of future performance. It has also been noted that CEBRA does not consider that it is well placed to define performance benchmarks and that these should be agreed by the stakeholder community on the basis of its understanding of the operations of the system and its constraints.

Lane *et al.* (2018) provides an example of how benchmarks might be set by stakeholders, including the establishment of decision rules or criteria that can be used to define different levels of performance and to monitor performance over time. The monitoring framework should be capable of detecting trend changes in the system over time, where the probability of a change in performance is significant. It should also be capable of detecting when performance benchmarks are not met, that is the absolute level of performance.

The following example uses confected data to represent a general pathway to demonstrate how the leakage rate can be used to measure and monitor performance on a pathway, including at different levels of aggregation. The leakage rate is expressed as the number of units with biosecurity risk material not intercepted as a proportion of the total number of units. A detailed description of the method and model developed for this analysis is provided in Lane *et al.* (2018).

The analysis uses the estimates of leakage rates generated by the model and calculates two further measures. These are:

- An assessment of changes in the estimated leakage rate over time; and
- A comparison of the leakage rate with a benchmark to judge if the leakage rate is meeting agreed minimum performance standards.

To assess whether *changes in the leakage rate over time* are significant, probability intervals around the estimates are calculated. Figure 9, for example, shows the estimated leakage rate for a pathway as well as a 90% probability interval. The grey shading represents the range of estimates in which we can have 90% confidence that the real estimate occurs. Providing this measure of the statistical uncertainty around the estimates helps managers to identify whether changes in the estimates are significant or whether they may be the result of random influences such as fluctuations in the volume of material on the pathway. The change in the estimated leakage rate between 2012-13 and 2013-14 might be judged to be not highly significant because the 2013-14 estimate lies almost within the 90% probability interval of the 2012-13 estimate. The change between 2015-16 and 2016-17 is clearly a significant change because the latter estimate is well above the probability interval of the 2015-16 estimate, indicating a deterioration in overall pathway performance.

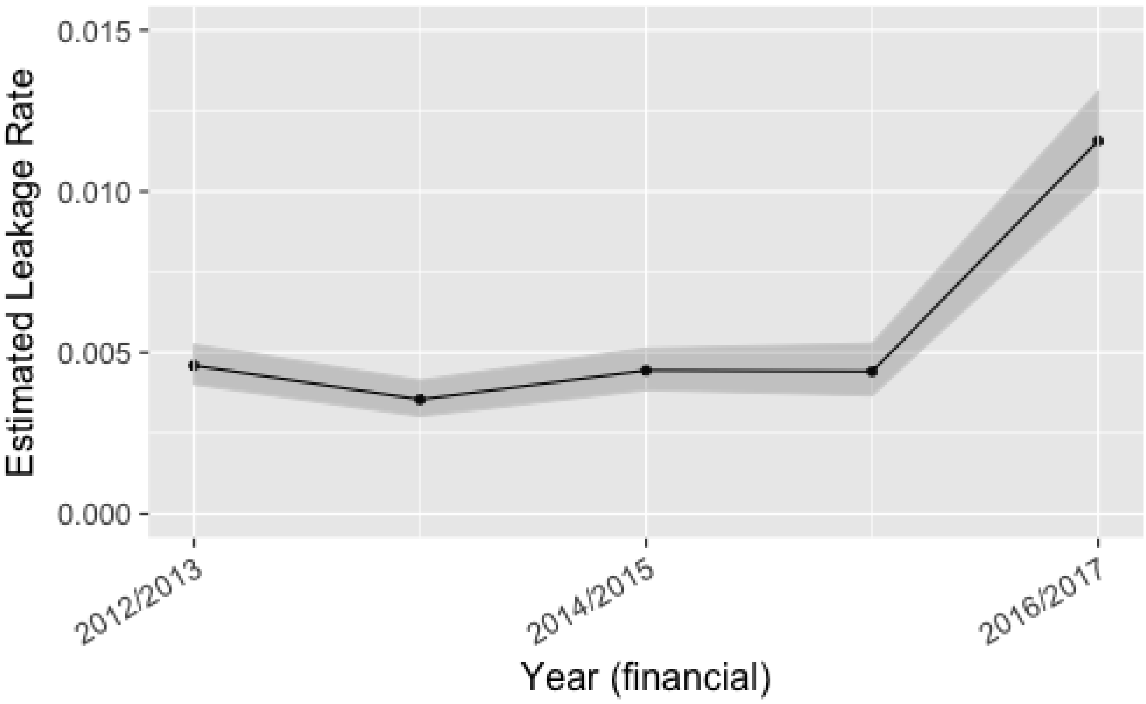


Figure 9: Estimated leakage rates (proportion) and 90% probability intervals for an example pathway using confected data.

Comparisons of the leakage rate with a performance benchmark or target are also based on a probability framework similar to that described above. They provide additional context for pathway managers in order to support decision making. The following illustrates the concepts in the analysis.

Benchmarks are specified for both the leakage rate (L) and the estimated change in leakage rate (C) from the previous time to the current time. The performance benchmarks used in the example presented here are arbitrary. As discussed earlier, appropriate performance benchmarks should be established by stakeholders who have a sound understanding of the operations of the system or pathway, including any constraints under which it operates and the biosecurity risk that arises from leakage.

We compare the estimated leakage rate L with an acceptable cut-off, say, 0.002 (0.2%). We say that if the estimated probability that the true leakage rate is higher than 0.002 is, say, less than 60%, then the leakage is *acceptable*. In Table 12 below, this is symbolised as row title ‘Pr(L > 0.002) < 60%’. However, if the estimated probability that the true leakage rate is higher than 0.002 is, say, more than 90%, then we should take action (row title ‘Pr(L > 0.002) > 90%’). If the estimated probability is between 60% and 90% then we might pay greater attention to activity on the pathway by, for example, increasing sampling to obtain more information (row title ‘60% < Pr(L > 0.002) < 90%’).

Table 12: Example decision matrix to assess the health of a pathway based on monitoring the trend and level of the indicator

	Pr(C > 0) < 60%	60% < Pr(C > 0) < 90%	Pr(C > 0) > 90%
Pr(L > 0.002) < 60%	Acceptable	Acceptable	Acceptable
60% < Pr(L > 0.002) < 90%	Acceptable	Pay Attention	Pay Attention
Pr(L > 0.002) > 90%	Pay Attention	Take Action	Take Action

Note: This decision matrix is for an indicator that should be low, so being above the benchmark or increasing over time is not desirable. The rows refer to the value of the leakage rate, L, and the columns refer to the change in the leakage rate, C. (Adapted from table 2.1, Lane *et al*., 2018).

Similarly, we can compare the estimated change in the leakage rate, C, between the previous and the current period. We can say that if the estimated probability that the true leakage rate is increasing is, say, less than 60%, then the leakage is *acceptable* (column title ‘Pr(C > 0) < 60%’). However, if the estimated probability that the true leakage rate is increasing is, say, more than 90%, we then we should take action (column title ‘Pr(C > 0) > 90%’). If the estimated probability is between 60% and 90% then we might, again, pay increasing attention to the pathway by, for example, increasing sampling to obtain more information (column title ‘60% < Pr(C > 0) < 90%’).

Note again that these cut-off values are selected for the purposes of example and are not intended to reflect recommended values in any way. Depending on the expected biosecurity risk of contamination, stakeholders may prefer a more stringent set of criteria, for example, 10% in place of our 60% and 40% in place of our 90%.

These two decision rules can be combined to provide a more complete picture of pathway performance. An example of a possible combined decision rule that can be used to make judgments about the performance of a pathway using performance benchmarks is shown as a matrix in Table 12. The matrix uses two dimensions – the probability that the indicator is increasing; and the probability that the indicator is above the benchmark. In the case of the leakage rate indicator, both of these conditions are undesirable because lower leakage rates are preferred to higher. The matrix uses the same numeric cut-offs to categorise performance on the pathway as used in the narrative example outlined above.

Using the two dimensions, assessments can be made of the overall performance, or health of the pathway being monitored. We have classified these as:

- Take action: the pathway is not performing to an acceptable standard, either because leakage rates are increasing, or performance benchmarks are not being met, or some combination of these two. Action is required to improve performance.
- Pay attention: some elements of performance are not meeting an acceptable standard. Additional monitoring of the pathway is required to ensure there is no deterioration in performance.
- Acceptable: the pathway is meeting acceptable standards – leakage rates are not increasing significantly, and performance benchmarks are being met. No additional action is required.

Figure 10 illustrates how the indicators of change in the leakage rate and the performance benchmarks can be combined to present information on the overall health of a pathway. The example shows four entry points independently, as well as the aggregation of all four. It aggregates all classes of units and all inspection types. Lane *et al.* (2018) provides detail on how the model aggregates across sub-pathways using volume weights. The cut-offs used are as per Table 12 and the narrative example above.

The results presented in Figure 10, based on the arbitrary performance benchmarks outlined above, show that the overall health of the pathway is acceptable. At Entry Point A, a steep increase in the leakage rate in the last recorded period results in a performance rating of Take Action, and rates of change in leakage rates at Entry Point D lead to a performance rating of Pay Attention. The increase in the leakage rate in Entry Point C is similar to Entry Point A but the leakage level in Entry Point C is so low that it is still acceptable.

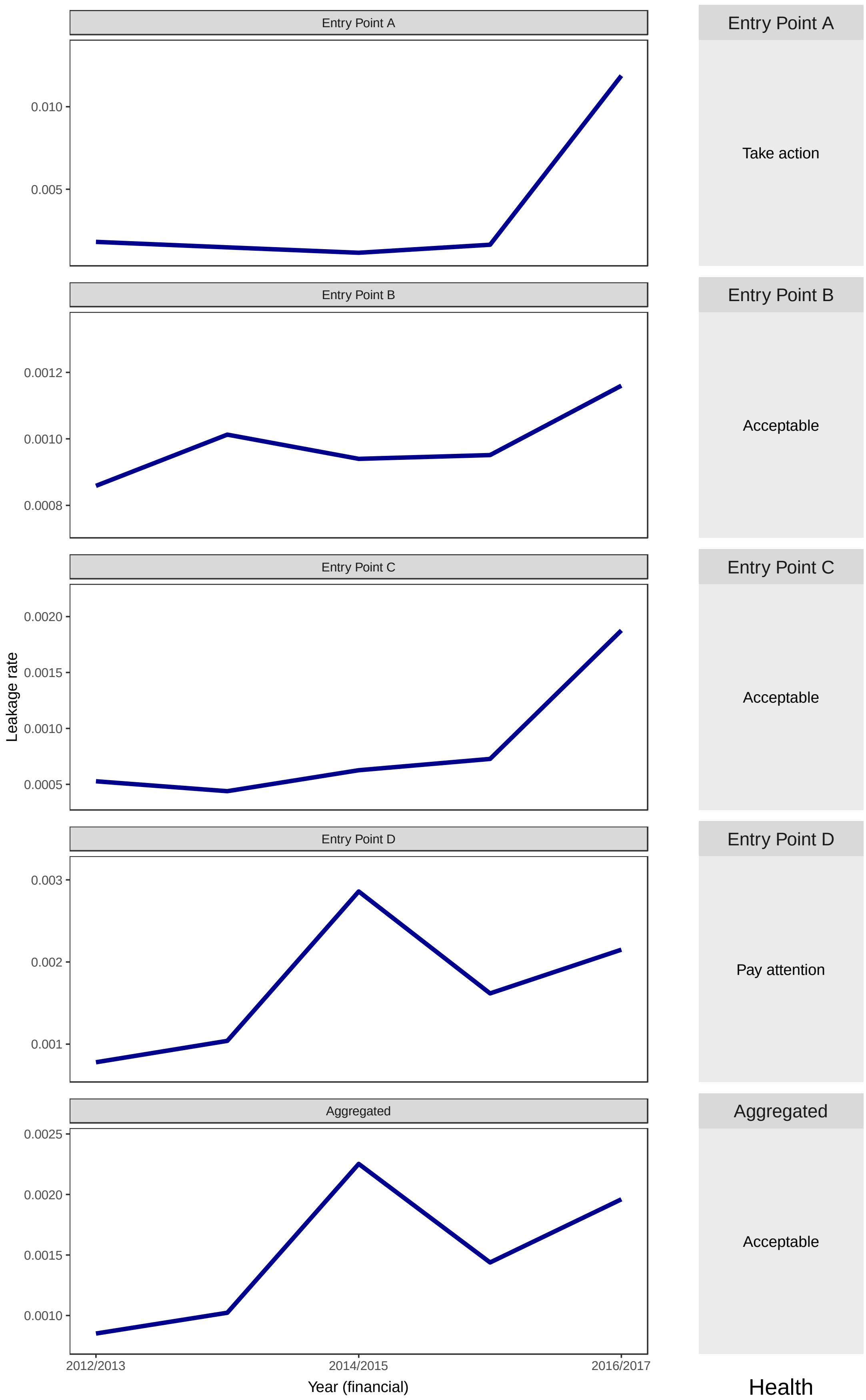


Figure 10: Leakage rate (proportion) and assessment of the overall performance for an example pathway using confected data.

5.4.3 Qualitative indicators of the direct outcome of screen activities

The overarching evaluation question posed to stakeholders and experts in relation to this set of activities is:

How effectively do activities to screen entry pathways to detect non-compliance contribute to the direct outcome that the number of priority pests and diseases entering Australia is reduced?

Most of the issues relevant to this question are captured in the activity measures proposed in section 5.4.1 and in the measurement of the leakage rate. These include the effectiveness of profiling activities; the accuracy and comprehensiveness of end-point surveys; the quality and capacity of diagnostic services; the effective implementation of management and or treatment options to mitigate risk; and the effectiveness of approved arrangements and quarantine facilities that contain risk. Some evaluation criteria that might be raised with stakeholders to add a qualitative dimension to the high level evaluation question are the following:

- Assessment and inspection outcomes are used to improve profiling;
- Significant diagnostic results are used to inform import management and policy; and
- Border interception data are shared with post-border agencies to improve pathway analysis, to ensure that new surveillance risks are known, and to target post-border surveillance activities appropriately.

These focus on whether systems and protocols are in place to ensure that results of significant activities at the border feed into future processes to manage risk.

Table 13 outlines a rubric for this evaluation question.

Table 13: Rubric for Key Evaluation Question 1c

Question 1c: How effectively do activities to screen entry pathways to detect non-compliance contribute to the direct outcome that the number of priority pests and diseases entering Australia is reduced?

	Performance standards				
	Advanced	Good	Developing	Inadequate	Insufficient evidence
	Performance is clearly very strong or exemplary in relation to the question. Any gaps or weaknesses are not significant and are managed effectively	Performance is generally strong in relation to the question. No significant gaps or weaknesses, and less significant gaps or weaknesses are mostly managed effectively	Performance is inconsistent in relation to the question. Some gaps and weaknesses. Does not always meet minimum expectations or requirements	Performance is unacceptably weak in relation to the question. Does not meet minimum expectations or requirements	Evidence is unavailable or of insufficient quality to determine performance

Evaluation criteria*					
Assessment and inspection outcomes	Highly effective processes and protocols are in place to ensure that assessment and inspection outcomes are virtually always used to improve profiling.	Effective processes and protocols are in place to ensure that assessment and inspection outcomes are usually used to improve profiling.	Processes and protocols are being developed to ensure that assessment and inspection outcomes can be used to improve profiling.	A systematic approach to the use of assessment and inspection outcomes is not in place and does not contribute to improved profiling.	Evidence is unavailable or of insufficient quality to determine performance
Significant diagnostic results	Highly effective processes and protocols are in place to ensure that significant diagnostic results are virtually always used to inform import management and policy.	Effective processes and protocols are in place to ensure that significant diagnostic results are usually used to inform import management and policy.	Processes and protocols are being developed to ensure that significant diagnostic results can be used to inform import management and policy.	A systematic approach to the use of significant diagnostic results is not in place and does not inform import management and policy.	Evidence is unavailable or of insufficient quality to determine performance

*Refer to text for description of the evaluation criteria

5.5 System-level outcome: IGAB objective 1; KEQ 1

As described in the system description, anticipate, prevent and screen activities contribute to the overarching system-level objective, IGAB objective 1, to:
Reduce the likelihood of exotic pests and diseases, which have the potential to cause significant harm to the economy, the environment and the community (including people, animals and plants), from entering, becoming established or spreading in Australia.

Two indicators are proposed for this outcome. The first is the same as the indicator of the direct outcome of screen activities, namely the leakage rate. This is because lower leakage rates reduce the possibility of exotic pests and diseases establishing and spreading in Australia. The complement of the leakage rate, that is the capture rate, or the amount of biosecurity risk material that is captured at the border, is also relevant. This is because higher capture rates reduce the possibility of exotic pests and diseases from entering, establishing and spreading in Australia.

Table 14: Performance indicators of the system-level outcome (IGAB objective 1; KEQ 1)

System-level outcome	**Performance indicator**	**Rationale**
Reduce the likelihood of exotic pests and diseases from entering, becoming established or spreading in Australia	The leakage rate – the amount or rate of biosecurity risk material that is not intercepted at the border The amount of biosecurity risk material that is captured by the system	Lower leakage rates reduce the possibility of exotic pests and diseases establishing and spreading in Australia. Higher capture rates reduce the possibility of exotic pests and diseases entering, establishing and spreading in Australia.

5.6 Prepare for an incursion or outbreak of pests and diseases

5.6.1 Activity measures

Table 15 proposes measures of activities in the biosecurity system that underpin stakeholder preparedness for an incursion or outbreak of pests and diseases.

Table 15: Activity measures: prepare for an incursion or outbreak of pests and diseases

Activity measure		Performance indicator
Response agreements	Appropriate agreements and plans are in place that support biosecurity preparedness for incursions and outbreaks across all sectors and industries	Number and proportion of sectors and industries covered by current agreements and planning documents
		Number of emergency response arrangements and programs with overseas counterparts, other jurisdictions and industry
Training and simulation activities	Emergency capability is maintained at a high level through relevant training and simulation activities	Number of training events, including participant assessment, based on defined roles and competencies
		Number of simulation exercises conducted by government and industry
Farm biosecurity	Training and education programs support on-farm biosecurity awareness, understanding and monitoring practices	Level of awareness of the Farm Biosecurity Program by Australian producers (from the AHA/PHA Farm Biosecurity Program producer survey)
		Level of understanding of biosecurity among Australian producers (source as above)
		Proportion of producers monitoring crops or livestock for pests or diseases (source as above)
		Number and proportion of farms with formal farm biosecurity plans in place

Support tools	Tools are available to support preparedness for response, surveillance and long-term management of pests and diseases	Number of jurisdictions participating in harmonised systems and tools for data collection, storage and sharing (AusPest Check, NAHIS, MAX)
		Number and proportion of sectors/industries where national pest and disease spread modeling capability (animal, plant, aquatic) has been developed
		Number of vaccine banks established for significant EDA

5.6.2 Performance indicators for Key Evaluation Question 2a

Question 2a: How effectively do activities to prepare for an incursion or outbreak of pests and diseases contribute to the direct outcome that system participants are ready to respond to priority pest and disease incursions and outbreaks?

The direct outcome of prepare activities is described in the system description as: *Participants in the biosecurity system are ready to respond to priority pest and disease incursions and outbreaks*. While not explicitly stated, this implies that resources, systems and tools are in place that support detection and response activities, as well as the long-term management of pests and diseases. 'Participants' refers to all stakeholders: government, industry, producers and the general community.

The proposed indicator of this direct outcome is deliberately posed at a high level (Table 16). It is not about individual elements of preparedness, but rather about how prepared the system as a whole is to deal with incursions and outbreaks of pests and diseases. Emergency response simulation exercises and reviews of past response actions identify critical gaps in preparedness at national and jurisdictional levels. Those critical gaps are the symptoms of shortcomings of different aspects of preparedness, including governance, legislation, policy, arrangements and plans, capacity and capability. Identification of gaps is a first step only but provides the basis for implementing actions to rectify the issues identified. The proposed performance measure addresses how many critical gaps in emergency response preparedness identified at the national and state/territory levels have been addressed within appropriate time frames. This provides a summary measure of how prepared the system as a whole is to respond to pest and disease incursions.

Table 16: Performance indicators for Key Evaluation Question 2a

Question 2a: How effectively do activities to prepare for an incursion or outbreak of pests and diseases contribute to the direct outcome that system participants are ready to respond to priority pest and disease incursions and outbreaks?

Direct outcome	Performance indicator	Rationale
Participants in the biosecurity system are ready to respond to priority pest and disease incursions and outbreaks	Number and proportion of critical gaps in preparedness, identified through emergency response simulation exercises and reviews (post incident or other), that are addressed in a timely and positive manner	Simulation exercises and reviews identify critical gaps in all areas of response preparedness at national and jurisdictional levels. These gaps should be addressed in a timely manner to ensure effective response preparedness in the future

5.6.3 Qualitative indicators of the direct outcome of prepare activities

In order to capture the judgements of stakeholders and experts on the effectiveness of prepare activities, the following overarching question is posed:

How effectively do activities to prepare for an incursion or outbreak of pests and diseases contribute to the direct outcome that system participants are ready to respond to priority pest and disease incursions and outbreaks?

The evaluation criteria, or things that are important when answering this question, can encompass the following:

- Emergency response deeds, plans and strategies are comprehensive and up to date
- Training and simulation exercises maintain emergency response capability at a high level
- Gaps identified in preparedness through simulation exercises and post-incident reviews are evaluated and addressed in appropriate timeframes
- Farm biosecurity programs and practices help reduce the risk of pests and diseases establishing and spreading
- Data management systems support the sharing of information about pest and disease incidents between jurisdictions.
- National level modelling of pests and diseases is available to support responses to emergency incursions and outbreaks
- The National Biosecurity Response Team is adequately resourced and trained
- Vaccine bank arrangements are in place where appropriate
- APVMA is equipped to provide emergency use permits where appropriate

Table 17 outlines a rubric for this evaluation question.

Table 17: Rubric for Key Evaluation Question 2a

Question 2a: How effectively do activities to prepare for an incursion or outbreak of pests and diseases contribute to the direct outcome that system participants are ready to respond to priority pest and disease incursions and outbreaks?

	Performance standards				
	Advanced	Good	Developing	Inadequate	Insufficient evidence
	Performance is clearly very strong or exemplary in relation to the question. Any gaps or weaknesses are not significant and are managed effectively	Performance is generally strong in relation to the question. No significant gaps or weaknesses, and less significant gaps or weaknesses are mostly managed effectively	Performance is inconsistent in relation to the question. Some gaps and weaknesses. Does not always meet minimum expectations or requirements	Performance is unacceptably weak in relation to the question. Does not meet minimum expectations or requirements	Evidence is unavailable or of insufficient quality to determine performance
Evaluation criteria*					
Emergency response agreements, plans and strategies	Emergency response agreements, plans and strategies are virtually always comprehensive and up to date and provide excellent guidance on emergency risk management.	Emergency response agreements, plans and strategies are mostly comprehensive and up to date and provide good guidance on emergency risk management.	Emergency response agreements, plans and strategies provide incomplete coverage and are sometimes out of date. The guidance they provide on emergency risk management is inconsistent.	Emergency response agreements, plans and strategies and plans do not provide comprehensive coverage and are not up to date. They provide poor guidance on emergency risk management.	Evidence is unavailable or of insufficient quality to determine performance
Training and simulation exercises	Training programs and simulation exercises virtually always ensure a very high degree of readiness for a response to an emergency pest or disease incursion or outbreak.	Training programs and simulation exercises usually ensure a high degree of readiness for a response to an emergency pest or disease incursion or outbreak.	Training programs and simulation exercises ensure some readiness for a response to an emergency pest or disease incursion or outbreak but there may be some gaps in preparedness across sectors and/or participants.	Training programs and simulation exercises are not sufficiently comprehensive to ensure appropriate readiness for a response to an emergency pest or disease incursion or outbreak. There are significant gaps across sectors and/or participants.	Evidence is unavailable or of insufficient quality to determine performance
Addressing gaps in preparedness	Gaps in preparedness identified through simulation exercises and post-incident reviews are virtually always evaluated and addressed in appropriate timeframes.	Gaps in preparedness identified through simulation exercises and post-incident reviews are usually evaluated and addressed in appropriate timeframes.	Some gaps in preparedness identified through simulation exercises and post-incident reviews are evaluated and addressed in appropriate timeframes but some gaps persist.	Gaps identified in preparedness through simulation exercises and post-incident reviews are not generally evaluated and addressed in appropriate timeframes.	Evidence is unavailable or of insufficient quality to determine performance

	Performance standards				
	Advanced	Good	Developing	Inadequate	Insufficient evidence
Farm biosecurity	Farm biosecurity programs and practices virtually always make a significant contribution to reducing the risk of pests and diseases establishing and spreading.	Farm biosecurity programs and practices usually make a good contribution to reducing the risk of pests and diseases establishing and spreading.	Farm biosecurity programs and practices make some contribution to reducing the risk of pests and diseases establishing and spreading.	Farm biosecurity programs and practices make little contribution to reducing the risk of pests and diseases establishing and spreading.	Evidence is unavailable or of insufficient quality to determine performance
Support tools	There is a comprehensive range of tools that provide highly effective support for participants in the biosecurity system to be better prepared for incursions or outbreaks of pests and diseases. These include data management and sharing systems, awareness building and education programs, national scale pest and disease modelling, vaccine banks, and the capacity to issue emergency use permits for chemical products. during an emergency.	There is a range of tools that provide effective support for participants in the biosecurity system to be better prepared for incursions or outbreaks of pests and diseases.	There are some tools available that support participants in the biosecurity system to be better prepared for incursions or outbreaks of pests and diseases but gaps in provision reduce their effectiveness.	Tools available to support participants in the biosecurity system to be better prepared for incursions or outbreaks of pests and diseases are very limited, with significant gaps in effectiveness.	Evidence is unavailable or of insufficient quality to determine performance
National Biosecurity Response Team	The National Biosecurity Response Team is extremely well resourced, including having surge capacity, highly trained in emergency management, and virtually always available to respond to emergencies across all sectors.	The National Biosecurity Response Team is well resourced and trained and can usually respond effectively to emergencies across sectors.	The National Biosecurity Response Team is adequately resourced and trained and able to respond effectively to some emergencies across sectors.	The National Biosecurity Response Team is not adequately resourced or trained and is frequently unable to respond effectively to emergencies.	Evidence is unavailable or of insufficient quality to determine performance

*Refer to text for full description of the evaluation criteria

5.7 Detect pest or disease incursions or outbreaks in Australia

5.7.1 Activity measures

Measures of activities undertaken to detect incursions or outbreaks of pests and diseases in Australia are proposed in Table 18.

Table 18: Activity measures: detect pest and disease incursions or outbreaks in Australia

Activity		Activity measure
Surveillance	Targeted and general surveillance programs encompass regional or national priority pests and diseases, environmental and social priorities	Number and proportion of priority pests and diseases, environmental and social priorities that are covered by an early detection surveillance program, targeted or general
		Number and proportion of surveillance systems that achieve the expected sensitivity for early detection
	National surveillance efforts are connected to international initiatives and programs to receive early warning information	Number of international surveillance networks that provide early warning of potential pest and disease risks
Diagnostics	Diagnostic tests are carried out using appropriate methods under a quality assurance scheme that ensures timely and accurate results	A national inter-laboratory proficiency testing program ensures consistent and comparable results between laboratories
		Nationally agreed standard diagnostic testing protocols exist and are used for all priority pests and diseases
		Number and proportion of diagnostic tests (by government diagnostic facilities and third-party providers) that meet specificity, sensitivity and timeliness requirements
		Proportion of diagnostic laboratory providers and tests (animal and plant) with NATA accreditation for testing laboratories (ISO/IEC 17025)

		Number and proportion of priority pests and diseases that are covered by primary and secondary laboratory diagnostic capacity
	Diagnostic services are supported through integrative institutional arrangements that improve their effective operation	Number and proportion of priority pests and diseases where there is a nominated national reference laboratory responsible for maintaining competence in diagnosis and for transferring tests and technologies to other laboratories
		Number and proportion of diagnostic service providers that are part of national networks (LEADRR and NPBDN)
Traceability	Movements of plant and animal risk material is effectively tracked and spread of pests and diseases effectively traced, improving chances to contain or eradicate an incursion or outbreak	Number and proportion of major animal and plant production industries with an official property identification system in place to support the development/operation of traceability systems
		NLIS meets the National Livestock Traceability Performance Standards, as measured through AHA audit results.
		Number and proportion of emergency responses where the initial source of an incursion or outbreak was identified

5.7.2 Performance indicators for Key Evaluation Question 2b

Question 2b: How effectively do activities to detect an incursion or outbreak of pests and diseases contribute to the direct outcome that the time taken to detect incursions and outbreaks of priority pests and diseases is reduced?

The direct outcome of detect activities, as described in the system description, is: *The time taken to detect incursions or outbreaks of priority pests and diseases is reduced*.

Time is generally important for detection of incursions and outbreaks because early detection allows control measures to be implemented while the spread of a pest or disease is limited. This is not necessarily universally applicable as the rapid spread of some pests and diseases means they may not be eradicable even if they are detected immediately after entry or outbreak, and conversely some pests and diseases spread very slowly. The proposed performance indicator is designed to take account of these different characteristics by considering whether pests and diseases are detected in a timeframe that would allow successful containment or eradication. The accuracy of diagnostic tests influences the timeliness of detection because false negatives may delay detection of a pest or disease. Therefore, the proposed performance indicator incorporates indirectly the impact of diagnostic accuracy on the timeliness of detection (Table 19).

Table 19: Performance indicators for Key Evaluation Question 2b

Question 2b: How effectively do activities to detect an incursion or outbreak of pests and diseases contribute to the direct outcome that the time taken to detect incursions or outbreaks of priority pests and diseases is reduced?

Direct outcome	**Performance indicator**	**Rationale**
The time taken to detect incursions or outbreaks of priority pests and diseases is reduced	Number and proportion of incursions or outbreaks where priority pests and diseases are detected and reported in time to enable containment or eradication	Early detection, when the extent of spread is small, maximises chances of containment or eradication
	Number and proportion of reports of early detection of priority pests and diseases by source, for example, targeted surveillance program or producer reports	A broad range of sources contributing to early detection indicates that the overall surveillance system has good coverage and reduces the risk of missing an incursion or outbreak of a pest or disease

5.7.3 Qualitative indicators of the direct outcome of detect activities

In relation to detect activities, the overarching evaluation question posed to stakeholders and experts is:

How effectively do activities to detect an incursion or outbreak of pests and diseases contribute to the direct outcome that the time taken to detect incursions or outbreaks of priority pests and diseases is reduced?

The evaluation criteria, or things that are important when answering this question encompass the following:

- Surveillance activities are based on a robust and transparent planning process that is informed by trade forecasts and analysis, intelligence reports and data on biosecurity risk material intercepted at the border, and encompass high priority pests and diseases, as well as environmental and social priorities
- Surveillance programs are based on sound statistical design and achieve appropriate sensitivity and specificity

- Diagnostic laboratories are adequately maintained and resourced and capable of surge capacity in the event of an emergency
- Diagnostic capability is adequate and supported by professional development programs and strategic recruitment
- Livestock traceability systems meet the National Livestock Traceability Performance Standards
- Identified sources of incursions and outbreaks are shared with relevant partners in the biosecurity system and inform pre-border, border and post-border activities

Table 20 outlines a rubric for this evaluation question.

Table 20: Rubric for Key Evaluation Question 2b

Question 2b: How effectively do activities to detect an incursion or outbreak of pests and diseases contribute to the direct outcome that the time taken to detect incursions or outbreaks of priority pests and diseases is reduced?

	Performance standard				
	Advanced	Good	Developing	Inadequate	Insufficient evidence
	Performance is clearly very strong or exemplary in relation to the question. Any gaps or weaknesses are not significant and are managed effectively	Performance is generally strong in relation to the question. No significant gaps or weaknesses, and less significant gaps or weaknesses are mostly managed effectively	Performance is inconsistent in relation to the question. Some gaps and weaknesses. Does not always meet minimum expectations or requirements	Performance is unacceptably weak in relation to the question. Does not meet minimum expectations or requirements	Evidence is unavailable or of insufficient quality to determine performance
Evaluation criteria*					
Surveillance planning and coverage	Surveillance activities are virtually always based on a transparent planning process that is shared between appropriate biosecurity system participants and encompasses high priority pests and diseases, as well as environmental and social priorities.	Surveillance activities are usually based on a transparent planning process that is shared between appropriate biosecurity system participants and encompasses high priority pests and diseases, as well as environmental and social priorities.	Some surveillance activities are based on a transparent planning process that may be shared between appropriate biosecurity system participants. There are some gaps in coverage of high priority pests and diseases, as well as environmental and social priorities.	Surveillance activities are generally not based on transparent planning or sharing between biosecurity system participants. There are significant gaps in coverage of high priority pests and diseases, as well as environmental and social priorities.	Evidence is unavailable or of insufficient quality to determine performance

	Performance standard				
	Advanced	Good	Developing	Inadequate	Insufficient evidence
Surveillance design and performance	Surveillance activities are virtually always based on contemporary, best practice survey design and statistical techniques and achieve appropriate sensitivity and specificity that gives a very high level of confidence in results.	Surveillance activities are usually based on contemporary, best practice survey design and statistical techniques and achieve a level of sensitivity and specificity that gives confidence in results.	Some surveillance activities are based on contemporary, best practice survey design and statistical techniques. There are gaps in sensitivity and specificity that limit the confidence in some results.	Surveillance activities are generally not based on contemporary, best practice survey design and statistical techniques. They generally do not achieve the appropriate sensitivity and specificity to provide confidence in surveillance results.	Evidence is unavailable or of insufficient quality to determine performance
Diagnostic laboratory capacity	The diagnostic laboratory system is maintained and resourced to a very high level with sufficient surge capacity to cope with virtually all emergency situations.	The diagnostic laboratory system is maintained and resourced to a high level with sufficient surge capacity to cope with most emergency situations.	The diagnostic laboratory system is adequately maintained and resourced and has the capacity to respond to some emergency situations although surge capacity is limited.	The diagnostic laboratory system is not well maintained and resourced and there are significant gaps in its capacity to respond to emergency situations.	Evidence is unavailable or of insufficient quality to determine performance
Diagnostic laboratory capability	Diagnostic capability is very high and supported by targeted professional development programs and strategic recruitment.	Diagnostic capability is high and supported by professional development programs and strategic recruitment.	Diagnostic capability is adequate although some gaps are evident. Professional development programs and recruitment are not always strategic and hence do not always meet capability gaps.	There are significant gaps in diagnostic capability. There are insufficient professional development programs to build capability and recruitment is ad hoc rather than strategic.	Evidence is unavailable or of insufficient quality to determine performance
Livestock traceability	Livestock traceability systems virtually always meet the National Livestock Traceability Performance Standards.	Livestock traceability systems usually meet the National Livestock Traceability Performance Standards.	Livestock traceability systems sometimes meet the National Livestock Traceability Performance Standards.	Livestock traceability systems generally do not meet the National Livestock Traceability Performance Standards.	Evidence is unavailable or of insufficient quality to determine performance
Plant pest traceability	Plant pest traceability activities are highly effective and virtually all plant pests can be traced to source.	Plant pest traceability activities are usually effective and most plant pests can be traced to source.	Some plant pest traceability activities are effective and some plant pests can be traced to source.	Plant pest traceability activities are generally not effective and few plant pests can be traced to source.	
Sharing of tracing results	Identified sources of incursions and outbreaks are virtually always shared with relevant partners in the biosecurity system and inform pre-border and border activities.	Identified sources of incursions and outbreaks are usually shared with relevant partners in the biosecurity system and can inform pre-border and border activities.	Some identified sources of incursions and outbreaks are shared with relevant partners in the biosecurity system and may inform pre-border and border activities although notable gaps in sharing occur.	Identified sources of incursions and outbreaks are generally not shared with relevant partners in the biosecurity system and do not generally contribute to informing pre-border and border activities.	Evidence is unavailable or of insufficient quality to determine performance

*Refer to text for full description of the evaluation criteria

5.8 Respond to an incursion or outbreak of pests and diseases

5.8.1 Activity measures

Measures of the activities undertaken to respond to an incursion or outbreak of pests and diseases are outlined in Table 21.

Table 21: Activity measures: respond to an incursion or outbreak of pests and diseases

Activity		Activity measure
Initial investigation	Detections are reported within the timeframe specified in the relevant deed or jurisdictional legislation	Number and proportion of incidents where first reporting timelines specified in the deeds or jurisdictional legislation are met
Emergency response	Movement controls contribute to containing or eradicating incursions or outbreaks	Number of cases of non-compliance with movement controls imposed as part of ERP
	Incident management teams are well equipped to deal with emergency responses	Number and proportion of staff in Incident Management Teams with operational experience. Level of experience grouped into year ranges (e.g. trainee, <1 year, 1-3 years, 3-5 years, >5 years
	Stakeholders and the general public are informed about incidents and responses in a consistent and coordinated manner	Number and proportion of incidents where the NBCEN operated according to pre-agreed arrangements, or where communication about incidents and responses was coordinated at the jurisdictional level through the appropriate mechanism
Proof of freedom	Effective proof of freedom surveillance provides confidence, including to trading partners, that an EPP has been eradicated or that an EAD has been contained or eradicated	Number and proportion of proof of freedom surveillance activities that lead to the closure of a response plan
Transition to management	Effective transition to management plans provide confidence that the impacts of plant pest incursions will be managed effectively in the longer term	Number and proportion of transition to management plans outside the EPPRD that achieve their specific objectives within 12 months

	Stakeholders and the general public are informed about incidents and responses in a consistent and coordinated manner	Number and proportion of incidents where the NBCEN operated according to pre-agreed arrangements, or where communication about incidents and responses was coordinated at the jurisdictional level through the appropriate mechanism

5.8.2 Performance indicators for Key Evaluation Question 2c

Question 2c: How effectively do activities to respond to an incursion or outbreak of pests and diseases contribute to the direct outcome that the number of priority pests and diseases that establish and spread is reduced?

The direct outcome of respond activities, as described in the system description, is that *the number of priority pests and diseases that establish and spread is reduced.*

The starting position for each emergency response is different. Some response activities are significantly influenced by preceding deficiencies in preparedness, surveillance or diagnostics, but others are not. This means that an effective response cannot only be measured by a reduction in high priority pests and diseases that establish, or by a reduction in status notifications. An effective response should also be measured by assessing whether response activities achieved their objectives. Each response plan states objectives that are based on the starting position, the situation at the time, which is influenced by activities that came before. Objectives can be the containment or eradication of a pest or disease but may also include the orderly transition to management. Successful responses where the objective is to contain or eradicate will reduce the number of high priority pests and diseases establishing, while response plans where the objective was to transition to management will not. Consequently, a second performance measure for respond activities is proposed that focuses on whether responses have met their objectives.

Performance indicators for Key Evaluation question 2c are detailed in Table 22.

Table 22: Performance indicators for Key Evaluation Question 2c

Question 2c: How effectively do activities to respond to an incursion or outbreak of pests and diseases contribute to the direct outcome that the number of priority pests and diseases that establish and spread is reduced?

Direct outcome	Performance indicator	Rationale
The number of priority pests and diseases that establish and spread is reduced	Number and proportion of emergency responses that result in containment or eradication of an incursion or outbreak	Containment or eradication is the desired outcome of a response. A higher proportion of successful responses indicates that response planning and implementation are effective

	Number and proportion of emergency responses that achieve their objective other than eradication and containment	A higher proportion of response plans that achieve their objective indicates effective initial investigation, response planning and implementation

5.8.3 Qualitative indicators of the direct outcome of respond activities

In relation to respond activities, the overarching evaluation question posed to stakeholders and experts is:

How effectively do activities to respond to an incursion or outbreak of pests and diseases contribute to the direct outcome that the number of priority pests and diseases that establish and spread is reduced?

The evaluation criteria, or things that are important when answering this question, can encompass the following:

- Investigations in the incident management phase are transparent and effective, they consider all relevant information and available tools to increase the likelihood of developing and implementing a response plan that achieves its objectives
- Risk assessments undertaken as part of an initial investigation include analysis of technical feasibility and cost-benefit, are comprehensive, delivered on time and are of high quality
- Response activities are well coordinated, and sufficient resources are available to implement all activities in the response plan
- Quarantine areas and movement restrictions are well designed and implemented and support containment and eradication of pests and diseases
- Recruitment and training of incident management personnel is strategic and aligns with requirements based on post-incident reviews
- Real-time and post-incident evaluation of response activities is undertaken in a structured way and identified issues are shared to allow continuous improvement in emergency response activities
- Biosecurity participants are informed and engaged throughout an emergency response
- Transition to management activities provide affected stakeholders with information and help to limit the impacts of pests and diseases into the future

Table 23 outlines a rubric for this evaluation question.

Table 23: Rubric for Key Evaluation Question 2c

Question 2c: How effectively do activities to respond to an incursion or outbreak of pests and diseases contribute to the direct outcome that the number of priority pests and diseases that establish and spread is reduced?

	Performance standard				
	Advanced	Good	Developing	Inadequate	Insufficient evidence
	Performance is clearly very strong or exemplary in relation to the question. Any gaps or weaknesses are not significant and are managed effectively	Performance is generally strong in relation to the question. No significant gaps or weaknesses, and less significant gaps or weaknesses are mostly managed effectively	Performance is inconsistent in relation to the question. Some gaps and weaknesses. Does not always meet minimum expectations or requirements	Performance is unacceptably weak in relation to the question. Does not meet minimum expectations or requirements	Evidence is unavailable or of insufficient quality to determine performance
Evaluation criteria*					
Incident investigations	Investigations in the incident management phase are virtually always transparent and highly effective, and consider all relevant information and available tools, which maximises the likelihood of developing and implementing a response plan that achieves its objectives.	Most investigations in the incident management phase are transparent and effective. They usually consider all relevant information and available tools, which increases the likelihood of developing and implementing a response plan that achieves its objective.	Some investigations in the incident management phase are transparent and effective. There are sometimes gaps in the information and tools that are taken into account and this reduces the likelihood of developing and implementing a response plan that achieves its objectives.	Investigations in the incident management phase are generally not transparent and effective, and do not consider all relevant information and available tools. This limits the likelihood of developing and implementing a response plan that achieves its objectives.	Evidence is unavailable or of insufficient quality to determine performance
Risk assessments	Risk assessments undertaken as part of an initial investigation virtually always include analysis of technical feasibility and cost-benefit ratios; and are virtually always comprehensive, delivered on time and of high quality.	Risk assessments undertaken as part of an initial investigation usually include analysis of technical feasibility and cost-benefit ratios; and are usually comprehensive, delivered on time and of high quality.	Some risk assessments undertaken as part of an initial investigation include analysis of technical feasibility and cost-benefit ratios. There are gaps in comprehensiveness, timeliness, and quality.	There are significant gaps in risk assessments undertaken as part of an initial investigation, including gaps in analysis of technical feasibility and cost-benefit ratios, comprehensiveness, timeliness and quality.	Evidence is unavailable or of insufficient quality to determine performance
Coordination and resourcing of response activities	Response activities are virtually always well-coordinated, and sufficient resources are available to implement all activities in the response plan effectively.	Response activities are usually well coordinated, and sufficient resources are usually available to implement all activities in the response plan effectively.	Some response activities are well coordinated. Resourcing is not always sufficient to implement all activities in the response plan effectively.	Response activities are generally not well coordinated, and sufficient resources are generally not available to implement all activities in the response plan.	Evidence is unavailable or of insufficient quality to determine performance

	Performance standard				
	Advanced	Good	Developing	Inadequate	Insufficient evidence
Quarantine areas and movement restrictions	Quarantine areas and movement restrictions are virtually always well designed and implemented and provide highly effective support for the containment and eradication of pests and diseases.	Quarantine areas and movement restrictions are usually well designed and implemented and provide effective support for the containment and eradication of pests and diseases.	Some quarantine areas and movement restrictions are well designed and implemented and provide some support for the containment and eradication of pests and diseases.	Quarantine areas and movement restrictions are generally not well designed or implemented and generally do not provide effective support for the containment and eradication of pests and diseases.	Evidence is unavailable or of insufficient quality to determine performance
Incident management personnel	Recruitment and training of incident management personnel is virtually always highly strategic and aligned with requirements based on post-incident reviews.	Recruitment and training of incident management personnel is usually strategic and aligned with requirements based on post-incident reviews.	Recruitment and training of incident management personnel is generally ad hoc. Post-incident reviews may not inform recruitment and training activities and this may lead to some gaps in capability.	Recruitment and training of incident management personnel is not aligned with requirements identified in post-incident reviews and there may be significant gaps in capability.	Evidence is unavailable or of insufficient quality to determine performance
Evaluation of response activities	Real-time and post-incident evaluation of response activities is virtually always undertaken in a structured way and identified issues are shared to support continuous improvement in emergency activities.	Real-time and post-incident evaluation of response activities is usually undertaken in a structured way and identified issues are usually shared to support continuous improvement in emergency response activities.	Real-time and post-incident evaluation of response activities is somewhat ad hoc. This may limit the identification and sharing of issues and reduce the potential for continuous improvement in emergency response activities.	Real-time and post-incident evaluation of response activities is generally not undertaken in a structured way. Any identified issues are generally not shared and do not contribute to continuous improvement in emergency response activities.	Evidence is unavailable or of insufficient quality to determine performance
Engagement and communi-cations in an emergency	Biosecurity participants and the community are virtually always extremely well informed and engaged throughout an emergency response.	Biosecurity participants and the community are usually well informed and engaged throughout an emergency response.	Biosecurity participants and the community may be well informed and engaged throughout an emergency response but there may be some gaps in coverage across all stakeholders.	Biosecurity participants and the community are generally not well informed and engaged throughout an emergency response and there are significant gaps in coverage across all stakeholders.	Evidence is unavailable or of insufficient quality to determine performance
Transition to management activities	Transition to management activities virtually always provide affected stakeholders with sufficient information and help to reduce the impacts of pests and diseases into the future.	Transition to management activities usually provide affected stakeholders with sufficient information and help to reduce the impacts of pests and diseases into the future.	Transition to management activities provide affected stakeholders with information but there may be some gaps that constrain the capacity to reduce the impacts of pests and diseases into the future.	Transition to management activities generally do not provide affected stakeholders with sufficient information and these significant gaps constrain the capacity to reduce the impacts of pests and diseases into the future.	Evidence is unavailable or of insufficient quality to determine performance

*Refer to text for full description of the evaluation criteria

5.9 System-level outcome: IGAB objective 2; KEQ 2

The system-level outcome, IGAB objective 2, is to:
Prepare and allow for effective response to, and management of, exotic and emerging pests and diseases that enter, establish or spread in Australia.

Because of the cumulative and sequential nature of the relationship between prepare, detect and respond components of the biosecurity system the proposed performance indicator applies to both the direct and system-level outcomes (Table 24).

Table 24: Performance indicators of the system-level outcome (IGAB objective 2; KEQ 2)

System-level outcome	Performance indicator	Rationale
Prepare and allow for effective responses to, and management of, exotic and emerging pests and diseases that enter, establish or spread in Australia	Number and proportion of emergency responses that result in containment or eradication of an incursion or outbreak	Containment or eradication is the desired outcome of a response. A higher proportion of successful responses indicates that response planning and implementation are effective
	Number and proportion of emergency responses that achieve their objective other than eradication and containment	A higher proportion of response plans that achieve their objective indicates effective initial investigation, response planning and implementation

5.10 Recover from an incursion or outbreak and adapt to new circumstances

5.10.1 Activity measures

Measures of the activities undertaken to recover from an incursion or outbreak of pests and diseases and adapt to new circumstances are outlined in Table 25.

Table 25: Activity measures: recover from an incursion or outbreak and adapt to new circumstances

Activity		Activity measure
Relief and recovery	Arrangements supporting relief and recovery are developed and maintained	Number and proportion of governments and industries that have up to date emergency relief and recovery plans that include biosecurity
Long-term management strategies	Long -term management strategies are implemented to reduce the adverse impacts of an established pest or disease	Number of long-term management strategies that have reduced the impact of established pests and diseases to an acceptable level
Community-led programs	Community-led programs coordinate action to target pests and diseases where collective action has a social benefit	Number and proportion of significant established pests and diseases that are covered by community-led programs
Regulation/compliance	Regulation and compliance activities target enforcement actions	Number and proportion of business accreditations under the ICAS that are suspended or cancelled because of non-compliance with treatment procedures
		Number and proportion of landholders issued with non-compliance notices relating to biosecurity regulations (e.g. direction notices, infested land notices and control notices)
Area freedom and export certification	Area freedom surveillance programs support export certification and market access	Number of area freedom surveillance programs undertaken to support market access

5.10.2 Performance indicators for Key Evaluation Question 4a

Question 4a: How effectively do activities to recover from an incursion or outbreak and adapt to new circumstances contribute to the direct outcomes that the realised impact on the economy, environment and community of pests and diseases that establish and spread in Australia is reduced and that international and domestic market access and tourism are enabled?

The direct outcomes of recover and/or adapt activities, as described in the system description, are that: the realised impact of pests and diseases on the environment, economy and the community is reduced; and that domestic and international market access and tourism are minimised. Table 26 outlines proposed performance indicators for these outcomes.

Table 26: Performance indicators for Key Evaluation Question 4a

Question 4a: How effectively do activities to recover from an incursion or outbreak and adapt to new circumstances contribute to the direct outcomes that the realised impact on the economy, environment and community of pests and diseases that establish and spread in Australia is reduced and that international and domestic market access and tourism are enabled?

Direct outcome	Performance indicator	Rationale
The realised impact of pests and diseases on the economy, the environment and the community is reduced	Impact on the economy in AUD as determined in cost-benefit analysis as part of response planning for major incidents Other examples: Grain yield loss (in million $) because of established weeds (SoE, 2016a) Direct economic impact of vertebrate pests on agriculture in Australia (Gong *et al.*, 2009) Total expenditure by farmers on weed management (in billion $, ABS, 2008) Number of species that have become extinct since the first documented occurrence of a pest or disease (e.g. Chytridiomycosis; SoE, 2016b)	Cost-benefit analysis completed as part of the initial investigation for a response provides a measure of the impact of pests and diseases on the economy The Australian State of the Environment website has information about the economic impacts of individual or groups of pests and diseases, however, there is no estimate of the cumulative impact of all pests and diseases on the economy One-off studies can provide a snapshot in time but would need to be repeated to be useful for evaluation of economic impacts over time. For example, the Invasive Animals Cooperative Research Centre did a one-off study on the economic impact of four introduced invasive pest animals, and the Australian Bureau of Statistics did a Natural Resource Management

	Number of threatened mammal species that are under major threat from cane toads (SoE, 2016b) Area of native vegetation affected by root-rot in hectares (SoE, 2016b)	survey in 2006-07 to estimate the cost of managing weeds The Australian State of the Environment website has key findings for biodiversity, land, inland water and coasts that relate to invasive species and pests and diseases. However, linking the occurrence of pests and diseases to impacts on the environment is difficult. The narrative in the State of the Environment Report about invasive species and diseases contains little information.
Disruption to domestic and international market access and tourism is minimised	Loss of value from market closures or disruptions, including tourism markets	Fewer market closures and disruptions and quicker restoration of access minimises the impact of an outbreak on trade and tourism dependent industries and the Australian economy

5.10.3 Qualitative indicators of the direct outcome of recover and/or adapt activities

In relation to recover and/or adapt activities, the overarching evaluation question posed to stakeholders and experts is:

How effectively do activities to recover from an incursion or outbreak and adapt to new circumstances contribute to the direct outcomes that the realised impact on the economy, environment and community of pests and diseases that establish and spread in Australia is reduced and that disruptions to market access are minimised?

The evaluation criteria, or things that are important when answering this question can encompass the following:

- Relief and recovery plans are implemented effectively and at the appropriate time to support affected communities during and after an incident
- Long-term management programs are monitored and evaluated and reduce the impacts of established pests and diseases
- Domestic biosecurity or quarantine measures that restrict trade and market access and impose compliance costs on industries are costed, and restricted to those that are necessary and efficient, and applied only to the extent necessary to manage the identified risk. They are reviewed regularly
- Community-led programs contribute to managing the long-term impacts of pests and diseases
- Compliance with biosecurity regulations supports the long-term management of the impacts of pests and diseases

- Area freedom surveillance programs are based on best practice statistical design and support export certification and market access

Table 27 outlines a rubric for this evaluation question.

Table 27: Rubric for Key Evaluation Question 4a

Question 4a: How effectively do activities to recover from an incursion or outbreak and adapt to new circumstances contribute to the direct outcomes that the realised impact on the economy, environment and community of pests and diseases that establish and spread in Australia is reduced and that international and domestic market access and tourism are enabled?

	Performance standards				
	Advanced	Good	Developing	Inadequate	Insufficient evidence
	Performance is clearly very strong or exemplary in relation to the question. Any gaps or weaknesses are not significant and are managed effectively	Performance is generally strong in relation to the question. No significant gaps or weaknesses, and less significant gaps or weaknesses are mostly managed effectively	Performance is inconsistent in relation to the question. Some gaps and weaknesses. Does not always meet minimum expectations or requirements	Performance is unacceptably weak in relation to the question. Does not meet minimum expectations or requirements	Evidence is unavailable or of insufficient quality to determine performance
Evaluation criteria*					
Relief and recovery plans	Relief and recovery plans are virtually always implemented effectively and at the appropriate time and provide highly effective support to affected communities during and after an incident.	Relief and recovery plans are usually implemented effectively and at the appropriate time and provide effective support to affected communities during and after an incident.	Relief and recovery plans are generally implemented at the appropriate time but gaps in their provisions limits the support they provide to affected communities during and after an incident.	Relief and recovery plans have significant gaps in, for example, coverage, communications, resourcing, and do not provide effective support to affected communities during and after an incident.	Evidence is unavailable or of insufficient quality to determine performance
Long-term management programs	Long-term management programs employ a wide range of tools and strategies, are virtually always monitored and evaluated regularly, and are highly effective in reducing the impacts of established pests and diseases.	Long-term management programs employ a range of tools and strategies, are usually monitored and evaluated regularly, and are effective in reducing the impacts of established pests and diseases.	Long-term management programs employ a limited range of tools and strategies, are monitored and evaluated on an ad hoc basis. They have some effect on reducing the impacts of established pests and diseases.	There are significant gaps in the rage of tools and strategies employed by long-term managements plans that limits their effectiveness in reducing the impacts of established pests and diseases.	Evidence is unavailable or of insufficient quality to determine performance

	Performance standards				
	Advanced	Good	Developing	Inadequate	Insufficient evidence
Domestic biosecurity or quarantine measures	Domestic biosecurity or quarantine measures that restrict trade or market access and impose compliance costs are virtually always costed and restricted to those that are necessary and efficient. They are virtually always reviewed regularly.	Domestic biosecurity or quarantine measures are usually costed and restricted to those that are necessary and efficient. They are usually reviewed regularly.	Domestic biosecurity or quarantine measures are sometimes costed and sometimes restricted to those that are necessary and efficient. Reviews are undertaken on an irregular basis.	Domestic biosecurity or quarantine measures are generally not costed and may not be restricted to those that are necessary and efficient. Any review process is ad hoc.	Evidence is unavailable or of insufficient quality to determine performance
Community-led programs	Community-led programs are virtually always highly effective in managing the long-term impacts of pests and diseases.	Community-led programs are usually effective in managing the long-term impacts of pests and diseases.	Community-led programs are sometimes effective in managing the long-term impacts of pests and diseases.	Community-led programs are generally not effective in managing the long-term impacts of pests and diseases.	Evidence is unavailable or of insufficient quality to determine performance
Compliance with biosecurity regulations	There is a very high level of compliance with biosecurity regulations that provides highly effective support for the long term management of the impacts of pests and diseases.	There is a high level of compliance with biosecurity regulations that provides effective support for the long term management of the impacts of pests and diseases.	There is an adequate level of compliance with biosecurity regulations that provides some support for the long term management of the impacts of pests and diseases.	There is a low level of compliance with biosecurity regulations, which limits the support provided to the long term management of the impacts of pests and diseases.	Evidence is unavailable or of insufficient quality to determine performance
Area freedom surveillance	Area freedom surveillance programs are virtually always based on contemporary, best practice survey design and statistical techniques that support export certification and provide a very high level of confidence in market access claims.	Area freedom surveillance programs are usually based on contemporary, best practice survey design and statistical techniques that support export certification and provide confidence in market access claims.	Some area freedom surveillance programs are based on contemporary, best practice survey design and statistical techniques but some gaps reduce support for export certification and confidence in market access claims.	Area freedom surveillance programs are generally not based on contemporary, best practice survey design and statistical techniques, provide limited support for export certification and reduce confidence in market access claims.	Evidence is unavailable or of insufficient quality to determine performance

*Refer to text for full description of the evaluation criteria

5.11 System-level outcomes: IGAB objectives 3 and 4; KEQs 3 and 4

The system-level outcomes of recover and/or adapt activities, IGAB objectives 3 and 4, are to:
Ensure that, where appropriate, significant pests and diseases already in Australia are contained, suppressed or managed by relevant stakeholders, and to *Enable international and domestic market access and tourism*.

The proposed performance indicators of direct outcomes and system-level outcomes are similar. However, the proposed indicator of direct outcomes is concerned with the impacts of pests and diseases on the economy (including market and tourism disruptions), the environment and the community, whereas the indicator of system-level outcomes (Table 28) focuses on the effectiveness of management actions designed to contain and suppress established pests and diseases.

Table 28: Performance indicators of system-level outcomes (IGAB objective 3 and 4; KEQs 3 and 4)

System-level outcome	Performance indicator	Rationale
Nationally significant pests and diseases already in Australia are contained, suppressed or managed by relevant stakeholders	Number and proportion of significant pest and diseases subject to long-term management where status has not changed	Maintenance of pest and disease status indicates that long-term strategies are effective in containing, suppressing or otherwise managing the impacts of pests and diseases. A change in status that indicates further spread of a pest or disease is not favourable.
Enable international and domestic market access and tourism	Number of outbreaks of endemic pests or diseases	If ongoing management is effective, the number of outbreaks of endemic pests and diseases should be low, thereby minimising the impact on the economy, including domestic and international trade and tourism, the environment and the community

6 Evaluating the efficiency of the biosecurity system

6.1 Introduction

Incursions and outbreaks of pests and diseases have the potential to cause significant harm to the economy, the environment, human health and communities. The costs imposed by these risks include not only the direct damages they cause but also the costs incurred to prevent or mitigate their effects (Kompas, 2017). Biosecurity agencies and others involved in the system have limited resources to address these issues and are concerned to ensure that they are used efficiently. Decisions about how to allocate resources to maximise efficiency are challenging in biosecurity because of the wide range of potential risks across many species and pathogens, the variety of risk management measures available, and the interactions between different measures. This is further complicated by the fact that decisions to allocate resources often need to be made without full information on the nature of the biosecurity threat, for example the invasion dynamics of a species or pathogen, and where there is significant uncertainty about the impacts of prevention and control measures (Kompas*,* 2017).

The efficiency with which resources are deployed in the biosecurity system is defined in this project as one of the core attributes of a healthy system that will be used to inform the performance evaluation framework. An efficient biosecurity system is one that will, broadly speaking, allocate its limited resources across all components of the system in a way that maximises biosecurity risk reduction.

The objective in this chapter is to consider whether a rigorous method exists or can be developed to measure, or evaluate on some defined dimensions, the efficiency of the national biosecurity system that can be repeated at regular intervals and form the basis for assessing efficiency trends over time.

The chapter:

- outlines the dimensions of efficiency – productive efficiency, allocative efficiency and dynamic efficiency – as defined by the Productivity Commission (PC, 2013);
- reviews the measures of efficiency used by the Productivity Commission in its annual Report on Government Services (PC, 2018);
- reviews data available to calculate productive efficiency in the biosecurity system;
- discusses allocative efficiency in the context of a complex biosecurity system, recognising that the way in which resources are allocated across the system is a key determinant of overall economic efficiency. It introduces portfolio allocation theory as a tool for measuring allocative efficiency, reviews how this has been applied in the biosecurity context, and discusses impediments to using this methodology on a whole of system basis; and
- develops KEQ and evaluation criteria that are designed to assess whether resources in the biosecurity system are allocated efficiently.

The chapter does not consider issues related to the financing of the biosecurity system, including the level of funding, how funding is shared between participants in the system, and the sustainability of funding mechanisms. These and related issues were addressed in detail by the IGAB review (Craik *et al.,* 2017) and in the response to that review by Australian agriculture ministers (AMF, 2018). In this project the financing of the biosecurity system is considered one of the key enabling functions that supports the operation of the system and is represented in that part of the system description (chapter 3, Figure 2). It is addressed in chapter 7 on evaluating the capacity and capability of the system.

6.2 Defining efficiency

The term efficiency is commonly used in economics and other domains but is not always defined clearly or interpreted consistently within and across disciplines. The Productivity Commission (PC) is often required to assess the efficiency, and other attributes, of government policies and programs. To ensure transparency and consistency it has defined the way it uses efficiency and related concepts (PC, 2013). The following summarises the dimensions of efficiency defined by the PC – productive efficiency, allocative efficiency and dynamic efficiency.

Maximum *productive efficiency* requires that goods and services be produced at the lowest possible cost. A productively efficient outcome uses the least cost input mix required to produce a given output of any good or service. This occurs where no more output can be produced given the resources available, that is, the economy is on its production possibility frontier. The concept of productive efficiency goes beyond technical efficiency, which is the lowest volume of inputs per unit of output for each possible combination of inputs, because it takes into account the prices of inputs.

In the context of the biosecurity system, productive efficiency is interpreted to mean the amount of biosecurity risk reduction – the service provided by the biosecurity system – that is achieved per unit of investment in the system, measured across all inputs identified in the biosecurity system description.

Allocative efficiency is about ensuring that the community derives the greatest return from its scarce resources. A country's resources can be used in many different ways. The best or 'most efficient' allocation of resources uses them in the way that consumers value most, or from which they derive the most utility. For an economy, an allocatively efficient outcome is the output mix that best satisfies consumer preferences.

In the context of the biosecurity system, maximising allocative efficiency is about allocating all of the resources invested in the system in a manner that maximises the reduction in biosecurity risk. This is achieved where rates of return to investment on different biosecurity activities or control measures are equalised.

Dynamic efficiency refers to the allocation of resources over time, including allocations designed to improve economic efficiency and to generate more resources. This can arise from innovation – finding better products and better ways of producing goods and services with fewer inputs – or from growth in inputs. In the context of the biosecurity system, innovation in risk reduction methods through, for example, new equipment that makes detection of pest and disease incursions easier or new surveillance techniques, could lead to higher levels of risk reduction. Adding additional plant and veterinary resources to the system might lead to a similar outcome.

The focus of this chapter is on productive and allocative efficiency.

6.3 Measures of efficiency in the Productivity Commission's annual Report on Government Services

The Productivity Commission's annual Report on Government Services (RoGS) provides information on the equity, effectiveness and efficiency of government services in Australia. The RoGS facilitates improved service delivery, efficiency and performance, and accountability to governments and the public by providing a meaningful information on the provision of government services, capturing qualitative as well as quantitative change (PC, 2018).

This Report focuses on social services provided by government that aim to enhance the wellbeing of people and communities by improving largely intangible outcomes such as health, education and community safety. The 2018 Report, for example, contains information on child care, education and training, health, justice, emergency management, community services, social housing and homelessness across 17 service areas. These service areas are chosen on the basis of a set of formal criteria.

The RoGS is designed to include a robust set of performance indicators, consistent with the principles set out in the Intergovernmental Agreement on Federal Financial Relations. The emphasis is on longitudinal reporting and the highlighting of improvements and innovation. A key focus of the Report is on measuring the comparative performance of government services across jurisdictions.

Each service area in the Report has a performance indicator framework and a set of objectives against which performance indicators report. Performance indicators include output indicators, grouped under equity, efficiency and effectiveness, and outcome indicators.

In the case of efficiency indicators, the Report focuses on productive efficiency. Government funding per unit of output delivered is a typical indicator of productive efficiency used in the Report, for example cost per hour for vocational education and training. Where data are unavailable, the report sometimes uses incomplete or proxy measures of technical or productive efficiency. There is generally no explicit link made between efficiency indicators and the outcomes of the service provision. Nor does the RoGS attempt to measure allocative efficiency across the provision of government services, either within or between service areas.

Table 29 provides examples of the productive efficiency measures contained in the 2018 RoGS.

Table 29: Selected efficiency indicators from Report on Government Services 2018

Social service	Service area	Efficiency indicator
Childcare, education and training	School education	Recurrent expenditure per school student
Justice	Police services	Police services expenditure per person
Emergency management	Fire services	Fire services expenditure per person
	Ambulance services	Ambulance services expenditure per person
Health	Public hospitals	Cost per admitted patient separation

Source: Productivity Commission (2018)

6.4 Measuring productive efficiency in the national biosecurity system

Taking the RoGS as a model, this section considers whether there are data available to construct an indicator of productive efficiency for the national biosecurity system. This requires data on the financial inputs to the system, which have been defined in the system description (chapter 3, Figure 2), as well as a measure of the outputs delivered by the system.

6.4.1 Inputs to the national biosecurity system

A diverse range of inputs is required to ensure the effective and efficient operation of the national biosecurity system. The system description categorises these as financial, physical and human resources. The financial, or dollar, inputs to the national biosecurity system are described in the system description as:

- all expenditure on biosecurity by the Australian, state and territory governments;
- industry levies on production for biosecurity purposes and fees paid for biosecurity services; and
- in-kind contributions by industry, landholders and community groups.

Some information is available on the first two of these, as outlined below

Australian, state and territory governments publish information on biosecurity expenditure in budget papers, although different reporting methods limit the capacity to aggregate or compare these data. In addition, these data will not necessarily be complete as agencies other than biosecurity agencies may contribute to some biosecurity activities but do not necessarily make this explicit in their budget statements. For example, the former Australian Department of the Environment and Energy undertakes some biosecurity related activities but its Portfolio Budget Statement does not provide sufficient information to determine how much is spent (Craik *et al.,* 2017).

The National Biosecurity Committee has undertaken a detailed stocktake of biosecurity investment in 2013-14, 2015-16 and 2016-17 that provides a comparable source of data on jurisdictions' overall expenditure on biosecurity. In the three years in which data were collected, each jurisdiction reported its biosecurity expenditure against defined investment categories (Table 30) and across sector (animal biosecurity, plant biosecurity, invasive animals/plants, and marine pests). A sixth investment category records the Australian government's investment in export regulation and assurance. The stocktake takes into account government funds and externally sourced non-government funds invested by government in each investment category. These external contributions include funds sourced or raised by industry, revenue from fees and charges and other cost recovery mechanisms.

Table 30: Investment categories in the National Biosecurity Investment Stocktake

IC1	Prevention of exotic/emergency pests and diseases (pre-border and border)
IC2	Preparedness for exotic/emergency pests and diseases, including early detection (surveillance)
IC3	National eradication/containment programs (cost-shared national programs)
IC4	Management of established pests and diseases of national significance
IC5	Management of other established pests and diseases
IC6	Export facilitation (Australian Government only)

Source: Craik *et al.* (2017)

The detailed stocktake results are confidential but aggregate level information for 2015-16 has been published in the IGAB review (Craik *et al.,* 2017) (Table 31).

Table 31: National biosecurity investment stocktake 2015-16 results by investment category and source of funds

($ million)	Australian Government	States and territories	All jurisdictions
Government (appropriation)	181	244	425
External (cost recovery and levies)	442	131	574
Total	623	375	999

Source: Craik *et al.* (2017)

A review of the 2015-16 stocktake information indicates that in that year:

- total expenditure in the national biosecurity system was $999 million
- Australian government expenditure accounted for 18 per cent of the total; state and territory expenditure for 24 per cent; and expenditure from cost recovered sources, for 57 per cent

- around 51 per cent of funds was invested in prevention and preparedness activities; 6 per cent was invested in eradication and containment programs; 26 per cent in management of established pests and diseases; and 17 percent was invested in export facilitation

Information on expenditure under the third category outlined above – in-kind contributions by industry, landholders and community groups – is not available. While the amounts paid to governments are known, as outlined in the stocktake data, the operational expenses and in-kind contributions made by industry are not collected and documented, although these are likely to be substantial.

The IGAB review recognised the stocktake data set as a valuable source of information on the level and trends in investment in the biosecurity system. However, it noted limiting issues, including that some categories of investment are not included, such as expenditure on research and innovation, and its reliance on self-reporting that could lead to questions around spending and categorisation. The review considered that greater consistency, transparency and rigour could be achieved if an independent body were to undertake the work. It recommended that the national stocktake should be replaced by the independent RoGS undertaken by the Productivity Commission (Craik *et al.,* 2017).

CEBRA understands that there are currently no plans to repeat the national stocktake exercise. This means that, in the absence of an alternative data capture system, only three years of data may be available on which an assessment of the productive efficiency of the biosecurity system can be made. This limits the usefulness of the existing data and does not support analysis of efficiency trends over time.

6.4.2 Outputs of the national biosecurity system

The key measurable output delivered by the national biosecurity system is a reduction in biosecurity risk, or the expected loss to Australia over the long term if there were no biosecurity system (DAWR, 2017b). This is consistent with the overarching goal of the IGAB to minimise the impacts of pests and diseases on Australia's economy, environment and community (COAG, 2019).

It is difficult to estimate the risk reduction created by the biosecurity system. To do so requires a measure of Australia's exposure to biosecurity risk in the absence of controls, or risk mitigation measures, and a measure of the residual risk after controls have been applied. The department has developed the risk return resource allocation (RRRA) model that calculates Australia's exposure to biosecurity risk in the absence of controls. Box 8 provides information on the RRRA model.

Analysis using the RRRA undertaken for the IGAB review (Craik *et al.,* 2017) found that, with the modelled $340 million investment in biosecurity controls by the Australian Government, Australia avoids a $24 billion long-term cost to the economy. No information from the model is available publicly on the level of uncontrolled risk or of residual risk after the implementation of risk mitigation measures.

Box 8: The risk return resource allocation model

The risk return resource allocation (RRRA) model is a complex mathematical model of Australia's biosecurity system that describes the cost and effectiveness of biosecurity controls designed to prevent pests, diseases and weeds from entering, establishing and spreading in Australia. It calculates Australia's exposure to biosecurity risk before controls, and the residual risk after controls have been applied. The costs to Australia's agriculture sector are defined in dollar terms; the costs to human health and the environment are based on constructed scales. The model considers only the Australian Government's investment in biosecurity and the risk reduction this creates. It does not include investments and associated risk reduction by state and territory governments or industry.

The RRRA model calculates the number of pests, diseases and weeds that are likely to pass the border each year. The likelihood of them establishing and spreading is combined with the consequences of that happening to obtain the magnitude of biosecurity risk.

The RRRA model uses Bayesian networks to represent the effect of controls in preventing organisms of biosecurity concern from entering Australia. Bayesian networks are used to combine the likelihood of an organism being present on a pathway and the efficacy of controls on that pathway to calculate the probability of each organism breaching the border. Information on approach rates, probabilities and the effectiveness of controls is drawn from the department's corporate systems and from the collective knowledge and judgments of experts.

The model is able to calculate the change in residual risk that results from changes in controls. This allows the impacts of new policies or control regimes to be evaluated before they are implemented.

Source: DAWR (2017b)

6.4.3 Productive efficiency measure

The measure of inputs to the biosecurity system from the investment stocktake, and the measure of the outputs the system delivers from the RRRA model, can be used to derive a measure of productive efficiency that is consistent with the PC's approach in the RoGS. This is not the intended use of either data set but they represent the best available data on inputs to and outputs of the biosecurity system. This measure would show that Australian Government investment of $623 million in 2015-16 (the input) delivered a reduction in risk of around $24 billion (the output).

Using this approach, a one-off estimate of the productive efficiency of Australian Government expenditure in the biosecurity system can be derived, disaggregated to the level of the available data. Measured at this broad level it provides an estimate of how much risk reduction has been achieved per unit of investment in the system. In the absence of comprehensive time series data on either investment or risk reduction it reveals little about trends in this measure of efficiency over time. In addition, this level of analysis cannot provide insight into whether the resources in the system have been allocated in a manner that maximises the returns on investment, that is that maximises the total risk reduction achieved given the level of investment made. Hence, it does not provide a measure of the allocative efficiency of the biosecurity system or provide any guidance on how to prioritise investment across the many risks and activities in the system.

6.5 Is there a better way to evaluate the efficiency of the biosecurity system?

Various methods are used by biosecurity agencies to allocate their limited resources in an efficient manner, that is that maximises the total value of risk reduction for the level of investment made. A common method is to use cost-benefit analysis to determine if the benefits estimated from the implementation of a risk mitigation measure outweigh its costs. For example, in developing a coordinated response to an incursion of a pest or disease, the National Management Group operating under the EADRA or the EPPRD may require that a cost-benefit analysis is undertaken before approving a response plan. In a broader budget allocation context, biosecurity agencies may rank alternative projects by their benefit-cost ratios (BCRs) and select projects in declining order of BCRs until the budget is exhausted (Brooks *et al.,* 2015).

A serious limitation of this approach is that it does not take into account the scale of the investment in any project and the benefits that each project would provide at different levels of funding. This prevents consideration of the potential gains from reallocating budget between projects. It can be particularly important in the biosecurity context where the benefits of a project per dollar spent can be highly sensitive to its scale, and typically display declining returns to scale. This means that the benefit gained from investing an additional dollar in a project falls as expenditure on the project increases. As a result, cost-benefit analysis, which assumes that the returns on investment in a project remain constant regardless of scale, cannot be used to determine the optimal, or the most efficient, allocation of resources across alternative activities in the biosecurity system. Box 9 from the Queensland government's biosecurity capability review illustrates this point.

Box 9: Exotic fruit fly surveillance – how many traps?

Consider the example of a local surveillance program for exotic fruit fly with a trapping system already in place. A cost-benefit analysis could be easily constructed for this activity. The cost of the number of traps, say there are 1000 in place, and their inspection and relevant diagnostics are known or could be determined easily. The avoided losses as a result of having a trapping system can be calculated – these are the losses that would have occurred to agricultural production without the trapping system or the early detection program in place. There is little doubt that the benefit cost ratio (BCR) in this case would be positive – most biosecurity activities have positive BCRs. However, the cost benefit analysis does not identify how many traps there should be. Should it be more or less than 1000, or is 1000 correct? It provides no information on scale. Cost-effectiveness, or a better portfolio allocation of funds, could occur with fewer or more traps. The cost benefit analysis cannot help determine this.

It also cannot help in determining resource allocations across different activities. It may be that the return on an alternative activity, for example further containment or eradication of red imported fire ants, is higher. If so, reallocating funds to this activity would result in better outcomes overall for the biosecurity system.

Source: Brooks *et al.,* 2015

6.5.1 Portfolio allocation approach

An alternative approach to maximising the efficiency of resource allocation in biosecurity is to allocate funds to activities or threats with the highest rates of return, that is, a portfolio approach to the allocation of investments (Kompas *et al.,* 2019). While the principles behind the portfolio allocation approach are clear, implementing them at a system-wide level is currently infeasible. Both these points are discussed below.

The portfolio allocation principle takes investments that have the highest rates of return, or the highest ratio of the *marginal* benefits to the *marginal* costs of investing in an activity, rather than the ratio of *total* benefits to *total* costs. At its most disaggregated, the approach can, in principle, consider where each dollar in a biosecurity budget should be spent – each successive dollar should be spent on the activity or threat with the highest marginal benefit or return. In most cases, the more resources that are directed to an activity or threat the lower its rate of return will be over time – consistent with diminishing rates of return in most biosecurity activities. Investment should occur across all activities and threats until rates of return are equalised everywhere, subject to an overall budget constraint (Kompas *et al.,* 2019). Allocating funding according to this principal will also ensure that the average benefit cost ratio across all activities and threats is maximised. If these allocation principles are applied, the resulting distribution of resources across the biosecurity system will deliver the highest level of biosecurity risk reduction for the available budget and can be considered the most economically efficient solution.

Implementation of a portfolio investment rule in the biosecurity system requires accounting for the impacts of uncertainty when estimating rates of return for any activity or threat. Uncertainty applies to biophysical variables such as the spread characteristics of an invasive pest or disease as well as the economic values attached to estimates of damages. The latter is particularly relevant to the non-market values typically associated with environmental damage from invasive pests and diseases. Both sets of variables are important in determining an efficient allocation of resources. Models and techniques have been developed to deal with uncertainty issues and have been applied to portfolio allocation decisions in biosecurity (Akter *et al.,* 2015, Barnes *et al.,* 2019).

Also important in implementing a portfolio investment rule is the need to take into account the timeframe over which alternative investments are made. Some pests, such as invasive weeds, may not generate damages for many years, while the consequences of foot-and-mouth disease will be much more immediate. These differences in timeframe require the use of discount rates to estimate the current value of damages or costs generated into the future. This can be contentious, particularly where applied to environmental damages (Brooks *et al*., 2015).

Despite these issues, applying a portfolio allocation approach to biosecurity investment decisions can provide a structured and transparent method to allocate investments across different invasive threats and biosecurity activities and to scale investments according to the available budget. It can provide a mechanism for determining the most economically efficient investment portfolio, that is, where rates of return on different biosecurity activities or controls are equalised. When there is a budget constraint, as is the case in all of Australia's public biosecurity agencies, the investments with the highest rates of return should be chosen first. As their rates of return fall with increasing scale of the investment, other activities or measures will be funded according to their relative rates of return. It is possible that some activities or threats will have rates of return that are always lower than all other alternatives and will not be allocated a budget. These are generally low risk-low consequence activities (Kompas *et al.,* 2019).

Biosecurity Queensland has observed that the practical effect of a portfolio allocation rule is to shift resources away from managing an existing pest or disease towards prevention and surveillance. This is because the cost of managing an existing pest or disease, through containment or eradication campaigns, will on average be smaller when an increased share of the biosecurity budget is allocated to prevention and surveillance (Brooks *et al.,* 2015).

6.5.2 Applications of portfolio allocation theory in biosecurity

Portfolio theory has been widely used in the finance sector to determine the optimal allocation of investments across a set of financial assets with uncertain returns in order to maximise returns and minimise volatility or uncertainty. It has also been used in environmental decision making, including in biodiversity conservation, land-use planning and forest and water management (see Akter *et al.,* 2015) and in invasive pest management (Prattley *et al.,* 2007; Yemshanov *et al.,* 2014).

The application of portfolio allocation theory in a large complex system such as biosecurity, where investment decisions are made by many participants to address risks across multiple pathways, pathogens and species, is currently not feasible. Applications of the approach across a limited range of biosecurity threats and control measures include:

- optimal investment in the general fruit fly trapping program (Kompas *et al.,* 2017a;c)
- optimal surveillance for the early detection of papaya fruit flies (Kompas *et al.,* 2017a)
- active surveillance measures and an optimal response to a potential foot-and-mouth disease outbreak (Garner *et al.,* 2017; Kompas *et al.,* 2017b),
- possible rates of return on a range of active surveillance measures, pre-incursion, for foot-and-mouth disease (Kompas *et al*., 2017b),
- optimal expenditure on the containment and possible eradication of red imported fire ants (Kompas *et al*., 2019),
- investment in the control of various weeds (Kompas *et al*., 2016),
- biosecurity surveillance in the Torres Strait (Barnes *et al*., 2019).

In a broader application of the portfolio allocation approach, Kompas *et al.* (2017), examine the optimal allocation of resources across four significant pests and diseases – red imported fire ants (RIFA), foot-and-mouth disease, papaya fruit fly and hawkweed – and three control measures – prevention or border quarantine, active surveillance for early detection, and eradication. Two of the species (RIFA and hawkweed) are largely eradication projects and the remaining two involve mainly entry prevention and preparedness activities. They represent four diverse threats and multiple control options that must be met from the same control budget.

6.5.3 Expanding the application of portfolio theory in biosecuity

Extending this analytical framework to a large number of projects, across different species, pathways and control measures to derive an optimal allocation of resources, becomes increasingly complicated and resource intensive. A portfolio allocation approach needs, as a prior condition, basic infrastructure capability, including information systems, the capacity to capture and analyse information, diagnostic capabilities, and supportive legislative and budget processes (Brooks *et al*., 2015). It demands significant data on which to calculate rates of return on multiple activities. This includes data on the likelihood and consequences of pest and disease incursions and on the costs of alternative control options, as well as the probability of their success at different scales. Applying a broadly-based portfolio allocation approach also requires technical models and expertise to undertake the optimisation analysis and to include the impacts of uncertainty on key parameter values. Some of the data and modelling requirements have been demonstrated in the applications referred to above. Expanding the application of portfolio allocation theory to a wider range of problems will require significant further investment in data and capability.

As Biosecurity Queensland notes, finding a full suite of portfolio allocations across all biosecurity measures and threats faced by a biosecurity organisation is not currently possible (Brooks *et al*., 2015). The challenge is magnified if considering the optimal allocation of resources at the national or system-wide level, crossing jurisdictional boundaries. However, some steps can be taken to progressively build the basis for future applications of a portfolio allocation approach.

These include that biosecurity organisations take a systematic approach to adopting the work developed by researchers and other organisations and form collaborations that assist in developing the necessary data and capabilities (Brooks *et al.,* 2015). For example, model frameworks already exist to assist in calculating rates of return on biosecurity activities. These range from simple portfolio rules to complex bioeconomic and spatial modelling for specific threats or biosecurity activities (Kompas *et al*., 2019).

While it takes time and resources for an organisation to build up rates of return measures across its portfolio of activities, a possible starting point for any organisation is to consider allocative efficiency at a relatively small scale. As an example, it might initially examine threats and activities that appear intuitively to deliver low returns. These are likely to be low-risk and low-consequence threats that are funded on the basis of historical practice rather than contemporary assessment. Even in the absence of precise rates of return measures, it is often possible to determine which of these activities should be continued and which phased out over time (Brooks *et al.*, 2015).

Further, before a full portfolio approach can be adopted, organisations can increase the consideration they give to budget allocations in a systematic and rigorous manner. This might involve, for example, examining expenditure across threats in terms of risk profiles – considering explicitly the likelihood of occurrence and the economic consequences of alternative threats – before allocating budget across multiple activities. Expert elicitation exercises may be required to estimate these measures (Brooks *et al*., 2015).

Taking progressive steps to implement a portfolio approach to investment allocation, even in the absence of complete information, can be beneficial because it accustoms decision-makers to think explicitly about where returns are highest and to allocate resources in that direction. In addition, decision making processes and decisions become more transparent and predictable and enhance confidence in the appropriate use of resources (Brooks *et al.*, 2015).

6.6 Qualitative assessment of the efficiency of biosecurity system

In relation to the efficiency of the biosecurity system, the overarching question posed to stakeholders and experts is:

*Are the resources invested in the biosecurity system allocated across activities in a manner that maximises the efficiency of the system and delivers the highest return on investment? (*KEQ 5)

It is not currently possible to answer this question with confidence. This is because of the lack of contemporary time series data on investment in the biosecurity system and the risk reduction achieved as a result of control measures, as well as the lack of comprehensive measures of the marginal costs and benefits of alternative risk reduction activities.

However, it is possible to develop evaluation criteria that help address whether the biosecurity system is developing the capacity to undertake meaningful evaluations of resource allocation efficiency. The criteria posed below are adapted from the Queensland Biosecurity Capability Review (Brooks *et al.*, 2015), which identified the attributes of an organisation with appropriate investment and prioritisation decision-making capability. Eliciting responses to these criteria from participants in the system and other experts can help inform the answer to the KEQ. Because biosecurity budgets are determined by jurisdictions, the evaluation criteria relate to the jurisdictional rather than to the national level.

Evaluation criteria

- The budget available for biosecurity is transparent
- Expenditure on biosecurity is routinely monitored, evaluated and reviewed to assess rates of return on activities and inform future resource allocation
- Decision-makers make use of available knowledge, tools and models to support budget allocation decisions
- Data capture and analysis systems are available to decision-makers, or under development, that support and inform a whole of portfolio approach to budget allocation. This includes capture and analysis of information on the rates of return to different activities in the system.

Consistent with the methodology in chapter 5 on the effectiveness of the biosecurity system, Table 32 outlines a rubric for this KEQ.

Table 32: Rubric for efficiency of the biosecurity system

	Performance standards				
	Advanced	Good	Developing	Inadequate	Insufficient evidence
	Performance is clearly very strong or exemplary in relation to the question. Any gaps or weaknesses are not significant and are managed effectively	Performance is generally strong in relation to the question. No significant gaps or weaknesses, and less significant gaps or weaknesses are mostly managed effectively	Performance is inconsistent in relation to the question. Some gaps and weaknesses. Does not always meet minimum expectations or requirements	Performance is unacceptably weak in relation to the question. Does not meet minimum expectations or requirements	Evidence unavailable or of insufficient quality to determine performance
Evaluation criteria*					
Jurisdictional biosecurity budgets are transparent	Comprehensive information on biosecurity budgets by activity is virtually always updated regularly and available to decision makers.	Information on biosecurity budgets by activity is usually updated regularly and made available to decision makers.	Information on biosecurity budgets by activity is collected on an ad hoc basis and may be made available to decision makers.	Information on biosecurity budgets by activity is not routinely collected or is not available to decision makers.	Evidence unavailable or of insufficient quality to determine performance
Jurisdictional expenditure on biosecurity is monitored, reviewed and evaluated to assess rates of return	Expenditure on biosecurity by activity is virtually always routinely monitored, reviewed and evaluated and comparative rates of return are assessed to inform investment decision making.	Expenditure on biosecurity by activity is usually monitored, reviewed and evaluated and some assessment of comparative rates of return is undertaken that informs investment decision making.	Some expenditure information by activity is available to decision makers but is insufficient to compare rates of return across activities.	There is no routine monitoring, review or evaluation of biosecurity budgets and rates of return are not assessed.	Evidence unavailable or of insufficient quality to determine performance
Tools and models are used to support budget allocation decisions	Tools and models are virtually always used to support budget allocation decisions across all activities.	Tools and models are usually used to support budget allocation decisions across groups of activities.	Tools and models are used on an ad hoc basis to support budget allocation decisions across some activities.	Tools and models are generally not used to support budget allocation decisions.	Evidence unavailable or of insufficient quality to determine performance
Data capture and analysis systems are available to support decision making	Comprehensive best practice data capture and analysis systems are developed and maintained across all activities to support budget allocation decision making.	Data capture and analysis systems are progressively developed across activities to support budget allocation decision making.	Some data capture and analysis systems have been developed and maintained across some activities. There is less reliance on manual systems to analyse data and support budget allocation decisions.	Data capture and analysis systems are poorly developed and do not cover a broad range of activities. Analysis to support budget allocation decisions mostly relies on manual systems.	Evidence unavailable or of insufficient quality to determine performance

*Refer to text for description of the evaluation criteria

7 Evaluating the capacity and capability of the biosecurity system

7.1 Introduction

One of the core attributes of a healthy biosecurity system identified in the evaluation framework for this project is its capacity and capability – or its ability to provide the appropriate quantity and quality of human, physical, financial and organisational resources to deliver the expected system outputs and outcomes. Capacity and capability are critical aspects of organisational and system performance (e.g.LaFond *et al.*, 2002; Meyer *et al.*, 2012) and directly underpin other attributes of health. Without the appropriate capacity and capability, the biosecurity system cannot, for example, deliver effective and efficient outcomes, nor can it be resilient or sustainable over the long term.

The system description developed in this project (chapter 3, Figure 2) identifies the range of investments in the biosecurity system that support its activities. These are diverse and encompass investments in human resources, including both the number, or capacity, of people who work within the system and their capability. There are also extensive physical resources that support the biosecurity system, including inspection facilities, laboratories, post-entry quarantine facilities, office accommodation and information technology and data analysis systems. Direct financial investments by governments and private participants in the system amount to approximately $1 billion a year (Craik *et al*., 2017).

The system description also identifies the factors that influence or enable the operation of the biosecurity system across the range of its activities. These include core organisational capabilities, including its governance arrangements, the R&I that underpins biosecurity innovation and the ability to manage engagement and communications activities with all participants in the system. These influencers or enablers are considered part of the capacity and capability of the system and are evaluated in that context.

The objective in this section is to propose a method for evaluating the capacity and capability of the national biosecurity system that can be repeated at regular intervals in order to understand changes over time. The section:

- considers some definitions of capacity and capability and defines their meaning in the context of this project;
- reviews the ways in which the capacity and capability of different systems have been evaluated, including by the Commonwealth government, state and territory governments, not-for-profit organisations and business;
- proposes a method for evaluating the capacity and capability of the biosecurity system and identifies elements of capacity and capability that can be evaluated at a high-level and with a system focus; and
- proposes indicators of capacity and capability for each element.

7.2 Defining capacity and capability

As part of the project, a review of the literature on organisational capacity and capability was undertaken, including the application of these terms in government, not-for-profit and business contexts. The principal outcome of this review was the lack of consensus on the meaning of the terms and the interchangeable nature of their definitions (Vincent, 2008).

When speaking about an organisation's ability to achieve its objectives and deliver outcomes, the literature mostly refers to the term capability. The following indicates how definitions vary according to context:

- the Australian Public Service Commission (APSC, 2019a) states that 'APS agencies need a combination of people, processes, systems, structures and culture to deliver outcomes';
- the Victorian Public Sector Commission (VPSC, 2015) defines capability 'as what an entity needs in order to deliver efficiently the outputs required to achieve the government's goals as set out in the entity's strategy';
- the Victorian state government, under its Health Improvement Capability Quotient tool, defines organisational capability as 'the ability of an organisation to perform a coordinated task, utilising organisational resources, for the purpose of achieving a particular end result' (DH, 2014);
- the International Organization for Standardization defines emergency management capability as 'the overall ability to effectively manage prevention, preparedness, response and recovery before, during and after potentially destabilizing or disruptive events' (ISO, 2016); and
- a report on the health sector defines capability as 'the ability to achieve and sustain coverage, access and quality over time' (LaFond *et al.*, 2002).

While these definitions are highly general, they provide useful guidance on defining the capacity and capability of the biosecurity system. For the purposes of this project, these are defined, collectively, as '*the extent to which the system has the appropriate quantity and quality of resources, including financial, physical, human and organisational resources, to meet its objectives, that is, its expected outputs and outcomes*'.

This definition can be disaggregated into two parts:

- the capacity of the system refers to the amount or quantity of resources in the system needed to achieve its objectives. Relevant questions refer to whether the system has enough of something;
- the capability of the system refers to the quality of those resources and whether they are adequate to achieve the objectives of the system. Relevant questions refer to whether the system has the appropriate quality of resources, noting that capability can be developed over time.

7.3 Assessing capacity and capability – examples from different domains

Many organisations have developed approaches to assessing their ability to meet their objectives. Because organisations interpret capacity and capability differently and operate in diverse contexts, the frameworks developed to measure or assess capacity and capability can vary widely. However, elements common to most include resource availability, organisational infrastructure and external stakeholder networks (Cox *et al.*, 2018). Table 33 outlines the diversity of frameworks used to assess capacity and capability across a range of domains in the public and private sectors.

Capacity and capability can be assessed using different tools that share common elements. Most tools for assessing capacity and capability are based on the use of tables that capture and assess performance of defined elements of an organisation or system by using performance criteria and standards or maturity levels. These are often accompanied by ranking or scoring systems. This approach is typically referred to as a Capability Maturity Model and has been used widely across a range of industries and applications, including software development (Paulk *et al.*, 1993), organisational quality (ISO, 2018), emergency management (ISO, 2016; Wang *et al.*, 2018) and public sector performance (APSC, 2019b; VGPB, 2019). Capability maturity models typically include a capacity dimension such as resource availability. They strongly resemble the evaluation rubrics implemented in this report.

Table 33: Examples of capacity/capability frameworks used in performance assessment across different domains

Domain	Elements of capacity/capability	Reference
Whole of government	The Australian Public Service Commission (APSC) capability review program consists of periodic reviews designed to assess the ability of agencies to meet the Australian government's objectives and future challenges. The capability framework consists of three principal themes, each with sub themes: 1. leadership: set direction; motivate people; develop people 2. strategy: outcome focused strategy; evidence-based choices; collaborate and build common purpose 3. delivery: innovative delivery; plan, resource and prioritise; shared commitment and sound delivery models; manage performance	APSC (2019c)
Government, biosecurity	The National Biosecurity Committee (NBC) developed a framework for jurisdictions to assess their ability to meet their normal commitments under the National Environmental Biosecurity Response Agreement: 1. strategic planning and policy development 2. development of legislation, regulation and compliance enforcement 3. surveillance 4. diagnostic services 5. research, development and extension 6. intelligence, information management and data systems 7. communication and engagement; and 8. organisation and management (expertise and personnel, infrastructure, finance)	NBC (2013)
Government, biosecurity	A panel of independent experts reported to the Queensland government on Queensland's baseline biosecurity capability to meet its current objectives and future challenges. Capability was divided into organisational and biosecurity-specific	Brooks *et al.* (2015)

Domain	Elements of capacity/capability	Reference
	capability. Assessment of organisational capability was based on the APSC capability model's four key elements – leadership, strategy, policy and service delivery. Assessment of biosecurity-specific capability was based largely on the NEBRA Normal Commitments framework but with significantly more disaggregation of elements under four key performance areas – strategic planning and policy development; systems support and oversight; communications and engagement; and outcomes focused services.	
Government, health	The Health Improvement Capability Quotient tool developed by the Victorian Government assists health services with assessing their level of organisational capability. Assessment is based on four domains and related criteria: 1. organisational systems and structures: framework for improvement; people development; measurement system; prioritisation of improvement activities; strategic alignment; systems approach to improvement; knowledge management; governance 2. workforce skills and knowledge: training and professional development in improvement; depth of improvement skills and knowledge; breadth of improvement skills and knowledge 3. results and system impact: analysis of operational metrics; improvement outcomes; impact of organisational KPIs 4. culture and behaviours: staff role in improvement; business improvement approach; spread of best practice; reward and recognition; staff engagement in improvement; leadership	DH (2014)
Government, emergency management	The State emergency management committee of Western Australia has developed an emergency management capability assessment tool based on seven core capabilities with multiple underlying dimensions: 1. governance: legislation; policies; emergency management plans 2. analysis and continuous improvement: risk assessment; horizon scanning; lessons management 3. community involvement: public information; risk awareness and understanding; shared ownership; sector information sharing 4. planning and mitigation: land-use planning; ecosystem management; infrastructure protection; essential services protection; minimise single points of failure; remoteness planning; business continuity planning; community activities 5. resources: people; volunteering; finance and administration; equipment/critical resources	SEMC (2016)

Domain	Elements of capacity/capability	Reference
	6. emergency response: situational assessment; evacuation; public protection; agency interoperability; mass casualty management; command, control and coordination 7. impact management and recovery coordination: mass fatality management; welfare; impact assessment; recovery coordination and rehabilitation	
Not-for-profit organisation	RAND Europe, an independent, not-for-profit policy research organisation examined organisational capacity in a range of public sector and non-profit organisations. The study identified six commonly used dimensions of organisational capacity: 1. leadership 2. strategy 3. structure/governance 4. skills 5. human capital 6. accountability	Cox *et al.* (2018)
Research, emergency management	The US North Carolina Preparedness and Emergency Response Research Center developed a framework for measuring organisational capacity in public health services and systems, consisting of eight dimensions: 1. fiscal and economic resources 2. workforce and human resources 3. physical infrastructure 4. inter-organisational relationships 5. data and informational resources 6. system boundaries and size 7. governance and decision-making structure 8. organisational culture	Meyer *et al.* (2012)

Of particular relevance to assessments of the capacity and capability of the biosecurity system are the frameworks adopted by the NBC's assessment of normal commitments under the NEBRA and the Queensland Biosecurity Capability Review.

The NEBRA establishes national arrangements for responses to nationally significant biosecurity incidents with predominantly public benefits (DAWR, 2012). The agreement determines that parties to the agreement are responsible for meeting their normal biosecurity commitments. Normal commitments are defined as the functions and capabilities parties should be able to carry out to meet national obligations. Table 34 outlines the eight capabilities, endorsed by the NBC, that each jurisdiction must demonstrate they possess to meet their NEBRA normal commitments (NBC, 2013). The NBC also endorsed an outcomes and performance standards framework and maturity matrix for jurisdictions to assess their ability to meet normal commitments.

In 2015, an independent panel of experts reviewed Biosecurity Queensland's baseline capability to meet its current objectives and future challenges (Brooks *et al.*, 2015). The review assessed the general organisational capability of the system as well as biosecurity-specific capability. The approach used to assess organisational capability was based primarily on the APSC capability framework (Table 33). Biosecurity-specific capability was assessed largely using the NEBRA Normal Commitments capability framework but providing greater disaggregation of the key elements. In both cases respondents scored performance against capabilities using a four point scale.

There is considerable overlap between the two frameworks, with the Queensland capability review's biosecurity-specific framework encompassing the eight capabilities used in the NEBRA normal commitments framework. Table 34 describes the high level concordance between the two.

Table 34: Concordance between Queensland capability review and NEBRA normal commitments capability assessment frameworks

Qld Biosecurity capability review	NEBRA normal commitments
Strategic planning and policy development	Strategic planning and policy development Intelligence
Systems support and oversight	Legislation, regulation and compliance Information management and data systems Organisation and management – expertise and personnel, infrastructure, finance
Communications and engagement	Communications and engagement
Outcomes focused services	Surveillance Diagnostics Research, development and extension

7.4 An approach to evaluating the capacity and capability of the biosecurity system

Taking the examples of capability assessment frameworks outlined in Table 33, particularly those of the Queensland Biosecurity Capability Review and the NEBRA normal commitments framework, the following approach is proposed for assessing the capacity and capability of the national biosecurity system:

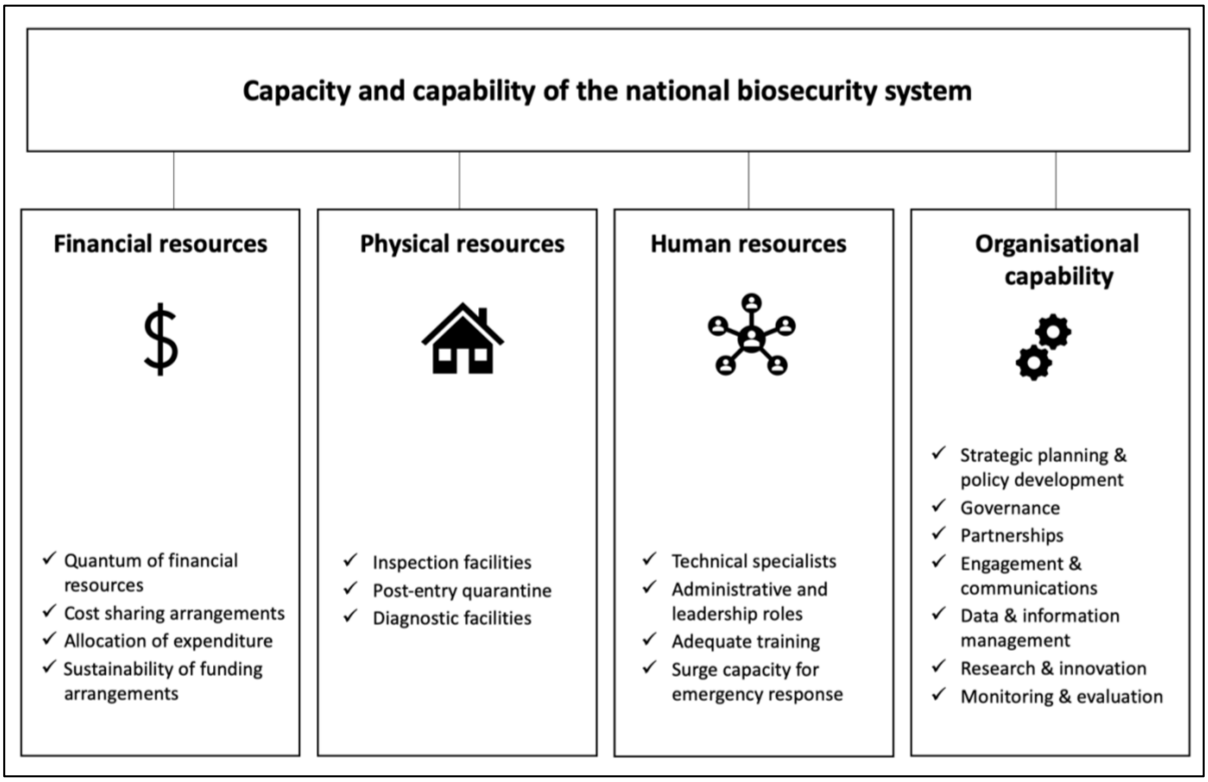


Figure 11: Capacity and capability of the national biosecurity system

Each of the key capabilities identified in the framework (Figure 11) links directly to the biosecurity system description developed in this project. The first three capabilities – financial, physical and human resources – are fundamental inputs to the system. Organisational capability comprises the influencing and enabling functions identified in the system description, that is, the functions that underpin all or most of the activities across the system. The exception to this is the resource allocation function, which is addressed in chapter 6 as a key determinant of the efficiency of the biosecurity system.

Indicators of system performance are identified for each of the key capabilities. Unlike indicators of the effectiveness of the biosecurity system developed in chapter 5 of this report, there is no direct link between the capacity and capability of the system and system outputs and outcomes. Capacity and capability influence all activities in the system and have an impact on all outputs and outcomes – both direct and system level.

Quantitative measures are proposed, where appropriate, to describe the three inputs to the system – financial, physical and human resources. These measures are relevant because they provide insight into the scale of these inputs to the system.

KEQ are also posed to elicit qualitative assessments of performance against capacity and capability, including the seven components of organisational capability. Rubrics are then constructed to summarise and order these qualitative assessments in a structured and transparent manner.

7.5 Financial resources

As observed by the IGAB review, the success of Australia's biosecurity system is reliant on sustained levels of well-targeted investment over time, underpinned by strong funding principles and arrangements that are nationally coordinated, consistently applied and well communicated (Craik *et al.*, 2017). This section considers how to evaluate this key component of the system, focusing on the level and sustainability of funding, and the appropriate mix of funding sources. Issues related to the allocation of investment in the biosecurity system are addressed in the chapter on efficiency and are not repeated here. However, the efficiency of investment is included as part of the evaluation criteria used to determine the performance of this component of the system.

Many observers of the system have noted that Australia's biosecurity agencies are under-resourced, that a continuously tight fiscal environment with limited biosecurity budgets has put pressure on the capacity of jurisdictions to meet their core biosecurity commitments, and that this has contributed to an observed decline in national biosecurity capability (for example Beale *et al.* 2008; Brooks *et al*. 2015; Schneider *et al.* 2015; Craik *et al.* 2017; PHA, 2017b). A related issue is that each jurisdiction's funding for biosecurity is determined largely independently and in response to individual pressures and stakeholder demands. This can result in asynchronous waxing and waning of available funding from jurisdictions and lack of coordination in post-border activities undertaken in the public interest.

Under the partnerships approach to biosecurity, significant direct contributions to funding the system are also made by producers and industry groups through levies on production and fees for services. There are also significant but unmeasured in-kind contributions from landholders and community groups. Because the range of investments and contributions by key parties in the national biosecurity system is not routinely captured and reviewed on a national basis it is not possible to estimate accurately how the levels and shares of funding have changed in recent years and whether funding has kept pace with changes in risk levels.

The IGAB outlines a fundamental principle for cost-sharing among participants in the biosecurity system: *Governments contribute to the cost of risk management measures in proportion to the public good accruing from them. Other system participants contribute in proportion to the risks created and/or benefits gained* (clause 16).

This principal is elaborated in the National Framework for Cost Sharing of Biosecurity Programs (NFCSBP), endorsed by the NBC but not publicly available. The NFCSBP sets out the key funding policy principles to guide and inform the development of a model for the cost-sharing of national biosecurity programs into the future, with an emphasis on securing contributions from risk creators and beneficiaries. The IGAB review notes that this framework is consistent with the funding principles published by the Independent Pricing and Regulatory Tribunal (IPART, 2013), the Australian Government Department of Finance's cost recovery guidelines (DF, 2014) and the Productivity Commission (PC, 2001) and has widespread support (Craik *et al*., 2017).

In the absence of collated data on investment by different participants in the system it is difficult to assess whether the cost sharing principle is met. The Australian Government Submission to a review into environmental biosecurity (AG, 2014) notes that while the emergency response deeds between government and industry (AHA, 2018c; PHA, 2018a) include cost-sharing mechanisms with industry beneficiaries, these arrangements do not extend to equally important activities such as preparedness and early detection. There are also limited mechanisms in place to secure contributions from risk creators for on-shore (post-border) biosecurity activities in the form of industry levies. The submission observes that it is important that structured and consistent mechanisms are implemented by all jurisdictions to ensure that risk creators and risk beneficiaries bear the appropriate share of risk management costs.

Sharing the costs of biosecurity risk management also underpins the long-term financial sustainability of the system. Given the anticipated growth in biosecurity risk and the tight fiscal environments faced by governments it is unlikely that jurisdictions alone can absorb the increasing costs of risk management. Equitable investment by all system participants will be essential to maintain an effective national biosecurity system. To support sustainable funding of the system, the IGAB review recommended that government budgets for biosecurity should be held at least at constant levels in real terms over the life of the next agreement. It also recommended that state and territory governments should agree a common cost-recovery framework and review their biosecurity cost-recovery arrangements to ensure they are nationally consistent, appropriate and transparent. It further recommended that all levels of government could help meet their budgetary challenges by reviewing biosecurity levies and charges to ensure they are commensurate with the agreed national cost-sharing principles (Craik *et al*., 2017). In response, Ministers recognised the importance of adequately resourcing the national biosecurity system and agreed the use of consistent cost recovery frameworks.

Measures of financial resources

An assessment of the financial resources in the biosecurity system requires as a starting point information on the scale and sources of investment. Since the last National Biosecurity Investment Stocktake in 2015-16, information of this nature has not been collected or collated on a consistent basis at the national level. The following information, based on the framework used in the investment stocktake, would underpin an evaluation of the financial resources invested in the system:

- Investment ($) by jurisdiction
- Investment ($) by jurisdiction and source – government appropriation and industry contributions through levies and charges
- Investment ($) by jurisdiction and category – six investment categories used in the national stocktake or other categories as agreed by jurisdictions

Collected on an annual basis, this information would allow regular assessments of biosecurity investment to be undertaken and would provide the foundation for analysis of system efficiency.

To obtain a more complete picture of the total investment in the biosecurity system it would be necessary to estimate additional, including in-kind, investments made by non-government participants in the system, including industry and community groups. As noted by the IGAB review, the total financial contribution by industry to the national biosecurity system is unknown as data on operational expenses and in-kind contributions are not collected or documented (Craik *et al.,* 2017). These include investment in monitoring and surveillance activities by some industries, contributions to activities managed by AHA and PHA and towards past and present incursion management.

Although acknowledged as significant, there has been no coordinated attempt to date to estimate the magnitude of these investments or to develop a methodology to support this. The IGAB Review recommended, and Ministers agreed, that AHA and PHA should coordinate an industry stocktake of national biosecurity investments and make the results public. As well as enhancing the transparency of industry investment in the system it would assist industry's claims for a greater role in biosecurity decision making (Craik *et al.,* 2017).

More difficult to estimate are the significant in-kind investments in the biosecurity system made by landholders and community groups such as Landcare. The responsibility for this would rest with relevant groups such as farmers federations and land management groups. The costs of developing a methodology to collect and interpret such data would need to be assessed by these groups and weighed against the perceived benefits of the exercise.

A further category of investment in the national biosecurity system is investment in biosecurity-specific research and innovation. The IGAB review estimates that average expenditure by the Rural Research and Development Corporations on biosecurity-related R&I in the three years from 2013-14 to 2015-16 was $62 million. In addition to this is significant expenditure by government funded organisations, including CSIRO and CEBRA, state and territory research facilities, universities and private companies. No aggregation of these investments has been made but would be required to develop a more complete picture of the financial resources invested in the biosecurity system.

Evaluation question

Is funding for the national biosecurity system adequate, equitable, efficient and sustainable?

Evaluation criteria

- Information is publicly available on investment in the biosecurity system by source and according to agreed and consistent investment categories
- The level of funding allocated by jurisdictions is sufficient to meet normal and emergency biosecurity commitments and is maintained at least at constant levels in real terms
- Costs are shared appropriately across government and industry participants in the biosecurity system according to principles articulated in the IGAB and the NFCSBP
- Funding arrangements encompass all appropriate mechanisms, for example, levies, fees, charges, to provide a sustainable funding base that can support the national system into the future
- Funding arrangements are reviewed regularly

- Investment in the biosecurity system is allocated across activities in a manner that maximises the efficiency of the system and delivers the highest return on investment

Table 35 provides a rubric for this evaluation question.

Table 35: Rubric for financial resources

	Performance standards				
	Advanced	Good	Developing	Inadequate	Insufficient evidence
	Performance is clearly very strong or exemplary in relation to the question. Any gaps or weaknesses are not significant and are managed effectively	Performance is generally strong in relation to the question. No significant gaps or weaknesses, and less significant gaps or weaknesses are mostly managed effectively	Performance is inconsistent in relation to the question. Some gaps and weaknesses. Does not always meet minimum expectations or requirements	Performance is unacceptably weak in relation to the question. Does not meet minimum expectations or requirements	Evidence unavailable or of insufficient quality to determine performance
Evaluation criteria*					
Investment information	Comprehensive information on investment in the biosecurity system by source and agreed investment category is collected regularly by all jurisdictions and made publicly available.	A consistent but not comprehensive set of information on investment in the biosecurity system by source and agreed investment category is collected regularly by most or all jurisdictions and made publicly available.	Some information on investment in the biosecurity system by source and agreed investment category is collected on an ad hoc basis by some or all jurisdictions and may be made publicly available.	Information on investment in the biosecurity system by source and agreed investment category is not routinely collected or is not publicly available.	Evidence unavailable or of insufficient quality to determine performance
Funding level	The level of funding allocated by all jurisdictions is sufficient to meet normal and emergency biosecurity commitments and is maintained at least at constant levels in real terms.	The level of funding allocated by most jurisdictions is sufficient to meet normal and emergency biosecurity commitments and is maintained at least at constant levels in real terms.	The level of funding allocated by some jurisdictions is sufficient to meet normal and emergency biosecurity commitments and is maintained at least at constant levels in real terms.	The level of funding allocated by jurisdictions is not sufficient to meet normal and emergency biosecurity commitments and is not maintained at constant levels in real terms.	Evidence unavailable or of insufficient quality to determine performance
Funding coordination	Jurisdictional funding for biosecurity is virtually always coordinated and results in synchronous and connected investment in post-border biosecurity activities undertaken in the national interest.	Jurisdictional funding for biosecurity is sometimes coordinated and sometimes results in synchronous and connected investment in post-border biosecurity activities undertaken in the national interest.	Coordination of jurisdictional funding for biosecurity is ad hoc and may result in synchronous and connected investment in post-border biosecurity activities undertaken in the national interest.	There is no coordination of jurisdictional funding for biosecurity.	Evidence unavailable or of insufficient quality to determine performance

	Performance standards				
	Advanced	Good	Developing	Inadequate	Insufficient evidence
Cost sharing	Costs are shared equitably across government and industry participants in the biosecurity system according to principles articulated in the IGAB and the National Framework for Cost Sharing Biosecurity Activities. Formal national cost-sharing arrangements are in place for all key biosecurity activities undertaken in the national interest. These principles are outlined in a consistent and transparent cost-recovery framework implemented by all jurisdictions.	Most jurisdictions implement a common and transparent cost recovery framework that is consistent with the principles articulated in the IGAB and the National Framework for Cost Sharing Biosecurity Activities. Formal national cost-sharing arrangements are in place for most key biosecurity activities undertaken in the national interest.	Some jurisdictions implement a common and transparent cost recovery framework that is consistent with the principles articulated in the IGAB and the National Framework for Cost Sharing Biosecurity Activities. Formal national cost-sharing arrangements are in place for some key biosecurity activities undertaken in the national interest.	There is no consistent and transparent cost recovery framework agreed by jurisdictions and it is not possible to determine how jurisdictions share the costs of biosecurity activities. Formal national cost-sharing arrangements do not extend beyond the existing emergency response deeds.	Evidence unavailable or of insufficient quality to determine performance
Funding mechanisms	Funding arrangements in all jurisdictions encompass all appropriate mechanisms, for example, levies, fees, charges, to provide a sustainable funding base that can support the national system into the future.	Funding arrangements in most jurisdictions encompass all appropriate mechanisms, for example, levies, fees, charges, to provide a sustainable funding base that can support the national system into the future.	Funding arrangements in some jurisdictions encompass all appropriate mechanisms, for example, levies, fees, charges, to provide a sustainable funding base that can support the national system into the future.	In general, jurisdictions do not use all available mechanisms to fund the biosecurity system.	Evidence unavailable or of insufficient quality to determine performance
Funding arrangement reviews	Funding arrangements are reviewed on a regular basis by all jurisdictions.	Funding arrangements are reviewed on a regular basis by most jurisdictions.	Funding arrangements are reviewed on an ad hoc basis by some or all jurisdictions.	Funding arrangements are not reviewed on a regular basis by any jurisdiction.	Evidence unavailable or of insufficient quality to determine performance
Investment allocation	Use score from efficiency rubric				

*Refer to text for description of the evaluation criteria

7.6 Physical resources

Extensive networks of physical resources support the biosecurity system. These include inspection facilities at major points of entry to Australia – airports, sea ports and international mail centres; post-entry quarantine facilities to screen high risk materials before they are cleared for entry to Australia; and diagnostic facilities, including laboratories, equipment and reference collections that support activities at the border and post border. Information technology (IT) systems that facilitate the collection, management and analysis of the significant amounts of data generated by the biosecurity system are also important but are considered in section 7.12 of this chapter. While many of the physical resources in the biosecurity system are managed and operated by the Australian and state and territory governments, industry also contributes resources, including approved premises for quarantine purposes and facilities and IT infrastructure operated by customs brokers and freight forwarders. Both the quantity, or capacity, of infrastructure and its quality is important to ensure the delivery of biosecurity services under normal operations and in emergency situations.

The Australian Government manages the risk of entry of pests and diseases at airports, seaports and international mail centres. It operates *inspection facilities* at these points to assess and manage risks associated with aircrafts, vessels, goods and travellers, and to undertake surveillance for pests and diseases of biosecurity concern. Key tools used at these entry points are detector dogs and x-ray equipment. Other infrastructure such as buildings and inspection premises support the inspection and clearance process. Access to sufficient high quality inspection infrastructure incorporating state-of-the-art technology underpins effective and efficient border processes. Inspections can also take place at approved arrangement sites, that is, premises of businesses that are accredited to handle imported goods of biosecurity interest or risk.

In the case of imports of live animals, hatching eggs and plant material, import conditions require that they be quarantined in Australia's *post-entry quarantine* facility, or other approved facilities, for specified periods of time, where they will be observed and tested to ensure that they do not present a biosecurity threat on release. The Australian government has consolidated its former dispersed operations into a single post-entry quarantine facility at Mickleham in Victoria. AHA has observed that the single site enables greater efficiencies in operations and consolidation of staff expertise and will better meet Australia's post-entry quarantine needs into the future (AHA, 2019).

Other post-entry quarantine facilities are approved by the department and managed by state governments or scientific or private operators. These include facilities for ornamental fish imports and some plant nursery stock and restricted seed imports. Compliance with biosecurity requirements by these approved facilities is audited regularly (PHA, 2018a).

Accurate diagnosis of animal diseases and plant pests underpins all aspects of the biosecurity system, including preparedness and response. *Laboratory* infrastructure and, in the case of plant pests, *national reference collections*, are essential to supporting diagnostic services.

There are eight government animal health laboratories in Australia, comprising CSIRO's Australian Animal Health Laboratory (AAHL) in Victoria and one in each state and the Northern Territory. All government laboratories are accredited by the National Association of Testing Authorities (NATA) to perform a range of animal health testing services, including those for trade and public health purposes. Some government laboratories – AAHL, AgriBio Victoria, the Elizabeth Macarthur Agricultural Institute in NSW and Queensland Health's Forensic and Scientific Services laboratory – are OIE reference laboratories for designated diseases. In addition to performing confirmatory diagnosis and in-depth investigation, reference laboratories play a national leadership or coordinating role in test development and transfer, production or supply of reference materials, expert scientific training and advice and other essential quality assurance functions (AHA, 2019).

Diagnostic services are also provided by university laboratories as well as private and industry-based laboratories. Many of these are also accredited by NATA for their relevant scope of testing services, a pre-condition for participation in official EAD testing.

The OIE's evaluation of Australia's veterinary services concluded that the network of animal health laboratories operated by governments, universities and the private sector was world class (Schneider *et al.*, 2015).

In the plant sector, the accurate and rapid identification of both established and exotic species can require close examination, expertise, morphological comparison with reference species and DNA sequence analysis (PHA, 2018a). In the event of an incursion, diagnostic expertise is required to identify an initial sample, to help determine the spread of the incursion – a critical factor in determining whether a pest is eradicable – and to provide evidence of eradication. Diagnostic capacity also supports many of the ongoing management practices that are integral to the production and trade of plant products. Rapid identification also supports quarantine processes such as maintaining pest free areas, which allow access to both domestic and international markets (PHA, 2018a).

Plant diagnostic services are distributed across every state and territory, including in most major agricultural and horticultural production areas. Services are delivered by a range of agencies, including the Australian, state and territory governments, commercial and private diagnostic laboratories, museums, CSIRO and universities. PHA publishes a list of Australia's diagnostic services, their capabilities, accreditations and collections in its annual Plant Health Status Report (PHA, 2018a).

In contrast with animal health laboratories, not all plant pest diagnostic laboratories are NATA accredited (PHA, 2018a). Plant pest diagnostic quality and reliability is supported by the Subcommittee on Plant Health Diagnostics (SPHD), the aims of which include to implement and maintain appropriate quality management systems in diagnostic laboratories.

Biological collections are an essential part of the plant biosecurity system and a vital support for effective diagnostics. Reference collections contain exotic pest specimens, common native relatives and lookalikes of exotic pests, type specimens, and historical material and records. Australia's collections are used to support proof of area freedom that comply with international standards. Collections are supported by human capability and other forms of information, contained, for example, in images, diagnostic protocols, gene sequences, on-line keys and other taxonomic resources. The interactions and linkages between collections, experts and other information sources are critical to the system's effectiveness (PHA, 2018b). SPHD released the National Plant Pest Reference Collections Strategy (NPPRCS) in 2018. The strategy reviews the current state of Australia's collections and makes recommendations, which, if implemented, would contribute to ensuring that collections deliver appropriate trade and biosecurity outcomes (PHA, 2018b).

Animal health and plant diagnostic laboratories are connected through the Laboratories Emergency Animal Disease Diagnosis and Response network and the National Plant Biosecurity Diagnostic Network, respectively. Membership of these networks offers participating laboratories access to training, standard testing procedures, quality controls for tests and support for laboratory preparedness and responses (AHA, 2018a).

In addition to the quality of laboratories and diagnostic services, a critical performance issue is their capacity to meet demand in an emergency situation, or their surge capacity. Surge capacity can be met through inbuilt redundancy in the system or through partnering arrangements that share physical resources and expertise to support emergency responses. Laboratory networks and relationships support an effective partnering approach.

Measures of physical resources

Because of the diverse and dispersed nature of physical resources in the biosecurity system it is challenging to develop a set of measures that provides a meaningful overview of resource quantity and quality. The following is a guide to the types of measures that could provide useful information on the physical resource base.

Inspection facilities

- Number of trained detector dogs by location
- Number of x-ray machines by type and location

Post-entry quarantine facilities

- Capacity of government operated post-entry quarantine facility by cats, dogs, horses, bees, ruminants, camelids, avians, plant material
- Capacity utilisation of government operated post-entry quarantine facility by cats, dogs, horses, bees, ruminants, camelids, avians, plant material

Laboratory facilities

- Number and capacity of NATA accredited animal health laboratories, government and non-government, by location
- Number and capacity of OIE reference laboratories, by location, including disease or pathogen
- Number and capacity of plant health laboratories, government and non-government, by location, by accreditation
- Number of plant pest reference collections that meet the standards developed under the NPPRCS)
- Number of priority plant pests represented in reference collections that meet the standards developed under the NPPRCS

Evaluation question

Are the physical resource inputs to the biosecurity system – inspection facilities, post-entry quarantine facilities, laboratory infrastructure and plant pest reference collections – of sufficient capacity and quality to manage biosecurity risk effectively in normal circumstances and in emergency responses?

Evaluation criteria

Inspection facilities

- inspection facilities at airports, sea ports and mail centres have sufficient capacity to meet current and forecast demand without unduly impeding the entry of goods and travellers;
- inspection facilities at airports, sea ports and mail centres use up to date/contemporary technology, equipment and tools to maximise the efficiency and effectiveness of inspection services

Post-entry quarantine facilities

- government operated post-entry quarantine facilities for animals and plant material have sufficient capacity to meet current and forecast demand;
- government operated post-entry quarantine facilities for animals and plant material meet contemporary quality standards for construction and operations;
- approved arrangements with private post-entry quarantine providers meet required standards and are audited/quality assured on a regular basis

Laboratories

- animal and plant diagnostic laboratories meet appropriate accreditation standards
- plant pest reference collections are sufficiently comprehensive, diverse and dispersed to support biosecurity risk management
- laboratory equipment and facilities are sufficient to handle high sample throughput with appropriate quality assurance. In emergency situations, laboratories can scale up to very high capacity;
- national laboratory networks support effective partnerships that are used to manage demand in normal and emergency circumstances;
- effective linkages with international reference laboratories enhance diagnostic capacity.

Table 36 provides a rubric for this evaluation question.

Table 36: Rubric for physical resources

	Performance standards				
	Advanced	Good	Developing	Inadequate	Insufficient evidence
	Performance is clearly very strong or exemplary in relation to the question. Any gaps or weaknesses are not significant and are managed effectively	Performance is generally strong in relation to the question. No significant gaps or weaknesses, and less significant gaps or weaknesses are mostly managed effectively	Performance is inconsistent in relation to the question. Some gaps and weaknesses. Does not always meet minimum expectations or requirements as far as can be determined	Performance is unacceptably weak in relation to the question. Does not meet minimum expectations or requirements	Evidence is unavailable or of insufficient quality to determine performance
Evaluation criteria*					
Inspection facilities	Inspection facilities at all airports, seaports and mail centres use best available technology, equipment and tools that maximise the efficiency and effectiveness of inspection services. There is virtually always sufficient capacity to meet current demand without impeding the entry of goods and travellers, and capacity is sufficient to meet forecast immediate demand growth.	Inspection facilities at most airports, seaports and mail centres use best available technology, equipment and tools that support the efficiency and effectiveness of inspection services. There is usually sufficient capacity to meet current demand without unduly impeding the entry of goods and travellers.	Inspection facilities at some airports, seaports and mail centres use best available technology, equipment and tools. There is often insufficient capacity to meet current demand and the entry of goods and travellers is often impeded. Planning for future demand growth is limited.	Inspection facilities at airports, seaports and mail centres often rely on outdated technology, equipment and tools that do not support efficient and effective inspection services. There is insufficient capacity to meet current demand and the entry of goods and travellers is frequently impeded.	Evidence is unavailable or of insufficient quality to determine performance
Post-entry quarantine facilities	Australian Government operated post-entry quarantine facilities for animals and plant material meet contemporary quality standards for construction and operations. There is virtually always sufficient capacity to meet current demand, as well as forecast immediate demand growth.	Australian Government operated post-entry quarantine facilities for animals and plant material meet contemporary quality standards for construction and operations in all or most commodity streams. There is sufficient capacity in all commodity streams to meet current demand, except in unusually high demand circumstances, as well as forecast immediate demand growth.	Australian Government operated post-entry quarantine facilities for animals and plant material meet contemporary quality standards for construction and operations in some commodity streams. There is sufficient capacity to meet current demand in normal circumstances but waiting times exceed expectations when demand rises above normal. Planning for future demand growth is limited.	Australian Government operated post-entry quarantine facilities for animals and plant material do not meet contemporary quality standards for construction and operations. There is insufficient capacity to meet current demand, reflected in lengthy waiting times in some commodity streams.	Evidence is unavailable or of insufficient quality to determine performance

	Performance standards				
	Advanced	Good	Developing	Inadequate	Insufficient evidence
Approved arrangements	Approved arrangements with private post-entry quarantine providers virtually always meet required standards and are audited or quality assured on a regular basis.	Approved arrangements with private post-entry quarantine providers usually meet required standards. They are audited or quality assured on a regular basis.	Some approved arrangements with private post-entry quarantine providers meet required standards. Some auditing or quality assurance is undertaken on a regular basis.	Approved arrangements with private post-entry quarantine providers generally do not meet required standards. Auditing or quality assurance is not always conducted on a regular basis.	Evidence is unavailable or of insufficient quality to determine performance
Laboratory accreditation	All animal diagnostic laboratories are accredited by NATA. All plant diagnostic laboratories are either accredited by NATA or meet an equivalent accreditation standard supported by the Subcommittee on Plant Health Diagnostics.	All animal diagnostic laboratories are accredited by NATA. Most plant diagnostic laboratories are either accredited by NATA or meet an equivalent standard supported by the Subcommittee on Plant Health Diagnostics.	All animal diagnostic laboratories are accredited by NATA. Some plant diagnostic laboratories are either accredited by NATA or meet an equivalent standard supported by the Subcommittee on Plant Health Diagnostics.	Animal and plant diagnostic laboratories generally do not meet appropriate accreditation standards.	Evidence is unavailable or of insufficient quality to determine performance
Plant pest reference collections	Plant pest reference collections are comprehensive, diverse and dispersed, supported by outstanding human capability and other forms of information, with outstanding linkages to other collections, experts and other forms of information. They are always able to support proof of area freedom claims that meet international standards.	Most plant pest reference collections are comprehensive, diverse and dispersed, supported by excellent human capability and other forms of information, with excellent linkages to other collections, experts and other forms of information. They are usually able to support proof of area freedom claims that meet international standards.	There are some plant pest reference collections that are comprehensive, diverse and dispersed and supported by human capability and other forms of information but significant gaps in coverage remain in some areas. They are sometimes able to support proof of area freedom claims that meet international standards.	Plant pest reference collections are generally not sufficiently comprehensive, diverse and dispersed to support proof of area freedom claims that meet international standards.	Evidence is unavailable or of insufficient quality to determine performance
Laboratory facilities	All laboratories have equipment and facilities that are sufficient to handle high sample throughput with appropriate quality assurance. In emergency situations, laboratories can scale up to very high capacity.	Most laboratories have equipment and facilities that are sufficient to handle high sample throughput with appropriate quality assurance. In emergency situations, laboratories can scale up to high capacity.	Equipment and facilities in some laboratories are sufficient to handle high sample throughput with appropriate quality assurance. There is some capacity to scale up operations in emergency situations.	Laboratory equipment and facilities are generally not sufficient to handle high sample throughput with appropriate quality assurance. There is little capacity to scale up operations in emergency situations.	Evidence is unavailable or of insufficient quality to determine performance

	Performance standards				
	Advanced	Good	Developing	Inadequate	Insufficient evidence
National laboratory networks	National laboratory networks are exceptionally well developed, encompassing all animal and plant laboratories, and provide comprehensive access to training, standard testing procedures, quality controls for tests and support for laboratory preparedness and responses. They are highly effective partnerships that are used to manage demand in normal and emergency circumstances.	National laboratory networks are well developed, encompassing most animal and plant laboratories. They provide good access to training, standard testing procedures, quality controls for tests and support for laboratory preparedness and responses. They are effective partnerships that are used to manage demand in normal and emergency circumstances.	National laboratory networks are reasonably well developed although there are some significant gaps in membership. They provide access to training, standard testing procedures, quality controls for tests and support for laboratory preparedness and responses among members. They can be used to help manage demand in normal and emergency circumstances although this is constrained by their membership.	National laboratory networks are not well developed and have relatively few participating members. Their capacity to provide support and to manage demand in normal and emergency circumstances is limited because of their reduced membership.	Evidence is unavailable or of insufficient quality to determine performance
International laboratory linkages	Linkages with international laboratories, including reference laboratories, are exceptionally well developed and provide a highly effective means of accessing surge diagnostic capacity in an emergency response.	Linkages with international reference laboratories, including reference laboratories, are well developed and provide an effective means of accessing surge diagnostic capacity in an emergency response.	There are some linkages with international laboratories, including reference laboratories. These linkages can sometimes be used to access surge diagnostic capacity in an emergency response.	Linkages with international laboratories are minimal and ad hoc and do not generally enhance access to surge diagnostic capacity in an emergency response.	Evidence is unavailable or of insufficient quality to determine performance

*Refer to text for description of the evaluation criteria

7.7 Human resources

Human resources – the people who lead, plan, operate and oversight the biosecurity system – are a fundamental resource without which the system would not exist. The system description identifies human resources, encompassing both the number, or capacity, of people who work within the system and their capability, as a key input to the system. A diverse range of skills is required to ensure the effective operation of the biosecurity system across all its activities – pre-border, at the border and post-border, under both normal circumstances and in emergency responses. These include specialist skills such as veterinary and plant sciences, taxonomy, diagnostics, epidemiology, and entomology. Advanced skills in statistics, data analytics and risk analysis are increasingly important inputs to effective biosecurity risk management. The human resources in the biosecurity system also include government officers who perform leadership, policy, management and operational functions, in offices and in the field. Also critical are the skills of those participants in the system that provide in-kind support such as producers who manage farm biosecurity and community groups that undertake and report on passive surveillance activities.

Information on the number of participants in the biosecurity system by skill contributes one element to the measurement of human resource capacity. AHA, for example, provides an annual update of the number of veterinary and auxiliary staff in Australia by employment category (AHA, 2019, Table 37). This is not biosecurity specific but provides a simple measure of the total veterinary and para veterinary resource available to maintain the core functions of Australia's animal health system. No equivalent measure is readily available for the human resources engaged in plant biosecurity activities. Estimates of the personnel involved in biosecurity related activities in government are possible from jurisdictional budget statements but there has been no collation of such statistics at the national level.

Table 37: Number of veterinarians and other animal health personnel in 2018

Registered veterinarians		**Auxiliary personnel**	
Government	785	Stock inspectors, meat inspectors, etc	2,464
Laboratories, universities, etc	988		
Private practitioners	10,574		
Other veterinarians	1,632		
Total	**13,979**	**Total**	**2,464**

Source: Animal Health Australia (AHA, 2019).

The capability or competency of personnel in the biosecurity system provides additional information regarding the potential performance of the system. In 2015, the OIE) conducted an evaluation of the performance of Australia's veterinary services (Schneider *et al.*, 2015). It ranked the competency of Australia's veterinary profession at the highest level, on the basis, in part, of excellent under-graduate and post-graduate training. Para veterinary professionals were also assessed as very competent and well trained for their roles. While this was an overarching assessment of veterinary human resources it can be assumed that those resources engaged in biosecurity activities share these competencies. No equivalent assessment of the overarching competency of personnel involved in plant biosecurity is available.

Measures of the number and competency of human resources can provide a simple view of the capacity of the system under normal conditions. More important in an assessment of biosecurity system health is the capacity of the human resource base to respond to emergency situations. Having access to people trained and ready to respond promptly to any biosecurity incident is fundamental to the success of response actions and can make a critical difference to the speed with which responses are initiated and the capacity for them to be sustained.

Different approaches can be taken to this capacity issue. For example, excess or redundant capacity with the appropriate skills and training can be maintained within the system for emergency response purposes. As jurisdictional budgets for biosecurity tighten this is unlikely to be a viable or sustainable option. Alternatively, a mix of baseload and surge staffing capacity can be managed through outsourcing or sharing/partnering models. Arrangements for accessing interstate or international professional staff such as through the International Animal Health Emergency Reserve (IAHER) are an example. The IAHER is an arrangement between Australia, Canada, Ireland, New Zealand, the United Kingdom and the United States to share personnel and resources during an EAD outbreak (AHA, 2109). Partnership arrangements between diagnostic laboratories can expand the available pool of trained diagnosticians in both animal and plant emergencies.

Underpinning an outsourced surge capacity model is the provision of training and awareness activities for potential participants in emergency responses. In the case of EADs, government officers, livestock producers, private veterinary practitioners and emergency workers can be called on to help in eradication or containment activities. A range of training opportunities exists to support their participation, including EAD awareness workshops for private practitioners, jurisdictional training for first responders, and real time foot-and-mouth disease training for veterinarians and livestock workers. In addition, governments fund the National Biosecurity Response Team (NBRT), a group of approximately 70 government response personnel with expertise in emergency management. The NBRT is cross-sectoral and can deploy rapidly in response to an animal, plant, aquatic or environmental biosecurity incident (AHA, 2019).

Administrative arrangements can support the effective operation of an outsourced surge capacity model, including the maintenance of registers of suitably qualified and trained people who can participate in emergency responses.

A healthy biosecurity system also requires a long term view of its human resource needs. This requires an understanding of the existing work force, including its size, skills mix and age structure, as well as active workforce and skills planning to meet current and future needs.

Measures of human resources

A comprehensive understanding of human resource availability for the biosecurity system would require an audit of those working in biosecurity by organisation, role, including technical, policy, administrative and leadership roles, as well as their qualifications and age structure. It would also require an assessment of the availability of such skills outside the biosecurity system that could be drawn upon in an emergency. Such an audit has not been undertaken, other than AHA's annual count of veterinary and para-veterinary personnel. To the extent available, the following data points would help to define baseload and surge human resource capacity in the system:

- Number of veterinarians and other animal health personnel, by sector
- Number of plant specialists, by specialty and sector
- Number of biosecurity staff in government, by role and jurisdiction
- Number of people with emergency animal disease training
- Number of people with emergency response training
- Number of members of the National Biosecurity Response Team
- Number of domestic and international partnership arrangements to share resources in an emergency

Evaluation question

Does the national biosecurity system have access to sufficient qualified and trained personnel to manage biosecurity risk effectively in normal circumstances and in emergency responses?

Evaluation criteria

- There are sufficient qualified and trained personnel, including in specialist, technical, generalist and leadership roles, to manage biosecurity risk effectively in normal circumstances
- The biosecurity system has access to sufficient qualified and trained personnel, including in specialist, technical, generalist and leadership roles, in government and the private sector, to respond rapidly and effectively to emergency situations
- Training and emergency awareness opportunities are provided to potential participants in the biosecurity system to underpin emergency response capacity
- Administrative processes and arrangements identify the availability and readiness of personnel across skills categories and locations
- Future skills and training requirements are forecast and addressed through a strategic workforce planning process coordinated at the national level

Table 38 provides a rubric for this evaluation question.

Table 38: Rubric for human resources

	Performance standards				
	Advanced	Good	Developing	Inadequate	Insufficient evidence
	Performance is clearly very strong or exemplary in relation to the question. Any gaps or weaknesses are not significant and are managed effectively	Performance is generally strong in relation to the question. No significant gaps or weaknesses, and less significant gaps or weaknesses are mostly managed effectively	Performance is inconsistent in relation to the question. Some gaps and weaknesses. Does not always meet minimum expectations or requirements	Performance is unacceptably weak in relation to the question. Does not meet minimum expectations or requirements	Evidence is unavailable or of insufficient quality to determine performance
Evaluation criteria*					
Human resources for normal operations	There are sufficient qualified and trained personnel, including in specialist, technical, generalist and leadership roles, to manage biosecurity risk effectively in normal circumstances.	There are sufficient qualified and trained personnel in most specialist, technical, generalist and leadership roles, to manage biosecurity risk effectively in normal circumstances. Consistent processes exist to fill gaps as they arise.	There are some gaps in sufficiently qualified and trained personnel in some specialist, technical, generalist and leadership roles, which can compromise the effective management of biosecurity risk in normal circumstances. Processes to address these gaps are ad hoc.	There are insufficient qualified and trained personnel across a range of specialist, technical, generalist and leadership roles to manage biosecurity risk effectively in normal circumstances.	Evidence is unavailable or of insufficient quality to determine performance

	Performance standards				
	Advanced	Good	Developing	Inadequate	Insufficient evidence
Human resources for emergency responses	The biosecurity system has access to sufficient qualified and trained personnel, including in all specialist, technical, generalist and leadership roles, in government and the private sector, to respond rapidly and effectively to emergency situations, either through the management of redundant capacity in the system or through the development of effective outsourcing or sharing/partnering arrangements.	The biosecurity system has access to sufficient qualified and trained personnel in most roles, either in government or the private sector, to respond rapidly and effectively to emergency situations either through the management of redundant capacity in the system or through the development of outsourcing or sharing/partnering arrangements.	The biosecurity system has access to sufficient qualified and trained personnel in some roles, in government or the private sector. Redundant capacity in the system is generally not available and outsourcing or sharing/partnering arrangements are not well developed. This limits the capacity to respond rapidly and effectively to emergency situations.	The biosecurity system does not have access to sufficient qualified and trained personnel, including in specialist, technical, generalist and leadership roles, in government and the private sector, to respond to emergency situations. There is no redundant capacity in the system and effective outsourcing or sharing/partnering arrangements have not been developed. The capacity to respond to emergency situations is severely constrained.	Evidence is unavailable or of insufficient quality to determine performance
Emergency training and awareness	Comprehensive and highly effective training and emergency awareness opportunities are provided to all available participants in the biosecurity system to underpin emergency response capacity.	Effective training and emergency awareness opportunities in most areas are provided to potential participants in the biosecurity system to underpin emergency response capacity.	Training and emergency awareness opportunities are provided to some potential participants in the biosecurity system to underpin emergency response capacity.	There are limited training and emergency awareness opportunities provided to potential participants in the biosecurity system. This limits the system's emergency response capacity.	Evidence is unavailable or of insufficient quality to determine performance
Administrative arrangements	Highly effective administrative processes and arrangements, including comprehensive registers of qualified, trained and available people, support the availability of human resources to participate in emergency responses.	Effective administrative processes and arrangements, including registers of most qualified, trained and available people, support the availability of human resources to participate in emergency responses.	Administrative processes and arrangements are undertaken in an ad hoc manner and are of limited utility in determining the availability of human resources to participate in emergency responses.	There are limited or no administrative processes or arrangements to support the availability of human resources to participate in emergency responses.	Evidence is unavailable or of insufficient quality to determine performance

	Performance standards				
	Advanced	Good	Developing	Inadequate	Insufficient evidence
Future skills and training	There is a comprehensive understanding of the human resource base that supports effective forecasting of future skills and training requirements. This is coordinated through a strategic workforce planning process at the national level.	There is good understanding of the human resource base that supports forecasting of future skills and training requirements. Strategic workforce planning processes at the jurisdictional level are used to inform national requirements.	Understanding of the human resource base is developing at the jurisdictional level and is used to inform future skills and training requirements. There is no nationally coordinated strategic workforce planning process.	Understanding of the human resource base is limited and does not provide a sound basis for forecasting future skills and training requirements. There is no nationally coordinated strategic workforce planning process.	Evidence is unavailable or of insufficient quality to determine performance

*Refer to text for description of the evaluation criteria

7.8 Strategic planning & policy development

An overarching strategy for the national biosecurity system that provides a clear and coherent vision, goals and desired outcomes can be a powerful tool for gaining the collective support of system participants. A clearly articulated strategy would provide the objectives of the system, the principles guiding its operation, the roles, responsibilities and accountabilities of participants, and the key biosecurity priorities. A strategy document that has the endorsement of participants can also provide the basis for consistent and harmonised biosecurity policy at all levels of government and provide guidance on prioritisation and decision making. It can also provide a foundation for prioritising biosecurity research and innovation efforts.

Each Australian state and territory has current or recent strategy or policy documents that provide objectives and guiding principles for their biosecurity systems. Other participants in the system have also developed strategy and policy documents that support action at the industry or sectoral level. The IGAB review noted, that at the time of its writing, there was no single, overarching national policy statement or strategy shared by all system participants. 'At present, the articulation of the national biosecurity system is made up of objectives, principles and policies embedded in various jurisdictional and industry policy documents, sectoral strategies and emergency response deeds, which have for the most part been developed in parallel but not always in conjunction with each other' (Craik *et al.*, 2017).

The IGAB review considered that system participants would benefit from a unifying national biosecurity statement that recognises a common understanding of biosecurity, shared responsibility and Australia's risk-based approach. It suggested that the statement should articulate a national vision and goals for biosecurity and key biosecurity principles; provide clarity on roles, responsibilities and accountabilities of participants; and outline national priorities and principles for managing biosecurity (Craik *et al.*, 2017).

The review's recommendation to develop such a statement was agreed to by Ministers and has now been actioned. A draft National Biosecurity statement was developed under the guidance of an independent working group comprising state, industry and environmental stakeholders. It was consulted on widely, with submissions received from community, industry, environmental and government interests. Further feedback was received through state and territory biosecurity roundtables and forums held by PHA and AHA. The final statement was presented to stakeholders at the National Biosecurity Forum in November 2018 and published on the department's website in June 2019. The statement outlines a broad vision for the biosecurity system and describes the roles of governments and other participants in the system.

The IGAB itself also provides clear statements around the goal and objectives of the national biosecurity system, as well as articulating key principles on which the system operates, and the responsibilities of the parties. As an agreement between the Australian and state and territory governments, it does not extend to responsibilities of non-government participants in the system although it recognises that biosecurity is a shared responsibility between all system participants.

Evaluation question

Is there a clearly articulated strategy for the national biosecurity system that has the endorsement of all participants in the system, and provides the basis for consistent and harmonised biosecurity policy development by all levels of government and by industry and community participants?

Evaluation criteria

- There is a documented national strategy for the biosecurity system that is contemporary, articulates the overarching objectives of the system, its guiding operational principles, the roles, responsibilities and accountabilities of its participants, and the key biosecurity management priorities
- Development of the national biosecurity strategy has been undertaken collaboratively with all participants in the biosecurity system – governments, industry and community – and has their overarching endorsement
- State and territory biosecurity strategies are consistent with and support the national strategy, while recognising individual contexts and circumstances
- Biosecurity policies at the Australian, state and territory levels are consistent with and support the national biosecurity strategy and are harmonised across jurisdictions, while recognising individual contexts and circumstances
- Policy development and review of existing policy follows best practice guidelines, is documented and engages all affected participants in the biosecurity system

Table 39 provides a rubric for this evaluation question.

Table 39: Rubric for strategy and policy development

	Performance standards				
	Advanced	Good	Developing	Inadequate	Insufficient evidence
	Performance is clearly very strong or exemplary in relation to the question. Any gaps or weaknesses are not significant and are managed effectively	Performance is generally strong in relation to the question. No significant gaps or weaknesses, and less significant gaps or weaknesses are mostly managed effectively	Performance is inconsistent in relation to the question. Some gaps and weaknesses. Does not always meet minimum expectations or requirements	Performance is unacceptably weak in relation to the question. Does not meet minimum expectations or requirements	Evidence is unavailable or of insufficient quality to determine performance
Evaluation criteria*					
National biosecurity strategy	There is a documented national strategy for the biosecurity system that is contemporary and articulates the overarching objectives of the system, its guiding operational principles, the roles, responsibilities and accountabilities of its participants, and the key biosecurity management priorities. This provides a unifying framework for state and territory, industry and sectoral strategies.	There are contemporary documents that articulate all or most of the elements of a national biosecurity strategy. They provide guidance for state and territory, industry and sectoral strategies.	Some elements of a national biosecurity strategy are articulated in contemporary documents. They provide guidance for state and territory, industry and sectoral strategies.	There is no documented national strategy for the biosecurity system or equivalent documentation. State and territory, industry and sectoral strategies are developed independently of a national framework.	Evidence is unavailable or of insufficient quality to determine performance
Biosecurity strategy development	Development of a national biosecurity strategy has been undertaken collaboratively with representative participants of all parties to the system – governments, industry and community – and has their overarching endorsement.	Development of a national biosecurity strategy or equivalent documentation has been undertaken collaboratively with representative participants of all or most parties to the system – governments, industry and community – and has their endorsement.	Development of a national biosecurity strategy or equivalent documentation has been undertaken with limited collaboration or consultation across participants in the biosecurity system – governments, industry and community – and cannot claim their endorsement with confidence.	Development of the national biosecurity strategy or equivalent documentation has not been undertaken collaboratively with participants in the biosecurity system – governments, industry and community – and cannot claim their endorsement.	Evidence is unavailable or of insufficient quality to determine performance

	Performance standards				
	Advanced	Good	Developing	Inadequate	Insufficient evidence
Jurisdictional biosecurity strategies support the national strategy	All key elements of state and territory biosecurity strategies – objectives; operational principles; roles, responsibilities and accountabilities of participants; and biosecurity management priorities – are consistent with each other and support the national strategy or equivalent, while recognising individual contexts and circumstances.	Most key elements of state and territory biosecurity strategies are consistent with each other and support the national strategy or equivalent, while recognising individual contexts and circumstances.	Some elements of state and territory biosecurity strategies are consistent with each other and support the national strategy, while some key elements diverge. Not all jurisdictional strategies support the key elements of the national strategy.	There are substantial inconsistencies between state and territory biosecurity strategies and they do not necessarily support the national strategy or equivalent.	Evidence is unavailable or of insufficient quality to determine performance
Consistency of biosecurity strategies and biosecurity policies	Biosecurity policies at the Australian, state and territory levels are consistent with and support the national biosecurity strategy; they are harmonised across jurisdictions, while recognising individual contexts and circumstances.	Most key elements of state and territory biosecurity policies are consistent with and support the national biosecurity strategy; they are generally harmonised across jurisdictions, while recognising individual contexts and circumstances.	Some key elements of state and territory biosecurity policies are consistent with and support the national biosecurity strategy; harmonisation across jurisdictions is limited.	There are substantial inconsistencies between state and territory biosecurity policies and they do not necessarily support the national biosecurity strategy or equivalent.	Evidence is unavailable or of insufficient quality to determine performance
Biosecurity policy development process	Stakeholders and the general public are engaged as valuable contributors and collaborators in biosecurity policy development.	A formal process for stakeholder and public consultation and contribution to biosecurity policy development is well developed and implemented.	Stakeholder and public consultation and contribution to biosecurity policy development occurs in some policy areas.	A process for facilitating stakeholder engagement in biosecurity policy development does not exist.	Evidence is unavailable or of insufficient quality to determine performance

*Refer to text for description of the evaluation criteria

7.9 Governance

Governance arrangements in the national biosecurity system provide a sound framework for the leadership and management of the system. They should clearly articulate the roles, responsibilities and accountabilities of participants and the relationships between them that define how they behave in the system. Governance arrangements encompass the institutional structures that underpin the operation of the system, as well as the legislative, regulatory and administrative arrangements that support system strategy and operations at the national and state and territory levels.

A key biosecurity system governance document at the national level is the IGAB. The revised IGAB (COAG, 2019) defines the overarching goal and objectives of the system, sets out the fundamental principles on which the biosecurity system will operate (Box 10), defines the roles and responsibilities of system participants and articulates institutional arrangements that support the system. In the latter context, it authorises the NBC to provide the strategic management and oversight of the national system and intergovernmental relationships and defines its reporting structure.

Box 10: Key biosecurity principles

- Biosecurity is a shared responsibility between all system participants.
- In practical terms, zero biosecurity risk is unattainable.
- Biosecurity investment prioritises the allocation of resources to the areas of greatest return, in terms of risk mitigation and return on investment.
- Biosecurity activities are undertaken according to a cost-effective, science-based and risk-managed approach.
- Governments contribute to the cost of risk management measures in proportion to the public good accruing to them. Other system participants contribute in proportion to the risks created and/or benefits gained.
- System participants are involved in planning and decision making according to their roles, responsibilities and contributions.
- Decisions governments make in further developing and operating our national biosecurity system should be clear and, wherever possible, made publicly available.
- The Australian community and our trading partners should be informed about the status, quality and performance of our national biosecurity system.
- Australia’s biosecurity arrangements comply with its international rights and obligations and with the principle of ecologically sustainable development.

Source: IGAB 2019 (COAG, 2019)

Other important governance settings are provided in the emergency response deeds managed by AHA, PHA and the department. The deeds are contractual agreements between the Commonwealth, state and territory governments and industry groups to increase Australia’s capacity to prepare for and respond to emergency pest and disease incursions. In particular, they define how to manage the costs and responsibility for an emergency response to a pest or disease outbreak.

The review of the IGAB (Craik *et al*., 2017) recommended a number of changes to strengthen governance arrangements in the national biosecurity system, including identifying lead ministers and agencies for biosecurity and implementing supporting whole of government arrangements through memoranda of understanding; clarifying the authority and remit of the NBC; adopting an NBC sub committee structure that aligns with national biosecurity system objectives and reform priorities; and ensuring that sectoral committees have clear and transparent responsibilities for pest and disease risks.

These recommendations have been agreed or agreed in principle by Ministers (DAWR, 2018b) and have been implemented or are in process of being implemented. A focus of the evaluation framework should be to determine whether the implementation of these recommendations has contributed to effective biosecurity governance arrangements in the national system.

Evaluation question

Are there clearly defined governance arrangements, including institutional, legislative and administrative structures, that support the operation of the national biosecurity system?

Evaluation criteria

- The Intergovernmental Agreement on Biosecurity (IGAB) clearly articulates governance arrangements in the national biosecurity system, including:
    - a mandate for advancing the objectives of the biosecurity system;
    - roles, responsibilities and accountabilities of system participants, including governments, industry and community; and
    - a commitment to strengthen partnerships between governments and other participants in the system
- Whole-of-government arrangements are in place at the national and state and territory level that identify lead and support agencies in the biosecurity system and their roles, responsibilities and accountabilities
- The institutional arrangements that underpin the operation of the biosecurity system are clearly articulated:
    - The IGAB authorises the NBC as the body responsible for implementing the agreement and establishes its terms of reference;
    - NBC terms of reference adequately reflect its role as the principal provider of strategic and policy advice on animal, plant and environmental biosecurity matters to relevant senior officials, primarily through the Agriculture Senior Officials' Committee (AGSOC) and ministers, primarily through the Agriculture Ministers' Forum (AGMIN);
    - The NBC subcommittee structure is aligned with national biosecurity system objectives and national biosecurity reform priorities. Subcommittees have clearly defined and delineated responsibilities that reflect pest and disease risks; and
    - NBC provides information through its dedicated website that supports public awareness of and engagement with biosecurity
- Appropriate contemporary legislation, regulations and administrative arrangements are in place at the Australian and state and territory government levels to support the strategic direction and operations of the biosecurity system and are harmonised across jurisdictions, while recognising individual contexts and circumstances

Table 40 provides a rubric for this evaluation question.

Table 40: Rubric for governance

	Performance standards				
	Advanced	Good	Developing	Inadequate	Insufficient evidence
	Performance is clearly very strong or exemplary in relation to the question. Any gaps or weaknesses are not significant and are managed effectively	Performance is generally strong in relation to the question. No significant gaps or weaknesses, and less significant gaps or weaknesses are mostly managed effectively	Performance is inconsistent in relation to the question. Some gaps and weaknesses. Does not always meet minimum expectations or requirements	Performance is unacceptably weak in relation to the question. Does not meet minimum expectations or requirements	Evidence is unavailable or of insufficient quality to determine performance
Evaluation criteria*					
Governance arrangements	The governance arrangements for the national biosecurity system are comprehensive, clearly articulated and provide an excellent framework for the leadership and management of the system. They include roles, responsibilities and accountabilities of system participants, operating principles for the system, and institutional arrangements to support the system. The various documents that outline governance arrangements, for example the IGAB and emergency response deeds, are consistent and integrated. Governance arrangements are reviewed regularly.	The governance arrangements for the national biosecurity system are clearly articulated and provide a good framework for the leadership and management of the system. Most of the elements of good governance arrangements are included in the key governance documents and these are reasonably consistent and integrated. Governance arrangements are reviewed regularly.	The governance arrangements for the national biosecurity system are sufficient to provide a framework for the leadership and management of the system. They articulate some of the elements of good governance arrangements but they are not necessarily well understood by system participants. Governance arrangements are considered or reviewed on an irregular basis.	The governance arrangements for the national biosecurity system are not well developed; some of the elements of good governance arrangements are not clear, and not well understood by participants; there is a lack of consistency and integration between governance documents. Governance arrangements are not considered or reviewed on a regular basis.	Evidence is unavailable or of insufficient quality to determine performance
Whole-of-government arrangements	Whole-of-government arrangements that clearly identify lead and support agencies in the biosecurity system and their roles, responsibilities and accountabilities are in place in all jurisdictions and support the delivery of their commitments under the IGAB.	Whole-of-government arrangements that clearly identify lead and support agencies in the biosecurity system and their roles, responsibilities and accountabilities, are in place in most jurisdictions and support the delivery of their commitments under the IGAB.	Whole-of-government arrangements that clearly identify lead and support agencies in the biosecurity system and their roles, responsibilities and accountabilities, are in place in some jurisdictions and support the delivery of their commitments under the IGAB.	Whole-of-government arrangements have not been identified or implemented in any jurisdiction.	Evidence is unavailable or of insufficient quality to determine performance

	Performance standards				
	Advanced	Good	Developing	Inadequate	Insufficient evidence
Institutional arrangements under the National Biosecurity Committee	The institutional arrangements that underpin the operation of the national biosecurity system are well developed and clearly defined, including the authority and remit of the National Biosecurity Committee, a subcommittee structure that aligns well with national biosecurity system objectives and reform priorities, and very clear and transparent responsibilities for sectoral committees.	The institutional arrangements that underpin the operation of the national biosecurity system are reasonably well developed and clearly defined; the authority and remit of the National Biosecurity Committee is clear; the subcommittee structure aligns reasonably well with biosecurity system objectives and reform priorities; and the responsibilities of sectoral committees are mostly clear and transparent.	The institutional arrangements that underpin the operation of the biosecurity system are reasonably well developed and clearly defined; the authority and remit of the National Biosecurity Committee is clear; the subcommittee structure lacks clear alignment with biosecurity system objectives and reform priorities; and the responsibilities of sectoral committees are not always clear and transparent.	The institutional arrangements that underpin the operation of the national biosecurity system are not clearly defined and not well aligned with the system's objectives and reform priorities. Roles and responsibilities of sectoral committees are not clear and may involve overlap or gaps in coverage.	Evidence is unavailable or of insufficient quality to determine performance
Legislation, regulations and administrative arrangements	Contemporary legislation, regulations and administrative arrangements are in place in all jurisdictions that support the strategic direction of the biosecurity system and provide opportunities for flexible implementation of policies and programs.	Contemporary legislation, regulations and administrative arrangements are in place in most jurisdictions that support the strategic direction of the biosecurity system and provide opportunities for flexible implementation of policies and programs.	Contemporary legislation, regulations and administrative arrangements are in place in some jurisdictions that support the strategic direction of the biosecurity system and provide opportunities for flexible implementation of policies and programs.	Legislation, regulations and administrative arrangements in jurisdictions are generally not contemporary and do not necessarily support the strategic direction of the biosecurity system or provide opportunities for flexible implementation of policies and programs.	Evidence is unavailable or of insufficient quality to determine performance

*Refer to text for description of the evaluation criteria

7.10 Partnerships

Shared responsibility, or a partnerships approach, has been a key principle of the national biosecurity system for some time (Craik *et al*., 2017). A series of reviews (Nairn *et al.*, 1996; Beale *et al.*, 2008; Matthews, 2011; DAWR, 2015b; Craik *et al.*, 2017) has articulated the principle and endorsed its application to the biosecurity system. In addition, state and territory biosecurity strategies have consistently referred to partnerships as a fundamental principle (Box 3).

However, the IGAB review (Craik *et al*., 2017) noted that shared responsibility is not clearly defined and hence a common understanding of the concept is yet to be realised. This has made it difficult to implement in a practical sense, although there are successful examples of its application across the biosecurity system. These include the animal and plant emergency response deeds, as well as the establishment of AHA and PHA as government-industry partnerships.

The IGAB review observed that governments have been perceived as reluctant to provide other participants in the system with opportunities to take greater ownership of and responsibility for biosecurity activities. It suggested that providing greater opportunities for industry, local government and community members to play an increased role in biosecurity would enhance the system's overall capacity and capability. The review cites examples of successful industry-led initiatives, including surveillance programs in the grains and horticulture sectors, and the Livestock Biosecurity Network that supports on-farm biosecurity. The review also noted that for industry to realise a greater role across the national biosecurity system, it must be prepared for the additional commitments and accountability that will stem from this, including taking ownership of issues and working in a coordinated fashion for the national interest. Underpinning a partnerships approach is an awareness and acknowledgement by key participants in the system of their roles and responsibilities and those of other system participants.

The IGAB review made a number of recommendations relating to strengthening the partnerships approach in the biosecurity system, including by providing a 'greater say' for industry and other stakeholders in biosecurity policies and processes. These included, among others, the development of a National Biosecurity Statement through a collaborative process; the establishment of a formal mechanism for industry and community to provide input into the NBC; and annual meetings between the NBC and AHA and PHA to discuss national biosecurity priorities and reforms.

These recommendations were agreed or agreed in principle by ministers (DAWR, 2018b) and are being progressed. Of note is the finalisation of the National Biosecurity Statement in 2019 with an outline of biosecurity roles and responsibilities and a clear statement of the importance of partnerships between the Australian and state, territory and local governments, industry, environmental bodies, land managers and the broader public. The IGAB 2019 also emphasises that biosecurity is a shared responsibility between all system participants and commits the parties to strengthen partnerships with industry, local governments, environmental groups and the broader community.

Evaluation question

Recognising that a partnerships approach strengthens relationships between biosecurity system participants and enhances the overall performance of the system, the evaluation question should seek to determine if the issues identified by the IGAB review and the responses accepted by Ministers have delivered identifiable and measurable changes in outcomes:

Is there a genuine partnerships approach to national biosecurity in which all participants – government, industry and community – recognise and understand their roles and responsibilities, take ownership of appropriate activities in the system, and have opportunities to participate in strategy and policy design and the implementation of national biosecurity arrangements?

Evaluation criteria

- Roles, responsibilities and accountabilities of system participants, including governments, industry and community, are agreed and articulated
- Non-government participants in the system affirm their understanding of the partnerships approach to biosecurity
- Non-government participants in the system are independently responsible for and accountable for activities to manage biosecurity risk such as farm biosecurity programs and surveillance activities
- Participants in the system share the costs of emergency response activities according to pre-agreed formulae under the relevant deeds
- Governments engage non-government participants in the system through consultative fora such as Biosecurity Roundtables, AHA/PHA annual meetings
- Non-government participants in the system are included in policy design and implementation activities through forums such as the NBC and its sub committees and working groups

Table 41 provides a rubric for this evaluation question.

Table 41: Rubric for partnerships

	Performance standards				
	Advanced	Good	Developing	Inadequate	Insufficient evidence
	Performance is clearly very strong or exemplary in relation to the question. Any gaps or weaknesses are not significant and are managed effectively	Performance is generally strong in relation to the question. No significant gaps or weaknesses, and less significant gaps or weaknesses are mostly managed effectively	Performance is inconsistent in relation to the question. Some gaps and weaknesses. Does not always meet minimum expectations or requirements	Performance is unacceptably weak in relation to the question. Does not meet minimum expectations or requirements	Evidence is unavailable or of insufficient quality to determine performance

Evaluation criteria*					
Roles and responsibilities	Roles, responsibilities and accountabilities of system participants, including governments, industry and community, are clearly defined and endorsed by all participants through mutually agreed statement(s).	Roles, responsibilities and accountabilities of system participants, including governments, industry and community, are broadly agreed and understood. Explicit endorsement through agreed statements by all participants may be lacking.	Roles, responsibilities and accountabilities of system participants, including governments, industry and community, are understood to a limited extent through the day-to-day operations of the system. There is no mutually agreed statement that endorses a partnerships approach.	Roles, responsibilities and accountabilities of system participants, including governments, industry and community, are not well understood. There is no mutually agreed statement that endorses a partnerships approach.	Evidence is unavailable or of insufficient quality to determine performance
Independent responsibilities of non-government participants	Governments strongly encourage the ownership of biosecurity activities by non-government participants in the biosecurity system and provide many opportunities for industry and community groups to play a strong independent role in the system across different areas, including surveillance, monitoring, reporting and assurance. Where implemented, these activities are evaluated and feedback is used to improve future performance.	Governments encourage the ownership of biosecurity activities by non-government participants in the biosecurity system and provide some opportunities for industry and community groups to play an independent role in the system across different areas, including surveillance, monitoring, reporting and assurance. These activities may be subject to evaluation and feedback to improve future performance. There is serious consideration of how to expand the ownership of non-government participants in the system.	Governments generally maintain control of most biosecurity activities and non-government participants in the system have limited opportunities to genuinely own responsibility for activities. Little evaluation is undertaken of non-government participation in the system. There is some consideration of how to expand the ownership of non-government participants in the system.	Governments remain responsible for the key activities in the biosecurity system and there is little ownership of activities by non-government participants. Governments are reluctant to provide greater opportunities for ownership to industry and community participants.	Evidence is unavailable or of insufficient quality to determine performance

Engagement with non-government participants	Governments engage genuinely and systematically with non-government participants in the system on a comprehensive range of issues using consultative fora such as Biosecurity Roundtables and AHA/PHA annual meetings. This raises the awareness of the biosecurity system to a high level and is acknowledged by industry and community as contributing to a genuine partnerships approach.	Governments engage with non-government participants in the system through consultative fora such as Biosecurity Roundtables and AHA/PHA annual meetings. Awareness of the system is improved and the partnerships approach is strengthened.	Governments sometimes engage with non-government participants in the system on some issues through appropriate consultative fora. There is little improvement in overall awareness of the system and the partnerships approach is not genuinely advanced.	Governments provide a one-way flow of information to non-government participants in the system. This limits the general awareness of the biosecurity system and does not contribute to a genuine partnerships approach.	Evidence is unavailable or of insufficient quality to determine performance
Inclusion of non-government participants in policy design and implementation	There is a genuine culture of engagement with non-government participants in relation to biosecurity policy design and implementation through fora such as the National Biosecurity Committee and its sub-committees and working groups. This creates strong partnerships with non-government participants.	Governments consult often with non-government participants in the system on biosecurity policy design and implementation through fora such as the National Biosecurity Committee and its sub-committees and working groups. This strengthens the partnerships approach.	Non-government participants in the system are consulted on significant policy design and implementation issues. The level of consultation does not improve the partnerships approach.	Governments remain solely responsible for biosecurity policy design and implementation and provide information to non-government participants in the system.	Evidence is unavailable or of insufficient quality to determine performance

*Refer to text for description of the evaluation criteria

7.11 Engagement and communications

Engagement and communication activities underpin effective cooperation of participants in the national biosecurity system, increase stakeholder awareness of biosecurity, and enhance the effectiveness of biosecurity activities. The partnerships approach relies on effective *engagement* of all participants in the system so that they understand the objectives of the system as well as their roles and responsibilities and those of other participants. It should result in greater participation by stakeholders in biosecurity activities and, where appropriate, change the behaviour of stakeholders, including the general community. Effective *communication* with biosecurity participants should ensure that all stakeholders have access to or are provided with essential information, including in emergency responses. Communication should utilise a range of channels and tools and be targeted and timely.

The IGAB review noted that some stakeholders characterise engagement and communication activities in the biosecurity system as being a one-way flow of information from governments rather than a genuine consultation process. In contrast, some stakeholders considered that government-industry roundtables provided genuine discussion with tangible outcomes, and that communication in an emergency and in managing established pests and diseases was positive.

The IGAB review also observed that general community awareness, understanding of and participation in biosecurity is low, except for travellers and those responsible for on-farm biosecurity. It noted that a national communication framework, strategy or plan could provide a stronger biosecurity narrative for the community and lead to behaviour change. The NBC endorsed the National Biosecurity Engagement and Communication Framework in 2013 with the aim of supporting and enhancing government communications with a range of stakeholders. The IGAB review considered that, despite articulating sound policy directions and priority reforms, the framework has failed to deliver the required change, largely as a result of leadership and resourcing issues in all jurisdictions.

The IGAB review also considered that state and territory governments could build on their existing partnerships with local and regional organisations, such as NRM bodies, catchment management authorities and local governments, to build an informed and proactive biosecurity community in their jurisdictions.

The IGAB review made two recommendations that relate to engagement and communication activities. The first was that the revised IGAB should include a core commitment by jurisdictions to ongoing stakeholder engagement and communication, building on existing partnerships, and with activities scrutinised as part of jurisdictional evaluations. This was accepted by Ministers and has been included as a core commitment of the parties to IGAB 2019.

The second recommendation responds to the review's observation that additional funding is needed to improve awareness and understanding of biosecurity, shared responsibility, the national system, and roles and responsibilities of participants. It recommended that funding for the biosecurity system should be increased and allocated to the areas of the system that are most underfunded, including national communication and awareness activities. Ministers agreed in principle to this recommendation and recognised the importance of adequately resourcing the national biosecurity system.

Evaluation question

Does engagement and communication in the national biosecurity system underpin the effective cooperation of all participants; support a partnerships approach to biosecurity management; increase stakeholder, including community, awareness of biosecurity; and enhance the effectiveness of biosecurity activities? Are communication activities, in normal circumstances and in emergency responses, targeted, timely and effective?

Evaluation criteria

- Governments lead engagement with system participants through a range of strategies and forums that improve awareness of biosecurity, shared responsibility, the operations of the national system and the roles and responsibilities of participants

- System participants are involved in planning and decision making according to their roles and responsibilities
- There is greater participation in biosecurity activities by industry and the community as a result of engagement activities
- There is evidence of behaviour change in system participants and the general community as a result of engagement activities
- Governments use a range of methods and communication channels to achieve targeted and timely communication on biosecurity issues, including priority biosecurity risks, and covering prevention, reporting, preparedness and response
- Formal communication plans for emergency response actions are developed in line with best practice guidelines and are tested in a real or simulated response
- Communication during emergency responses is consistent across jurisdictions, coordinated and rapid in order to underpin successful response actions

Table 42 provides a rubric for this evaluation question.

Table 42: Rubric for engagement and communications

	Performance standards				
	Advanced	Good	Developing	Inadequate	Insufficient evidence
	Performance is clearly very strong or exemplary in relation to the question. Any gaps or weaknesses are not significant and are managed effectively	Performance is generally strong in relation to the question. No significant gaps or weaknesses, and less significant gaps or weaknesses are mostly managed effectively	Performance is inconsistent in relation to the question. Some gaps and weaknesses. Does not always meet minimum expectations or requirements	Performance is unacceptably weak in relation to the question. Does not meet minimum expectations or requirements	Evidence is unavailable or of insufficient quality to determine performance
Evaluation criteria*					

	Performance standards				
	Advanced	Good	Developing	Inadequate	Insufficient evidence
Engagement with non-government participants	Governments engage genuinely and systematically with non-government participants in the system on a comprehensive range of issues using consultative fora such as Biosecurity Roundtables and AHA/PHA annual meetings. This raises the awareness of the biosecurity system to a high level and is acknowledged by industry and community as contributing to a genuine partnerships approach.	Governments engage with non-government participants in the system through consultative fora such as Biosecurity Roundtables and AHA/PHA annual meetings. Awareness of the system is improved and the partnerships approach is strengthened.	Governments sometimes engage with non-government participants in the system on some issues through appropriate consultative fora. There is little improvement in overall awareness of the system and the partnerships approach is not genuinely advanced.	Governments provide a one-way flow of information to non-government participants in the system. This limits the general awareness of the biosecurity system and does not contribute to a genuine partnerships approach.	Evidence is unavailable or of insufficient quality to determine performance
Communi-cations approach	Governments use a wide range of communications methods and channels to achieve targeted and timely communication on all areas of biosecurity, including priority biosecurity risks, and prevention, reporting, preparedness and response activities. Formal communications plans are developed and implemented to guide the communications strategy. All stakeholders have access to or are provided with essential information.	There are comprehensive communications plans for biosecurity using a range of methods and channels applied across all priority areas. Most stakeholders have access to or are provided with essential information.	Communications plans exist and cover the key communications areas. Targeting to stakeholders is limited and there are gaps in their access to information.	Communications to support biosecurity is ad hoc and not coordinated.	Evidence is unavailable or of insufficient quality to determine performance

	Performance standards				
	Advanced	Good	Developing	Inadequate	Insufficient evidence
Communi-cations during emergency responses	Formal communication plans and systems for emergency response actions are developed in line with best practice guidelines and are tested in real or simulated responses. Communications during emergencies are consistent across jurisdictions, coordinated and rapid in order to underpin successful response actions.	There are comprehensive communications plans and systems to support emergency responses. Communications during emergencies contribute to successful operations.	Communications plans and systems cover the key areas. There are sometimes gaps or lack of coordination that can slow emergency response times and reduce the effectiveness of response actions.	Communications for the management of emergency responses is ad hoc. This can impede the rapidity and effectiveness of response activities.	Evidence is unavailable or of insufficient quality to determine performance
Participation and behaviour change	As a result of comprehensive and coordinated engagement and communications activities, there is significantly greater participation in biosecurity activities and strong evidence of positive behaviour change by participants in the system.	As a result of engagement and communications activities, there is greater participation in biosecurity activities and evidence of positive behaviour change by participants in the system.	Some engagement and communications activities improve the participation in biosecurity activities and the behaviour of targeted groups.	Engagement and communications activities cannot be linked to any greater participation in biosecurity activities or to observable behaviour change in system participants.	Evidence is unavailable or of insufficient quality to determine performance

*Refer to text for description of the evaluation criteria

7.12 Data and information management

Comprehensive and reliable data and information that are available in a timely manner to all appropriate participants is a fundamental characteristic of a well-functioning biosecurity system. Data and information support the full range of activities in the biosecurity system, including anticipating, preparing for and responding to national biosecurity risks, managing ongoing biosecurity issues, and substantiating claims about pest and disease status. Data and information also underpin sound policy development, decision making and performance reporting (Craik *et al.*, 2017).

Many participants in the biosecurity system, including jurisdictions, industries and community organisations, collect and hold a range of data and information that is relevant to the operations of the system. However, as the IGAB review observed, many of these are based on manual systems, are not integrated, are not efficient and do not support assessments of risks or changes to pest and disease status (Craik *et al.*, 2017).

The IGAB review noted that all jurisdictions need to contribute to national data efforts. To support this, datasets and their requirements need to be agreed in advance to enable consistent and comparable data reporting. While there is no need for a single data holder, agreed sources and common formats and standards will enable data comparability and analysis.

Improving cooperation between jurisdictions on data and information is supported by the National Biosecurity Information Governance Expert Group, established under the NBC. It has been successful in developing nationally consistent minimum dataset specifications and standards, with a focus on emergency responses.

There has also been progress within and across jurisdictions on the development of software and technology platforms to manage the collection, collation and analysis of biosecurity data. These include the software platform MAX, developed by the Victorian government to collect, manage and report textual and spatial data. MAX is used by a further five jurisdictions for a range of purposes, including both routine and emergency biosecurity activities. AusPestCheck was developed by PHA to integrate and map plant surveillance data from multiple sources at minimal cost. DAWE is developing a Biosecurity Integrated Information System (BIIS) to provide modern technical architecture to enhance data capture, storage, access, sharing and analysis to support better and more timely decision making (Craik *et al*., 2017).

The application of advanced data analytics to biosecurity data and information is necessary to harness the full value of the data and information generated by the biosecurity system and to better contribute to risk management. Data analytics is the process of examining data from multiple sources in order to draw conclusions about the information they contain. It provides a capacity to understand the issues from perspectives that may not have been contemplated or are not yet apparent (Craik *et al*., 2017). DAWE is investing $16 million to develop an advanced analytics capability for biosecurity, utilising information captured by the BIIS. The Department also utilises the advanced analytics capability of ABARES and CEBRA to inform its risk management.

There is strong consensus among jurisdictions around the need for better and standardised biosecurity data sets and interoperable data management platforms that will allow seamless data sharing and the application of advanced analytics capacities. The IGAB review made a number of recommendations in response to these issues. In particular, it recommended that data and knowledge sharing should be a core commitment of jurisdictions in a revised IGAB and that minimum standards and specifications should be agreed for data sets. It also recommended that DAWE should lead the development of a common information architecture for the national biosecurity system, including data-sharing protocols and standards, for all jurisdictions to share and access biosecurity data and information in the national interest.

In responding, Ministers agreed that easily accessible, comprehensive and reliable data is essential for anticipating, responding to and managing national biosecurity risks and for decision making. A strong commitment to data and knowledge sharing has been included in IGAB 2019. All jurisdictions, through the NBC, have endorsed the National Minimum Dataset Specifications for surveillance and emergency activities. DAWE is developing a metadata registry that will support access and review of these specifications.

The IGAB review also recommended that a dedicated biosecurity analytics and intelligence centre should be established within DAWE to provide advice to Ministers and senior officials on emerging biosecurity risks. The Australian Government has announced funding of $36.5million over five years to support this initiative.

Evaluation question

Is biosecurity data and information managed, that is, collected, collated, analysed, stored and shared, optimally to support risk management and the effectiveness of biosecurity operations?
Are advanced data analytics used effectively to understand emerging biosecurity risks and to guide risk-related policy development and decision making?

Evaluation criteria

- All jurisdictions contribute to national biosecurity data and information efforts
- Nationally agreed datasets and standards have been specified across key biosecurity activities – surveillance, interceptions, emergency response and on-going management – to support consistent and comparable reporting
- All jurisdictions have access to and use contemporary software and technology platforms to collect, store and access data and information
- Interoperable data platforms have been developed and are used by all jurisdictions to share biosecurity data in a timely manner
- Data analytics capability is well developed in all jurisdictions and is used effectively to manage biosecurity risk

Table 43 provides a rubric for this evaluation question.

Table 43: Rubric for data and information management

	Performance standards				
	Advanced	Good	Developing	Inadequate	Insufficient evidence
	Performance is clearly very strong or exemplary in relation to the question. Any gaps or weaknesses are not significant and are managed effectively	Performance is generally strong in relation to the question. No significant gaps or weaknesses, and less significant gaps or weaknesses are mostly managed effectively	Performance is inconsistent in relation to the question. Some gaps and weaknesses. Does not always meet minimum expectations or requirements	Performance is unacceptably weak in relation to the question. Does not meet minimum expectations or requirements	Evidence is unavailable or of insufficient quality to determine performance
Evaluation criteria*					

	Performance standards				
	Advanced	Good	Developing	Inadequate	Insufficient evidence
National data sets and standards	Nationally agreed datasets and minimum standards have been agreed across key biosecurity activities – surveillance, interceptions, emergency response and on-going management – and sectors to support consistent and comparable reporting. All jurisdictions meet the standards and data can be aggregated nationally for all sectors.	Nationally agreed datasets and minimum standards have been agreed across key biosecurity activities and sectors to support consistent and comparable reporting. All or most jurisdictions meet the standards and data can be aggregated nationally for some sectors.	Nationally agreed datasets and minimum standards have been agreed across key biosecurity activities and sectors to support consistent and comparable reporting. Some jurisdictions meet the standards but there are compatibility gaps between jurisdictions and it is difficult to aggregate data nationally for most sectors.	Nationally agreed datasets and minimum standards have been agreed across key biosecurity activities and sectors to support consistent and comparable reporting. Data collection in some jurisdictions or some sectors does not meet the national standards; data collection is ad hoc and not undertaken in a systematic manner, if at all.	Evidence is unavailable or of insufficient quality to determine performance
Access to software and technology	All jurisdictions have invested in and use contemporary software and technology platforms to collect, store, access and share data and information, which contributes significantly to the efficiency and effectiveness of biosecurity risk management.	Most jurisdictions have invested in and use contemporary software and technology platforms to collect, store, access and share data and information. This contributes to efficient and effective biosecurity risk management.	Only some jurisdictions have invested in contemporary software and technology platforms for the collection, storage, access and sharing of data and information. This limits the efficiency and effectiveness of biosecurity risk management at the jurisdictional and national levels.	Software and technology platforms in jurisdictions are generally out of date and do not support the advanced collection, storage, access and sharing of data and information.	Evidence is unavailable or of insufficient quality to determine performance
Interoperable data platforms	Interoperable data platforms have been developed in all key sectors and are used by all jurisdictions and industry groups to share biosecurity data in a seamless and timely manner, in routine and emergency activities, and to support advanced analytics capabilities.	Interoperable data platforms have been developed in some sectors and are used by most jurisdictions and industry groups to share biosecurity data and to support analytics capabilities.	Interoperable data platforms have been developed in some sectors. They are used inconsistently to share biosecurity data.	Interoperable data platforms are limited in their scope across jurisdictions and sectors.	Evidence is unavailable or of insufficient quality to determine performance

	Performance standards				
	Advanced	Good	Developing	Inadequate	Insufficient evidence
Data analytics	Data analytics capability is highly developed in all jurisdictions and is used effectively to support biosecurity risk management within jurisdictions; results and insights can be shared nationally.	Data analytics capability is well developed in most jurisdictions and is used effectively to support biosecurity risk management. There is capacity to share results and insights with other jurisdictions.	Data analytics capability is not evenly developed in all jurisdictions – there are some significant gaps in capability that limit the capacity to share results and insights.	Data analytics capability is generally not well developed and not used effectively as a tool to manage biosecurity risk either at the jurisdictional level or nationally.	Evidence is unavailable or of insufficient quality to determine performance

*Refer to text for description of the evaluation criteria

7.13 Research and innovation

Innovation driven by research, development and extension underpins Australia's agriculture sector and the science- and risked-based approach to biosecurity. Research and innovation (R&I) are important drivers of change in biosecurity. As the IGAB review notes, R&I can inform decisions made by governments and industry; help to improve the efficiency of biosecurity operations; maintain Australia's favourable pest and disease status through the development and application of new risk management measures; and ensure adequate scientific and technical capacity is maintained (Craik *et al*., 2017).

R&I supports the science disciplines that underpin biosecurity, including animal and plant pathology, taxonomy, veterinary science, epidemiology and entomology. It also supports technological innovation that can contribute to improving the efficiency and effectiveness of biosecurity operations. New technologies can, for example, reduce the costs of typically high-cost activities such as surveillance and laboratory diagnostics; and improve early detection of exotic pests and diseases, leading to an increased likelihood of eradication and lower costs associated with containment and management measures (Craik *et al*., 2017). There is a range of emerging technologies and approaches with the potential to improve the efficiency of biosecurity activities, including autonomous and drone surveillance, robotics and artificial intelligence, next-generation sequencing, bionics technologies and sensors, biological controls and alternative border intervention management strategies.

As well as contributing to the financial sustainability of the biosecurity system, biosecurity-related R&I can be a pathway to other benefits, including improved agricultural productivity, enhanced market access and a range of environmental outcomes (Craik *et al*., 2017).

R&I is also important because it accounts for significant expenditure in the biosecurity system. The IGAB review estimates that average expenditure by the Rural Research and Development Corporations on biosecurity-related R&I in the three years from 2013-14 to 2015-16 was $62million (Craik *et al.,* 2017). In addition to this is significant expenditure by government funded organisations, including CSIRO and CEBRA, state and territory research facilities, universities and private companies. Given that biosecurity-related R&I competes for funding with other research priorities such as agricultural productivity, it is important to understand the benefits it delivers to the biosecurity system and the rates of return it generates relative to other research priorities and other biosecurity-related activities.

The IGAB review raised a number of issues with the current biosecurity R&I system that limit its capacity to address existing and emerging national biosecurity challenges. These include the fact that there are multiple funders and providers of research but a lack of national prioritisation, coordination and leadership. Funding is provided largely through the Australian and state and territory governments and the Rural Research and Development Corporations, which in turn receive funding from industry and government sources. Other research centres such as the Centre for Invasive Species Solutions contribute to the research funding effort. Providers are principally the CSIRO, state and territory research facilities and universities.

Priorities for biosecurity research are established as part of a hierarchy of national research priorities. The Australian Government's National Science and Research Priorities announced in 2015 include the 'protection of food sources through enhanced biosecurity' as one of its priority areas. The Rural Research, Development and Extension Priorities were agreed between Australian and state and territory ministers in 2016 and include biosecurity as one of four overarching priorities. The National Biosecurity Research, Development and Extension Priorities were endorsed by the NBC in 2017 and are designed to provide a unified, strategic and nationally consistent focus to biosecurity research and to improve national biosecurity outcomes (DA, 2019a). They align with existing jurisdictional strategies. These priorities are outlined in Box 11.

Sitting beneath these national level priorities are a number of strategies and frameworks relevant to biosecurity research, including the Animal Biosecurity RDE&E Strategy and the Plant Biosecurity RD&E Strategy, developed under the National Primary Industries Research, Development and Extension Framework, as well as general strategies with research components, including the Australian Pest Animal Strategy, the Australian Weeds Strategy and the National Fruit Fly Strategy. The IGAB review notes that the range of strategies at this level has resulted in the lack of a unified, national approach to coordination and delivery of biosecurity research and has limited their overall impact and effectiveness (Craik *et al*., 2017).

Box 11: National Biosecurity RD&E priorities

Prevention	Data and intelligence: prevent exotic pests and diseases from entering and establishing in Australia
Preparedness	Surveillance and diagnostics: understand and quantify the impact of pests and diseases
Eradication	Treatment and recovery: demonstrate the absence of pests and diseases
Containment	Risk and decision tools: improved decision-making tools and risk analysis
Management	General surveillance: manage the pests and diseases that are already in Australia
Engagement	Communication, community attitudes and awareness: socioeconomic drivers of adopting best practice

A further issue raised by the IGAB review is the inadequacy of cross-sectoral research, defined as research that generates outcomes that are applicable to, and benefit, more than one industry in a sector (for example, multiple horticulture industries) or more than one sector (for example, multiple plant industries or plant and animal industries) or the community overall. Examples of cross-sectoral research gaps include technological solutions for sampling of commodities such as contaminants in grain, and techniques to improve pest and disease surveillance and monitoring (Craik *et al*., 2017). Without a cross-cutting prioritisation and coordination process opportunities for such research can be missed. A recent development that aims to overcome these limitations is the formation of the Plant Research Biosecurity Initiative that brings together the seven plant-based RDCs and PHA to improve coordination and co-investment for plant biosecurity RD&E.

The IGAB review made two key recommendations relating to biosecurity R&I. The first was that the NBC should authorise and drive development of an agreed set of National Biosecurity R&I Priorities to guide national R&I investment. Ministers agreed the need for this set of priorities and noted that NBC had endorsed the national biosecurity research, development and extension priorities in 2017 (Box 11). Each government is currently progressing the implementation of these priorities, including through a national level working group under the NBC. Over time, existing sectoral and industry strategies and frameworks relevant to biosecurity research should be aligned to the new priorities.

The review also recommended that the Australian Government should establish a $25m national biosecurity innovation program to enable strategic co-investment in the system-level and environmental priorities developed under the above recommendation; that the Rural Industries RDC (now AgriFutures) should receive additional funding for a new cross-sectoral biosecurity R&I coordination and investment function for the RDCs; and that RDCS should be required to invest in and report against the new biosecurity R&I priorities. In response, the Australian government established in 2018 the Biosecurity Innovation Program with $25.2m allocated over its first five years. Investment under the program is designed to accelerate the identification, development and implementation of innovative technologies and approaches that can enhance the capacity of the national biosecurity system to manage changing and increasing biosecurity risks. Ministers noted that RDC investment is guided by and reported against the 2016 Rural Research, Development and Extension Priorities, of which biosecurity is an important part. Ministers delayed consideration of additional funding for AgriFutures until further work is completed on how best to progress national cross-sectoral priorities.

Evaluation question

Is the national biosecurity research and innovation (R&I) system sustainably funded and based on clearly articulated national priorities, including cross-sectoral priorities? Does national coordination of R&I allocate investment funds according to priorities, contribute to current and emerging challenges in biosecurity and deliver positive rates of return?

Evaluation criteria

- Priorities for national biosecurity R&I are clearly articulated and endorsed by NBC
- Funding for national biosecurity R&I is maintained or increased over time
- There is strong alignment between the national biosecurity R&I priorities and other biosecurity research strategies and frameworks, for example those developed by states and territory jurisdictions and industry or sectoral groups
- There is a national coordination mechanism to guide investment in national biosecurity R&I
- The national biosecurity R&I system contributes to meeting current and emerging challenges in biosecurity, including the sustainability of the biosecurity system
- Rates of return on investment in biosecurity R&I are measured and are positive

Table 44 provides a rubric for this evaluation question.

Table 44: Rubric for research and innovation

	Performance standards				
	Advanced	Good	Developing	Inadequate	Insufficient evidence
	Performance is clearly very strong or exemplary in relation to the question. Any gaps or weaknesses are not significant and are managed effectively	Performance is generally strong in relation to the question. No significant gaps or weaknesses, and less significant gaps or weaknesses are mostly managed effectively	Performance is inconsistent in relation to the question. Some gaps and weaknesses. Does not always meet minimum expectations or requirements	Performance is unacceptably weak in relation to the question. Does not meet minimum expectations or requirements	Evidence is unavailable or of insufficient quality to determine performance
Evaluation criteria*					
Priorities	Detailed priorities for national biosecurity R&I are clearly articulated and endorsed by the National Biosecurity Committee, with weightings or rankings attached to priority areas. These provide clear guidance for, and are strongly aligned with, priorities in other biosecurity research strategies and frameworks, including those developed by states and territories, industries and sectoral groups.	High level priorities for national biosecurity R&I are clearly articulated and endorsed by NBC. No specific weightings or rankings are attached to priorities. They provide general guidance for other biosecurity strategies, most of which are aligned with the national priorities.	Broad priority areas for national biosecurity R&I have been articulated and endorsed by NBC. They provide some general guidance for other strategies but are not sufficiently detailed to ensure alignment with the national priorities.	Nationally coordinated priorities for biosecurity R&I have not been developed.	Evidence is unavailable or of insufficient quality to determine performance

	Performance standards				
	Advanced	Good	Developing	Inadequate	Insufficient evidence
Funding	Funding for national biosecurity research and innovation (R&I) is directed to highest priorities, is sufficient to address all identified priorities and is maintained or increased in real terms over time.	Funding for national biosecurity research and innovation (R&I) is sufficient to address key identified priorities and is maintained in real terms over time.	Funding for national biosecurity research and innovation (R&I) is not sufficient to address identified priorities but may be maintained in real terms over time.	Funding for national biosecurity research and innovation (R&I) is not sufficient to meet identified priorities and declines in real terms over time.	Evidence is unavailable or of insufficient quality to determine performance
National coordination	There is a highly effective coordination mechanism at the national level between funders and providers of R&I that guides investment in national biosecurity priorities, ensures that activities are funded according to priority and seeks to maximise the returns on investment.	There is a national coordination mechanism that provides some guidance on investment in national biosecurity R&I against priorities.	There is some informal coordination at the national level between funders and providers that seeks to minimise gaps and overlaps in biosecurity R&I investment.	There is no coordination of biosecurity R&I investment at the national level. Funders and providers operate independently.	Evidence is unavailable or of insufficient quality to determine performance
R&I impacts and returns	The national biosecurity R&I system contributes strongly to meeting current and emerging challenges in biosecurity. Impacts, including rates of return on investment, are routinely tracked and measured over time and are strongly positive.	The national biosecurity R&I system contributes to meeting some of the current and emerging challenges in biosecurity. Impacts, including rates of return on investment, are measured for high priority projects/issues and are mostly positive.	The national biosecurity R&I system contributes to meeting some of the current and emerging challenges in biosecurity. Impacts, including rates of return on investment, are measured on an ad hoc basis and are variable.	There is no systematic tracking of impacts and rates of return of biosecurity R&I. It is not possible to determine with confidence if R&I delivers positive rates of return or how well R&I investment contributes to meeting current and emerging challenges.	Evidence is unavailable or of insufficient quality to determine performance

*Refer to text for description of the evaluation criteria

7.14 Monitoring and evaluation

An important element of the biosecurity system is the capacity to undertake monitoring and evaluation of its performance. When implemented effectively, an evaluation of the performance of the national biosecurity system can help identify, among the many components of the system, areas of strong performance relative to agreed attributes of performance, as well as areas of relative weakness. This can help support decisions about where to invest resources in the system in order to achieve its multi-layered objectives. The lessons derived from performance evaluation can also support consideration of the strategic direction of the biosecurity system and inform future system design. Good performance information is also critical to being able to tell a cohesive biosecurity performance story – public reporting of that performance information can help maintain the support of the community (Craik *et al.*, 2017).

There is no current framework for monitoring or evaluating the performance of the biosecurity system at the national level. The IGAB review made a number of observations and recommendations that pertain to performance evaluation (Craik *et al*., 2017). Specifically, it recommended that the Productivity Commission should undertake a report on government biosecurity services on a five-yearly basis. In their response to the review, Ministers agreed that the NBC would work with the Productivity Commission to determine the most feasible approach to achieve this outcome. The review also recommended that AGSOC establish an independent IGAB Evaluation Program to assess and report on each jurisdiction's core commitments under IGAB 2019, and that NBC report annually to AGMIN on its progress against priority reform areas. Ministers agreed to these recommendations and they are included in IGAB 2019.

IGAB 2019 includes additional references to performance evaluation, including a principle that 'the Australian community and our trading partners should be informed about the status, quality and performance of our national biosecurity system', and identifying national performance standards as a component of the system.

It is unrealistic to expect that an ideal performance monitoring and evaluation framework will be identified at the first attempt and that a performance measurement system will be implemented in one step that endures unchanged over time. As discussed in chapter 4 of this report, the process is often evolutionary and advances through trial and error (Mayne, 2004). The environment within which the biosecurity system operates is constantly changing, and hence ongoing planning and consequent revisions to performance indicators and expectations will be needed. A foundational step is that all jurisdictions recognise the importance of a national level performance evaluation system, including the participation of non-government partners, and commit appropriate resources to support its implementation.

Evaluation question

Given the starting point for this component of the biosecurity system, the following KEQ is posed:

Is there a commitment by all jurisdictions to develop and implement a performance monitoring and evaluation framework for the national biosecurity system?

Evaluation criteria

- Jurisdictions have made an in-principle commitment to develop and implement a performance monitoring and evaluation framework for the national biosecurity system
- A pathway and planning, including a timeline, to achieve this has been identified and agreed by all jurisdictions
- Participation of representative non-government partners in the system has been identified and agreed
- Resourcing, including financial, human and other resources, has been identified and allocated by jurisdictions

- Performance reporting commitments under IGAB 2019 are met

A comprehensive national level performance evaluation system will be an evolving construct, reflecting the changing environment in which the biosecurity system operates. As a result, the appropriate evaluation question and evaluation criteria will change over time.

Table 45 provides a rubric for this evaluation question.

Table 45: Rubric for monitoring and evaluation

	Performance standards				
	Advanced	Good	Developing	Inadequate	Insufficient evidence
	Performance is clearly very strong or exemplary in relation to the question. Any gaps or weaknesses are not significant and are managed effectively	Performance is generally strong in relation to the question. No significant gaps or weaknesses, and less significant gaps or weaknesses are mostly managed effectively	Performance is inconsistent in relation to the question. Some gaps and weaknesses. Does not always meet minimum expectations or requirements	Performance is unacceptably weak in relation to the question. Does not meet minimum expectations or requirements	Evidence is unavailable or of insufficient quality to determine performance
Evaluation criteria*					
Commitment	All jurisdictions have made an in-principle commitment to develop and implement a performance monitoring and evaluation framework for the national biosecurity system.	Most jurisdictions have made an in-principle commitment to develop and implement a performance monitoring and evaluation framework for the national biosecurity system.	Some jurisdictions have made an in-principle commitment to develop and implement a performance monitoring and evaluation framework for the national biosecurity system.	No jurisdictions have made an in-principle commitment to develop and implement a performance monitoring and evaluation framework for the national biosecurity system.	Evidence is unavailable or of insufficient quality to determine performance
Planning	All jurisdictions have identified and agreed a pathway and planning, including a timeline, to achieve this.	Most jurisdictions have identified and agreed a pathway and planning, including a timeline, to achieve this.	Some jurisdictions have identified and agreed a pathway and planning, including a timeline, to achieve this.	No jurisdictions have identified and agreed a pathway and planning, including a timeline, to achieve this.	Evidence is unavailable or of insufficient quality to determine performance
Participation	All jurisdictions have identified and agreed the participation of representative non-government partners in the system.	Most jurisdictions have identified and agreed the participation of representative non-government partners in the system.	Some jurisdictions have identified and agreed the participation of representative non-government partners in the system.	No jurisdictions have identified and agreed the participation of representative non-government partners in the system.	Evidence is unavailable or of insufficient quality to determine performance
Resourcing	All jurisdictions have identified and allocated resourcing, including financial, human and other resources, to achieve a national performance evaluation system.	Most jurisdictions have identified and allocated resourcing, including financial, human and other resources, to achieve a national performance evaluation system.	Some jurisdictions have identified and allocated resourcing, including financial, human and other resources, to achieve a national performance evaluation system.	No jurisdictions have identified and allocated resourcing, including financial, human and other resources, to achieve a national performance evaluation system.	Evidence is unavailable or of insufficient quality to determine performance

	Performance standards				
	Advanced	Good	Developing	Inadequate	Insufficient evidence
Reporting commitments	All jurisdictions meet the performance reporting commitments under IGAB 2019.	Most jurisdictions meet the performance reporting commitments under IGAB 2019.	Some jurisdictions meet the performance reporting commitments under IGAB 2019.	No jurisdictions meet the performance reporting commitments under IGAB 2019.	Evidence is unavailable or of insufficient quality to determine performance

*Refer to text for description of the evaluation criteria

8 Evaluating the robustness and resilience of the biosecurity system

8.1 Introduction

The analytical framework of this project has defined one of the key attributes of a healthy biosecurity system as its *robustness and resilience*. This is defined as the ability of the biosecurity system to withstand the impacts of an external shock or disturbance, to respond effectively to the impacts of such a shock, and to recover from and adapt to changed circumstances.

The objective in this chapter is to consider how the robustness and resilience of the biosecurity system can be assessed, and to develop measures of robustness and resilience that can be used to support an evaluation of system performance. These measures should be rigorous and able to be calculated at regular intervals in order to form the basis for assessing trends in robustness and resilience over time.

The chapter:

- defines the concepts of robustness and resilience and their application in various complex systems facing external shocks or perturbations. This is based on a review of the literature on the concepts of robustness and resilience in complex systems;
- considers the characteristics or attributes of robustness and resilience that are desirable in a complex system, including the biosecurity system;
- develops a framework for evaluating the robustness and resilience of the national biosecurity system, taking guidance from those developed in other domains;
- proposes a two-part process to capture qualitative and quantitative measures of robustness and resilience.

8.2 Defining robustness and resilience

The concepts of robustness and resilience have long been used in a range of disciplines. Derived from the Latin *robustus*, meaning strong, the concept of robustness emerged in statistics to refer to methods that are not affected by small deviations from assumptions (Bertolaso *et al.*, 2018). It has subsequently been used in engineering, ecology and psychology, among other domains. Definitions of robustness are broadly consistent, referring in general to the maintenance of some desired system characteristics despite fluctuations in the behaviour of its component parts or its environment (Carlson & Doyle, 2002). In ecology, for example, robustness has been defined as the ability of a system to withstand perturbations in structure without change in function (Jen, 2003). The robustness of engineering systems has been thought of as functional reliability in the presence of eventual failure. This can be achieved, for example, by inbuilding redundancy, where multiple components with equivalent functions backup the system; and by modularity, where subsystems are functionally insulated to prevent the spread of failure (Kitano, 2002). And organisational robustness has been defined as the capacity of an organisation to retain its fundamental characteristics under changing conditions (van Oss, 2012). The focus on withstanding shocks and maintaining system functions is common to most definitions of robustness.

Resilience, from the Latin *resilio* – to rebound – has a broader range of definitions across disciplines. The concept has been used to describe and analyse the responses of diverse and complex systems to a range of perturbations. Resilience was originally used in materials science to describe the resistance of materials to physical shocks (Winston, 1932). In ecology the term has been used to describe the ability of a system to absorb changes of state variables, driving variables and parameters and still persist (Holling, 1973). More recently, resilience terminology has been used widely in environmental science, engineering, operations research, management, business, economics and psychology (see reviews in Bhamra *et al.*, 2011; Martin-Breen & Anderies, 2011; Meerow & Newell, 2015; Annarelli & Nonino, 2016; Hosseini *et al.*, 2016; Cere *et al.*, 2017; Keating *et al.*, 2017; Fraccascia *et al.*, 2018). The concept has been applied widely in the emergency or disaster management context, including by multilateral organisations, development agencies and NGOs (Keating *et al*., 2017; Table 46). A general definition of resilience that can be applied across domains has been proposed by Rodin (2014) as the capacity of any entity – an individual, a community, an organisation or a natural system – to prepare for disruptions, to recover from shocks and stresses, and to adapt and grow from a disruptive experience.

Table 46: Some definitions of resilience from emergency and disaster management

Domain	Definition	Reference
Multilateral	The ability of a system, community or society to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner	UNISDR, 2011
Multilateral	The capacity of countries to withstand, adapt to and recover from national disaster and major economic crises	ESCAP, 2013
Multilateral	The ability of a system and its component parts to anticipate, absorb, accommodate or recover from the effects of a hazardous event in a timely and efficient manner, including through ensuring the preservation, restoration or improvement of its essential basic structures and functions	IPCC, 2012
Government	The ability to prepare and plan for, absorb, recover from and more successfully adapt to adverse events	NRC, 2012
NGO	The ability of individuals, communities, organisations or countries exposed to disasters and crises and underlying vulnerabilities to: anticipate, reduce the impact of, cope with and recover from the effects of adversity	IFRC, 2012
NGO	The ability of a system, community or society to resist, absorb, cope with and recover from the effects of hazards and to adapt to longer term changes in a timely and efficient manner	Pasteur, 2011

Source: Keating *et al*., 2017

In the public sector, contemporary applications of the concept are found in diverse policy contexts. For example resilience has been a key focus of the Organisation for Economic Co-operation and Development since the global financial crisis of 2008 (OECD, 2014); the World Health Organisation since the Ebola disease outbreak in 2013 (WHO, 2017); the US Homeland Security vision against terrorism and other hazards (DHS, 2014); and the Australian Government's approach to critical infrastructure (AG, 2010).

The review of literature highlights some of the key issues raised in the practical application of the resilience concept. Resilience is frequently seen as a property of complex systems, although it can be applied at lower levels such as the individual or the community or to any dimension of a system. Bruneau *et al.* (2003) for example conceptualise resilience as encompassing four dimensions – technical, organisational, social and economic. *Technical* resilience refers to the ability of physical systems, including components, their interconnections and interactions, and entire systems, to perform to accepted or desired levels when subject to stress, in this case an earthquake. The *organisational* dimension refers to the capacity of organisations to make decisions and take actions that contribute to achieving resilience. *Social* resilience consists of measures specifically designed to lessen the extent to which communities and government jurisdictions suffer negative consequences of a stress or shock through the loss of critical services. And *economic* resilience refers to the capacity to reduce both the direct and indirect economic losses resulting from a stress or shock.

There are evident intersections or overlaps in the definitions of robustness and resilience identified in the literature. Together they encompass the capacity to withstand stress, shock or disturbance and the capacity to respond to these external factors. Given the interrelated nature of the two concepts, this project has adopted the single term resilience to refer to the ability of the biosecurity system to withstand the impacts of an external shock or disturbance, to respond effectively to the impacts of such a shock, and to recover from and adapt to changed circumstances.

In the biosecurity context, the principal shock or disturbance to the system is a pest or disease incursion or outbreak. Such an incursion or outbreak can have significant impacts across the four dimensions outlined by Bruneau *et al.* (2003). For example, incursions of unwanted pests or diseases can affect the technical dimension, in this case interpreted as the ecosystem, by introducing new organisms into the existing environment. Social systems can be affected as communities respond to disruption and adapt over the longer term to changed circumstances. The economic dimension can be affected if a pest or disease incursion or outbreak leads to a loss or reduction in market access and to indirect losses to producers and others in the supply chain. And the organisational dimension, or the capacity of the biosecurity system to deliver its objectives, can be compromised if the response to a pest or disease incursion or outbreak requires resources to be diverted from their usual activities or requires additional resources to be made available to cope with the circumstances.

Organisational resilience can also be tested by disturbances that do not involve a pest or disease incursion but where changed circumstances in the external environment require adaptations in risk management that can stress the system. Australia's recent experience with brown marmorated stink bugs (BMSB) is one such example. The increased risk of an incursion of BMSB required the diversion of resources in 2018-9, which, according to the Inspector-General of Biosecurity, stretched Australia's border biosecurity system close to breaking point and imposed significant costs on sections of the shipping and importing industries (IGB, 2019).

The focus of the evaluation framework in this report is on organisational resilience, or how well equipped the biosecurity system is able to withstand shocks, that is, to reduce the likelihood of an incursion or other disturbance, as well as how prepared it is to respond to an external perturbation when such an event occurs. The capacity of the system to learn and adapt to changed circumstances is also important, not just after a shock but in normal times as well, such as adapting to changes in the risk status of trading partners.

8.3 Characteristics of resilience

In developing a framework to evaluate the resilience of the biosecurity system it is necessary to articulate the resilience characteristics, or attributes, that are considered desirable in a well-functioning system. The literature review undertaken for this section of the project reports on the characteristics of resilience that have been identified across a range of domains, including those developed from experience following an external shock. Examples of these include frameworks developed by intergovernmental organisations, including the OECD, WHO and the EU, as well as the Australian Government.

Rodin has proposed a general approach to resilience that identifies five main characteristics of resilience that are present, to different degrees and in different manifestations, in all resilient entities (Rodin, 2014):

Aware	The entity has knowledge of its strengths and assets, liabilities and vulnerabilities, and the threats and risks it faces. Being aware includes situational awareness: the ability and willingness to constantly assess, take in new information, and adjust understanding in real time.
Diverse	The entity has different sources of capacity so it can successfully operate even when elements of that capacity are challenged: there are redundant elements or assets. The entity possesses or can draw upon a range of capabilities, ideas, information sources, technical elements, people or groups.
Integrated	The entity has coordination of functions and actions across systems, including the ability to bring together disparate ideas and elements, work collaboratively across elements, develop cohesive solutions, and coordinate actions. Information is shared and communication is transparent.
Self-regulating	The entity can regulate itself in ways that enable it to deal with anomalous situations and disruptions without extreme malfunction or catastrophic collapse. Cascading disruptions do not result when the entity suffers a severe disfunction; it can fail safely.

Adaptive	The entity has the capacity to adjust to changing circumstances by developing new plans, taking new actions or modifying behaviours. The entity is flexible: it has the ability to apply existing resources to new purposes or for one element to take on multiple roles.

This framework has been applied by Kruk *et al.* (2015) to the health system, drawing on the experience of responding to the Ebola crisis in Africa. The health system shares a number of characteristics with the biosecurity system, including that many of the risks they face are unknown or emerging and require actions on multiple fronts to be prepared, and that there are significant public good aspects to mitigating these risks. These similarities increase the relevance of comparisons between the two systems.

8.4 Evaluating resilience

The characteristics of resilient systems provide guidance on how to evaluate whether the system meets the appropriate or desired level of resilience. Evaluation of resilience can be undertaken in many ways. Two generic approaches outlined by Hosseini *et al.* (2016) are semi-qualitative evaluation, where indicators assumed to be correlated with resilience are measured and possibly aggregated; and quantitative evaluation, based on a comparison of system performance before and after a shock. These approaches are complementary – one is about the innate characteristics of a system and preparedness; the other about post-disruption evaluation of performance. They can both be applied in a resilience evaluation framework and add depth to the performance narrative.

Semi-qualitative evaluations of resilience are usually constructed with a set of questions designed to assess different resilience-based characteristics of the system on some scale (Hosseini *et al.*, 2016). Assessments of the relevant characteristics from expert opinion can be aggregated in some way to form a measure of resilience. In general, indicators are attached to each characteristic of a resilient system. For example, Kruk *et al.* (2017) outline 25 indicators against five resilience characteristics (Table 47). Assessments of this nature can be used to establish a baseline measure of resilience when conditions are normal. This can be used to demonstrate how baseline resilience changes over time, for example in response to changes in policies, programs and other interventions designed to improve resilience (Cutter *et al.*, 2008). Semi-qualitative evaluations capture the innate or underlying characteristics of the system that have an impact on resilience.

Quantitative evaluations of resilience are used to measure the observed resilience of a system by comparing indicators before and after a shock and measuring the time taken for a system to revert to normal operations after a shock. Hosseini *et al.* (2016) classify quantitative measures into two types:

- *general measures* are those that assess the resilience of a system, regardless of its structure. These measures are comparable across different system contexts with
- similar underlying logic. These can be further classified as deterministic, which do not include the impacts of uncertainty such as the probability of a disruption, and probabilistic, which capture the stochasticity of system behaviour. These measures can further be classified as static in nature, or dynamic – accounting for time-dependent behaviour of the system

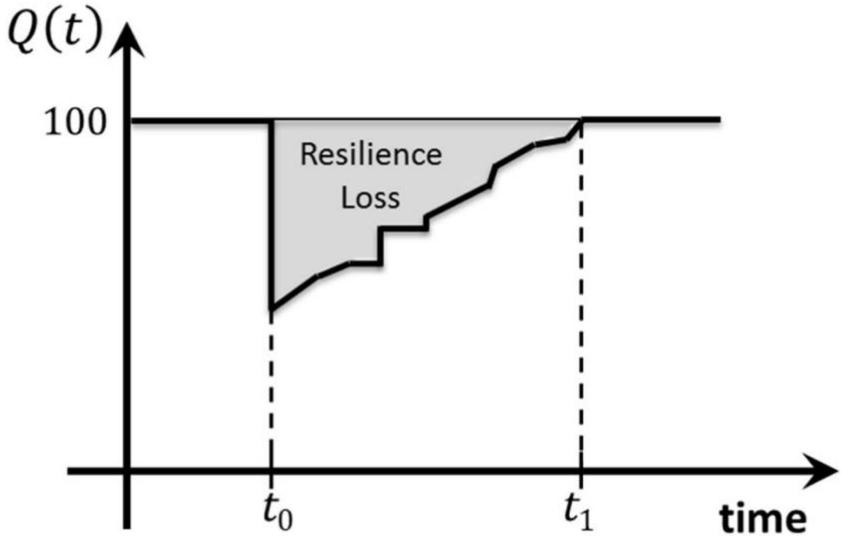
- *structural measures* examine how the structure of a system affects its resilience. In this approach system behaviour is observed and the characteristics of the system are modelled or simulated. Common approaches in the literature employ optimisation models, simulation models and fuzzy logic models

Table 47: Indicators of health system resilience

Resilience characteristics	Indicators
Aware	Distribution of health system assets and weaknesses Health service utilisation trends Presence of active epidemiologic surveillance system Functioning civil registration and vital statistics system List of decision makers in key sectors Breadth of functioning communication channels
Diverse	Scope of health services available in primary care Quality of care for sentinel conditions in basic package Financing of healthcare: adequacy of government health expenditure and financial protection
Self-regulating	Memorandums of understanding with non-state providers Database of service delivery alternatives for affected and unaffected populations Collaboration agreements with regional and global actors
Integrated	Existence of a national emergency coordination system and leaders Frequency of joint planning sessions and drills Process for development of a One Health strategy Index of Ministry of Health and government responsiveness to community need Population trust in health system Platforms for dialogue with community leaders In-country social scientists with experience working with health departments Availability of district health staff with public health training Agreement on roles and referral protocols for facilities
Adaptive	Formal provisions to reallocate funds in emergency Management capacity of district or local health teams Agreements on delegation of authority and funding in crises Mechanisms for, and capacity to, track progress and evaluate health system performance in crisis and in times of calm

Source: Kruk *et al*., 2017

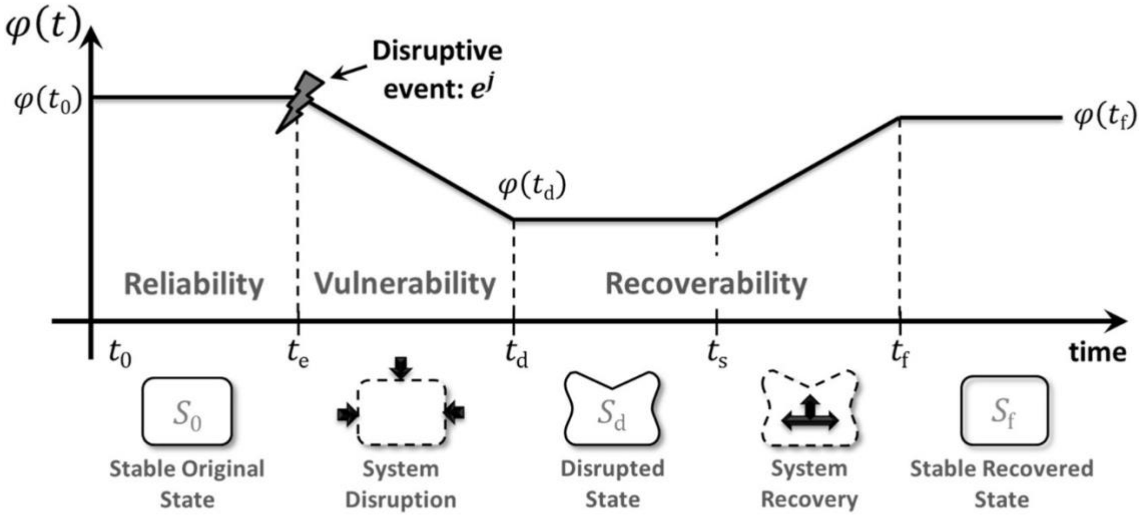
Because they are simpler to conceptualise and implement, this project focuses on general quantitative measures of resilience that are not system specific, although could be tailored to the biosecurity system. One useful deterministic static approach is that applied by Bruneau *et al.* (2003) to measure the loss of resilience in a community following an earthquake, based on the resilience triangle model (Figure 12). In this model, the 'quality' of the system, in this case community infrastructure, is assumed to be 100 per cent before the shock. This declines abruptly after the shock (t_0) and commences to recover immediately until it reaches 100 per cent after a period of time (t_1). The 'resilience loss' is identified as the shaded triangle inFigure 12.



Source: published in Hosseini *et al*., 2016 as an adapted version from Bruneau *et al*., 2003

Figure 12: Resilience triangle

Some of the simplistic assumptions in the resilience triangle model regarding the abrupt impacts of a disruption and the immediate recovery path have been relaxed in other models such as that represented in Figure 13 (Henry & Ramirez-Marquez, 2012). This time-dependent resilience metric quantifies resilience as a ratio of recovery to loss. It identifies three system states that are important in quantifying resilience: the *stable original state*, which represents normal functionality of the system before a disruption occurs; the *disrupted state*, which is brought about by a disruptive event; and the *stable recovered state*, which refers to the new steady state performance level once recovery activities are complete. Important dimensions of resilience that are depicted in Figure 13 are r*eliability*, or the ability of the system to maintain typical operation prior to a disruption; *vulnerability*, or the ability of the system to stave off initial impacts after a disruptive event; and *recoverability*, or the ability of the system to recover in a timely manner (Hosseini *et al.,* 2016).



Source: published in Hosseini *et al.*, 2016 as an adapted version from Henry & Ramirez-Marquez, 2012

Figure 13: Resilience described by system performance and state transitions

8.5 A resilient biosecurity system

This section proposes a two-part process for evaluating the resilience of the national biosecurity system, using information and examples from other domains as guidance.

The first part is to undertake a qualitative assessment of resilience, including articulating the attributes of resilience applicable to the biosecurity system. As discussed above, these attributes represent the inherent characteristics of the biosecurity system that are likely to have an impact on its resilience. These include the system's capacity to anticipate risk and prevent the emergence of risks at the border, to prepare for any required response actions, and to manage the impacts of risks post-border. Most of the indicators relevant to this part of the framework overlap with those developed elsewhere in this report, especially indicators of the effectiveness of different elements of the system and indicators of its capability. Consistent with the methodology used elsewhere in the report, a resilience rubric is proposed to capture and measure the views of experts on each of these indicators in a consistent and transparent manner.

The second part of the evaluation process involves capturing quantitative measures of resilience before and after a disruptive event or shock. A modelling approach is discussed that requires the identification of variables that help define resilience and that should be measured pre- and post-shock.

8.5.1 Qualitative assessment of the resilience of the biosecurity system

Box 12 are five proposed characteristics that contribute to resilience in the national biosecurity system.

Box 12: Proposed characteristics that contribute to resilience

Aware	Understand the operational context of the biosecurity system and use this to identify, assess and prioritise current and emerging risks on an ongoing basis.
Prepared	Have the appropriate plans, tools, agreements and arrangements in place to support biosecurity risk management in normal and emergency circumstances, including the capacity to detect pest and disease incursions through targeted and general surveillance activities.
Resourced	Have sufficient capability, including financial, physical and human resources, as well as organisational capability, to support biosecurity risk management in normal circumstances, as well as surge capacity to address emergency situations.
Responsive	Have the capacity to respond in a timely and effective manner to incursions of unwanted pests and diseases to increase the likelihood of eradication or containment; be able to deal with anomalous situations and disruptions to normal activities without cascading consequences.
Adaptive	have the capacity to recover from or adapt to new circumstances that arise after a pest or disease incursion, including adaptation by producers, industries and communities, including by taking new actions and modifying behaviours, or applying existing resources to new roles; using monitoring and evaluation processes to identify system performance issues and ways to address them.

Each of these characteristics corresponds largely with other parts of the performance evaluation framework, as outlined in Figure 14. This means that building a rubric to capture qualitative assessments of resilience can draw on the rubrics constructed for each of these parts of the framework. For example, because the ‘aware’ characteristic is correlated with the effectiveness of anticipate activities, the resilience rubric can incorporate the results of the anticipate rubric outlined earlier in the report (chapter 5, Table 6).

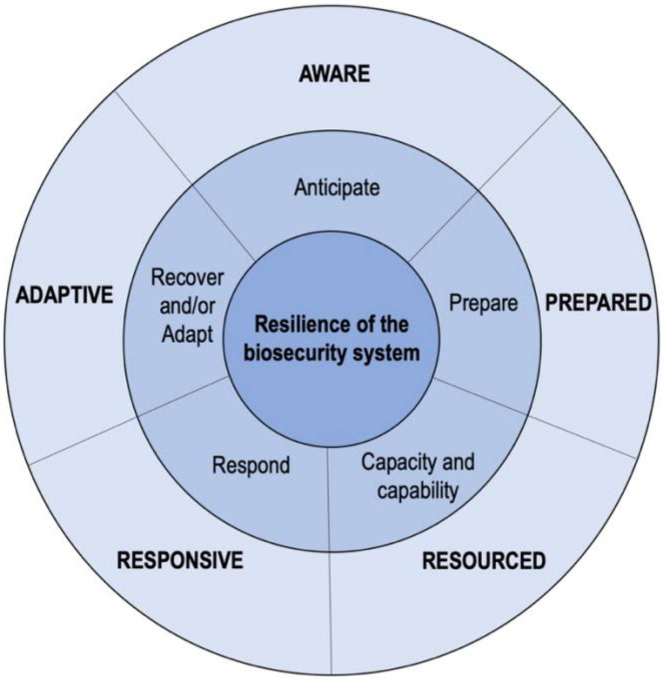


Figure 14: Concordance between resilience attributes and components of the biosecurity system

Evaluation question

In relation to the resilience of the biosecurity system, the overarching question posed to stakeholders and experts is:

Does the biosecurity system have the necessary resources and capability to reasonably withstand external shocks and disturbances without significant consequences, or to recover from shocks and disturbances in a reasonable time, and to adapt to changed circumstances?

Evaluation criteria

The evaluation criteria correspond to the five characteristics outlined above and can be summarised as:

- participants in the biosecurity system are aware – they understand the operational context of the system and use this to identify, assess and prioritise current and emerging risks on an ongoing basis
- the system is prepared – it has the appropriate plans, tools, agreements and arrangements in place to support biosecurity risk management in normal and emergency circumstances, including the capacity to detect pest and disease incursions through targeted and general surveillance activities
- the system is resourced – it has sufficient capability, including financial, physical and human resources, as well as organisational capability, to support biosecurity risk management in normal circumstances, as well as surge capacity to address emergency situations

- the system is responsive – it has the capacity to respond in a timely and effective manner to incursions of unwanted pests and diseases to increase the likelihood of eradication or containment; be able to deal with anomalous situations and disruptions to normal activities without cascading consequences
- the system is adaptive – it has the capacity to recover from or adapt to new circumstances that arise after a pest or disease incursion, including adaptation by producers, industries and communities, including by taking new actions and modifying behaviours, or applying existing resources to new roles; using monitoring and evaluation processes to identify system performance issues and ways to address them

A rubric can be constructed by using the outcomes of earlier rubrics for the effectiveness of anticipate, prepare, respond and recover and/or adapt elements of the biosecurity system, as well as for the capability dimension (Table 48). Each of these rubrics is based on a number of evaluation criteria. These have been outlined in earlier chapters of this report. For example, the rubric for the effectiveness of anticipate activities is constructed from eight evaluation criteria (chapter 5 section 5.2.3). These are aggregated using the methodology in Appendix 2 to form a single score for that rubric. The proposed rubric is at Table 49.

Table 48: Components of a rubric for resilience

Aware	Aggregated results for the effectiveness of anticipate activities
Prepared	Aggregated results for the effectiveness of prepare activities
Resourced	Aggregated results for capability
Responsive	Aggregated results for the effectiveness of response activities
Adaptive	Aggregated results for the effectiveness of recover and/or adapt activities

Using the same methodology, the outcomes of these individual rubrics can be aggregated to form a rubric for the resilience of the biosecurity system. The organisation may wish to attach weights to the individual elements of the rubric to reflect its perceived importance. For example, it may be the judgment of the organisation that activities to anticipate risk contribute more to the resilience of the system than activities to prepare for an incursion. In this case a higher weight would be attached to the Aware element of the resilience rubric than to Prepared (Figure 15).

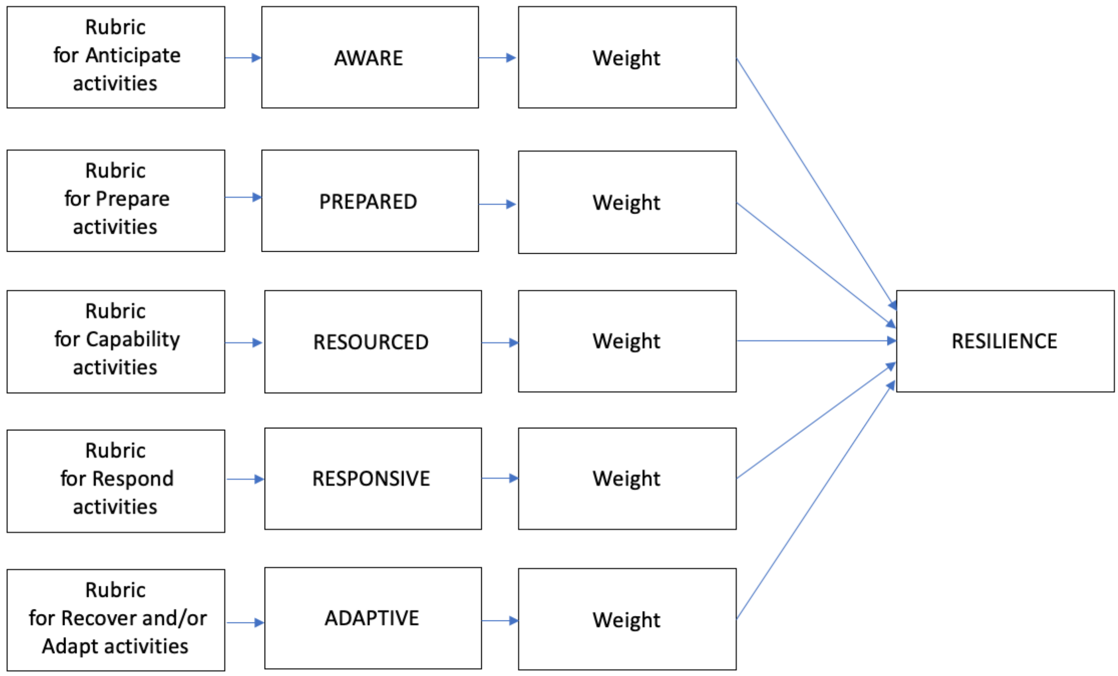


Figure 15: Elements of a rubric for resilience

8.5.2 Quantitative measures of resilience

While the qualitative evaluation of resilience (Table 49) can provide information on how the biosecurity system might be able to cope with an external shock or disturbance, this can only be tested after a shock or disruptive event. As described above, observed resilience can be assessed using different forms of models that measure indicators before and after a shock, including the time taken for a system to revert to normal operations.

This project does not propose the development of any particular model. The choice of whether to pursue a quantitative assessment of resilience, and the form of model to use, is one for the organisation to make. This should be based on the estimated benefits that enhanced understanding of system resilience can deliver compared with the costs of developing and implementing a quantitative approach.

If a quantitative assessment of resilience is considered desirable and cost-effective, the simplest approach is to develop a general static model that can be applied to the biosecurity system, based on the resilience triangle concept. This requires the identification of variables that are considered important to measure before and after an external shock or disturbance, that is a measure of the 'quality' of the system in Figure 12. Observations of these variables can provide an indication of how quickly the system returns to normal operations after an external shock. These variables could include, for example, the number of staff allocated to their normal roles; resources such as laboratory capacity that are engaged in normal operations; or the meeting of normal biosecurity commitments. More sophisticated quantitative modelling could be undertaken to define a structural model for the biosecurity system, if desired, including stochastic and dynamic dimensions.

Table 49: Rubric for the resilience of the biosecurity system

	Performance standards				
	Excellent	Good	Adequate	Poor	Insufficient evidence
	Performance is clearly very strong or exemplary in relation to the question. Any gaps or weaknesses are not significant and are managed effectively	Performance is generally strong in relation to the question. No significant gaps or weaknesses, and less significant gaps or weaknesses are mostly managed effectively	Performance is inconsistent in relation to the question. Some gaps and weaknesses. Meets minimum expectations or requirements as far as can be determined	Performance is unacceptably weak in relation to the question. Does not meet minimum expectations or requirements	Evidence is unavailable or of insufficient quality to determine performance
Evaluation criteria*					
Aware	Use score from anticipate rubric				
Prepared	Use score from prepare rubric				
Resourced	Use aggregated score from capability rubrics				
Responsive	Use score from response rubric				
Adaptive	Use score from recover and/or adapt rubric				

9 Evaluating the sustainability of the biosecurity system

9.1 Introduction

One of the key attributes of the biosecurity system, outlined in the evaluation framework (chapter 4), is its sustainability. This is defined as the ability of the system to meet its objectives over the medium to long term. Over time the pressures on the biosecurity system are expected to grow, with increasing volumes of trade and traveller movements and increasingly diverse import pathways. The global distribution of pests and diseases is also likely to shift in response to factors such as climate change and changes in market demand, while international supply chains are expected to become more complex over time.

These contextual factors will have an impact on the biosecurity risk profile facing Australia and the volume of risk that needs to be managed. A sustainable system will have the appropriate mechanisms in place to ensure that the objectives of the biosecurity system can continue to be met in the face of these pressures. These mechanisms will include the capacity to forecast changes in risk patterns over the medium to longer term, including the capacity to foresee disruptive events that might have sudden implications for risk management. This foresighting capacity helps support preparedness for longer term change in the system. Other mechanisms that underpin sustainability are sustainable funding processes to ensure the appropriate level of resourcing to the system and the efficient allocation of those resources; effective training processes to develop the human resource capability necessary to operate the system over the medium to long term; a targeted R&I effort to generate innovative and cost effective solutions to biosecurity problems; and organisational arrangements to ensure that the system as a whole is fit for the future.

The objective in this chapter is to consider how the sustainability of the biosecurity system can be assessed, and to develop measures of sustainability that can be used to support an evaluation of system performance. These measures should be rigorous and able to be calculated at regular intervals in order to form the basis for assessing trends in sustainability over time. The chapter:

- reviews indicators of likely growth in the risk management task over time;
- considers the factors or attributes of the system that will support its sustainability; and
- proposes a method to measure sustainability over the medium to longer term.

9.2 Forecast growth in the biosecurity risk management task

The Bureau of Infrastructure, Transport and Regional Economics has prepared medium-term forecasts of Australian freight and passenger movements that provide some indication of the potential change in the biosecurity task (BITRE, 2012, 2014). Over the period 2012-13 to 2032-33:

- total containerised trade – imports and exports – through Australian ports is projected to increase by 5.1 per cent a year, from 7.2 million twenty-foot equivalent units (TEUs) to 19.4 million TEUs
- total non-containerised trade is projected to increase by 3.9 per cent a year from 1.1 billion tonnes to 2.3 billion tonnes

- the number of cruise ship passengers is projected to increase by 1.8 per cent a year from 41,000 to 59,000. This number has already been surpassed with reports of inbound international cruise passengers reaching around 200,000 in 2018 (CLIA, 2018). An increasing number of cruise ships are visiting remote locations in northern Queensland and Western Australia
- the number of international air passenger movements through all Australian airports is forecast to increase by 4.9 per cent a year to 72.1 million by 2030-31, with inbound arrivals reaching 36.6 million

Other relevant forecasts include that air cargo to and from Australia is expected to grow by 4 per cent a year to 2025. This is likely to be underpinned by growing demand for just-in-time delivery for items such as high value manufacturing and mining products, and perishables such as food, time dependent medical supplies and cut flowers (DIRD, 2014).

Aggregate numbers such as these mask potentially significant changes in the complexity of trade and travel that could have implications for Australia's biosecurity risk management. For example, pressures on the biosecurity system will arise from changes in the origin and destination of trade and travellers, leading to increasingly diverse and potentially higher risk import pathways (Hulme, 2009; Dodd *et al.*, 2015). Similarly, international supply chains are expected to become more complex over time with final goods made up of components from multiple origins that may involve different risk profiles, while the growing use of online shopping requires new approaches to risk management. The global distribution of pests and diseases is also likely to shift in response to factors such as climate change, bringing with it a need to understand the climatic range of pest and disease hosts, pest and host behaviour under different climatic conditions, and patterns of trade in goods that are potentially affected by climate shifts. The recent increase in the risk of incursion of the brown marmorated stink bug is an example of how the changing global distribution of pests and the increasing complexity of supply chains can have significant impacts on the risk profile (Box 13).

Box 13: Brown marmorated stink bug

Brown marmorated stink bug (BMSB) is an exotic pest that can infest and damage more than 300 host plants, particularly temperate vegetables, fruits and nuts, as well as cotton and soybeans. Over the past two decades, BMSB has spread rapidly from its native range in East Asia (China, Japan and Korea) into Europe, North America and Chile and, in doing so, has caused significant agricultural losses. Australia and New Zealand are currently free of BMSB, despite large regions in both countries being deemed climatically suitable. Maintaining this pest-free status is becoming increasingly difficult as Australia imports large quantities of potentially contaminated goods from an expanding list of countries, ultimately increasing the risk of exposure to Australia’s agricultural industries.

In addition, increasingly long and complex supply chains for many goods that could transport the pest can make BMSB risk management difficult. For example, initial manufacturing plants can be far from the port of export. At-risk cargo such as motor vehicles can be stored after manufacture anywhere along the distribution route to the port, or at a marine terminal, for significant periods before export. One consignment may be manufactured in or pass through an area where BMSB are moving into hibernation, and become infested, while another may be treated or kept away from such risk. On board ship, some bugs emerging from hibernation may move and contaminate previously clean cargo. Other bugs may not emerge until after arrival, posing a risk of incursion unless cargo is treated.

The global spread of BMSB and its particular supply chain issues have created a significant challenge for the Australian biosecurity system. Since 2014, the Department of Agriculture has progressively changed import requirements for break-bulk and containerised sea cargo from risk countries and has expanded the range of approved treatments. In 2018-19, the department applied more stringent BMSB risk management measures to far more vessels carrying break-bulk cargo, and to far more containerised cargo consignments, than in previous years.

The Inspector-General of Biosecurity (IGB) has observed that the 2018-19 BMSB response had a significant impact on Australia’s border biosecurity system and on sections of the shipping and importing industries. Software systems to select and hold sea containers for biosecurity intervention, departmental staff resources to assess and inspect incoming cargo, and local industry facilities to hold and treat at-risk cargo were severely affected by the BMSB response. Other biosecurity programs were substantially reduced so that scarce resources could be allocated to the BMSB response.

The volume of incoming cargo requiring BMSB intervention is predicted to increase by at least 15 per cent in the 2019-20 season. The IGB notes that further strategic investment in both people and systems improvement, with surge capacity to handle biosecurity emergencies while maintaining ongoing business, will be essential into the foreseeable future.

Source: Inspector-General of Biosecurity, (IGB, 2019)

9.3 Characteristics of sustainability

As outlined above, a number of key factors underpin the medium to long term sustainability of the biosecurity system. These include:

- the capacity to forecast changes in risk patterns, including potentially disruptive events
- funding mechanisms that support the appropriate resourcing of the system
- training processes to develop human resource capability
- research and development efforts to generate innovate and cost-effective solutions to biosecurity problems
- organisational arrangements to ensure that the biosecurity system is fit for the future.

Approaches to addressing these are considered below.

9.3.1 Capacity to forecast change in risk patterns

There are many examples of the type of capability required to forecast medium to long-term change in biosecurity risk and support the capacity to address future challenges. These include regular analysis and reporting on issues relevant to biosecurity as well as one off assessments of future states.

In the former category are annual forecasts of medium-term trade in agricultural commodities undertaken by ABARES (for example ABARES, 2019). These forecasts can provide useful indicators of changes in production and trade patterns that have implications for biosecurity risk, as well as examining the factors underpinning these, such as trends in market demand and geographic changes in supply capacity.

One off assessments of issues relevant to biosecurity are undertaken by a range of organisations that may or may not be direct participants in the biosecurity system. Examples include CSIRO's 2014 report on Australia's biosecurity future (CSIRO, 2014), prepared in collaboration with AHA, the Plant Biosecurity Cooperative Research Centre (CRC) and Invasive Animals CRC, and based on wide consultation with industry, government and other scientific organisations. The report used strategic foresight to identify the major biosecurity trends and risks Australia may need to respond to in the next twenty to thirty years. Five 'megatrends' were identified as areas of significant change and growing complexity for the future of biosecurity (Box 14). The report considered that the interaction of megatrends could create megashocks – significant, relatively sudden and potentially high impact events. These included a nationwide incursion of a new exotic fruit fly; a bluetongue outbreak across Australia's major sheep producing regions; the successful establishment of black-striped mussel; and a rapid spike in antimicrobial resistance.

Other examples include a report for the then Rural Industries Research and Development Corporation on rural industry futures (Hajkowicz & Eady, 2015). It made the observation that projected changes in the global climate, environmental system and the world economy will create new and potentially deeper risks for farmers. These include increased biosecurity risk resulting from greater movement of people and goods across national boundaries.

Box 14: Megatrends affecting Australia's biosecurity future

An appetite for change
A growing population brings with it a growing demand for food. We are seeing greater agricultural intensification with vertical integration as well as expansion into niche markets such as organic produce and bioproducts, all of which could require entirely new approaches to biosecurity management.

The urban mindset
In a world with more densely populated cities, some with limited access to health and sanitation services and facilities, the increasing risk of an emerging infectious disease outbreak is self-evident. Australia's biosecurity system will need to engage with the growing numbers of small-scale urban and peri-urban producers and manage the consequences of urban sprawl bringing people into closer proximity with wildlife and agriculture.

On the move
While the increased movement of people, goods and vessels around the world allows for a more interconnected world, this movement also increases the probability of biosecurity threats hitting our shores. A widespread view within Australia's biosecurity system is that in today's world it's not a case of 'if' a new threat will get here, it's a case of 'when' it will arrive.

The diversity dilemma
A loss of biodiversity can have economic implications for a number of industries, including primary production and tourism, and can also be detrimental to human health and wellbeing. Agricultural biodiversity is also important when thinking about the future, as the reduction of genetic diversity in crops and livestock has the potential to lead to global food security issues.

The efficiency era
Declining biosecurity and agricultural resources and investment have the potential to create significant gaps in biosecurity capability. Technological developments in the areas of surveillance and monitoring, data and analytics, communication and engagement, as well as genetics and smaller, smarter devices will play a key role in helping achieve this. However, there are a number of potential barriers that will need to be addressed if technological innovation is to deliver the efficiencies required.

Source: CSIRO, 2014

Also relevant in this context is the ongoing research undertaken by CEBRA for the Australian and New Zealand governments. CEBRA provides research across a range of areas that enhances understanding of the issues, risks and response mechanisms related to biosecurity management. Current research on the development of risk maps for priority plant pests, for example, develops a forward-looking method to determine where, when and how a new pest species is likely to arrive in Australia, taking into account the climate and environmental suitability of a given location. Combined with information about global pest distribution and patterns of trade, this can be an effective tool for understanding potential changes in the biosecurity risk profile over time.

While there are many examples of research and analysis that can underpin a future view of biosecurity risk challenges, a key consideration is the capacity of policy makers and risk managers to translate observations into active risk management. This is a difficult dimension to measure and track over time and can depend on the specificity of the forecasts or future views expressed. The informed views of those involved in the system are required to determine if such research and analyses have a meaningful impact on risk management.

9.3.2 Sustainable funding mechanisms

Adequate financial resourcing of the biosecurity system is an important element of sustainability. Without the appropriate level of resourcing to support risk management in normal circumstance and in emergency situations, the system may not achieve its objectives. As noted by the IGAB review, the success of the biosecurity system relies on sustained levels of well targeted investment over time, underpinned by strong funding principles and arrangements that are nationally coordinated, consistently applied and well communicated (Craik *et al.*, 2017).

Chapter 7 of this report addressed financial resources in the biosecurity system as one of the key elements of system capability. Several of the criteria used to evaluate the performance of this component of the system are directly related to the sustainability of the system. These are whether funding levels are maintained at least at constant levels in real terms over time; whether all appropriate funding mechanisms, such as levies, fees and charges, are used to provide a sustainable funding base that can support the national system into the future; and whether costs are shared appropriately across government and industry participants in the system according to the principles outlines in the IGAB and the National Framework for Cost Sharing Biosecurity Activities. It also included whether financial resources in the system are allocated efficiently across activities. Efficient resource allocation maximises the return on funds invested in the system.

An assessment of the sustainability of the biosecurity system should incorporate the assessments of financial performance that were outlined in greater detail in section 7.5.

9.3.3 Human resource capability for the future

As discussed in section 7.7, human resources – the people who lead, plan, operate and oversight the biosecurity system – are a fundamental resource without which the system would not exist. A diverse range of skills is required to ensure the effective operation of the biosecurity system across all its activities – pre-border, at the border and post-order, under both normal circumstances and in emergency responses.

While section 7.7 focuses on the current operational needs of the biosecurity system, it is also necessary to ensure that the appropriate human capability will be available to meet future requirements. Three dimensions are important in this context. Firstly, it requires an understanding of the existing human resource base, including numbers of people in the system by category, skill level and age. Second, it requires strategic workforce planning to forecast future skills and training requirements. And finally, it requires the implementation of effective training processes to develop the human resource capability necessary for the future operation of the system.

Each of these dimensions should form part of any assessment of the sustainability of human capability in the biosecurity system.

9.3.4 Research and innovation to support sustainability

Section 7.13 discusses the role that research and innovation (R&I) plays in underpinning Australia's science- and risk-based approach to biosecurity. As the IGAB review notes, R&I can inform decisions made by governments and industry; help to improve the efficiency of biosecurity operations; maintain Australia's favourable pest and disease status through the development and application of new risk management measures; and ensure that adequate scientific and technical capacity is maintained (Craik *et al.*, 2017).

Targeted R&I is a key component of sustainability because it can contribute to improving the efficiency and effectiveness of biosecurity operations and reduce the cost of typically high-cost activities in the system such as surveillance and laboratory diagnostics. Section 7.13 discusses issues raised by the IGAB review that limit the capacity of the biosecurity R&I system to address existing and emerging challenges. These include a lack of national level prioritisation, coordination and leadership; the inadequacy of cross-sectoral research that benefits more than one industry or sector; and a lack of certain and sustainable funding streams.

As part of its response to the IGAB review, the Australian Government committed $25.2 million to the Biosecurity Innovation Program (AG, 2018). The purpose of the program is to invest in the identification, development and implementation of innovative technologies and approaches that will enhance the capacity of the national biosecurity system to manage biosecurity risk. It is designed to develop proof of concept/proof of value for innovative technologies and approaches to assist with screening of goods and travellers, as well as emerging technologies and approaches to improve biosecurity risk detection such as drone surveillance, artificial intelligence, robotics, next generation sequencing and new biological controls. The program provides the opportunity to collaborate with innovators from industry, universities and domestic and international research institutions to identify technologies and approaches that will contribute to the long term sustainability and effectiveness of Australia's biosecurity system (DA, 2019c). Approximately $13 million had been invested by end-August 2019.

Assessment of the contribution of R&I to the sustainability of the biosecurity system should include whether adequate funding is assured over the medium to long term; whether priorities are coordinated at the national level and clearly articulated; and whether the R&I system contributes to meeting emerging challenges in biosecurity risk management. These issues are addressed in the rubric developed in section 7.13.

9.3.5 Organisational sustainability

The forecast increase in the biosecurity task may require fundamental changes in the way biosecurity risk is managed into the future. Tight financial environments mean that increasing staffing levels and intervention activity to address an expanding and increasingly complex risk profile will not be viable over the medium to longer term. The recent experience with BMSB illustrates the types of pressures that are placed on the system when subjected to sustained increases in risk. In addition to the factors considered above, sustainability will require that the biosecurity system has the fundamental capability to organise, manage and govern itself so that it can meet its overarching objectives into the future under changing conditions. These core organisational capabilities were included in chapter 7 of this report on measuring the capacity and capability of the biosecurity system (Figure 16). One of these capabilities – research and innovation – has been addressed above. Each of the remaining capabilities also contributes to the long-term sustainability of the system.

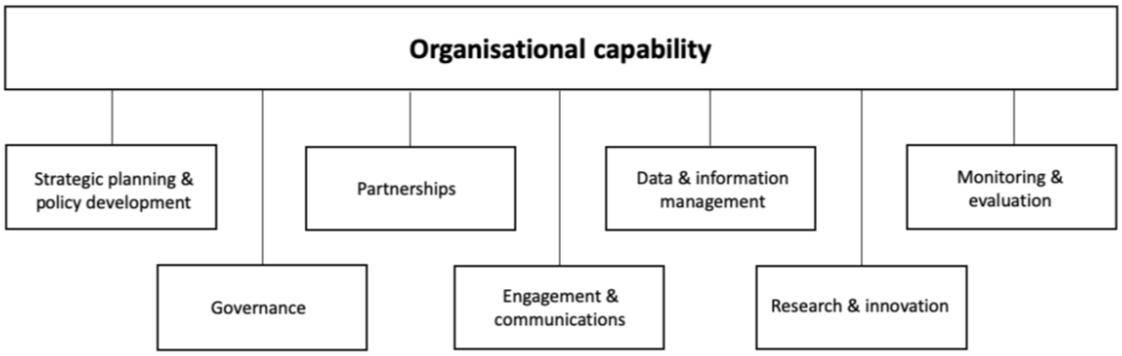


Figure 16: Elements of organisational capability

A clearly articulated national biosecurity strategy is important for sustainability because it sets the future direction of the system through defining the objectives it seeks to achieve, the principles guiding its operation, and the roles and responsibilities of its participants. It can also be a powerful tool for gaining the collective support of system participants. Underneath this strategic framework, policy is developed and implemented that shapes the way the system will operate into the future, including guiding national biosecurity priorities.

Effective governance arrangements are also critical to sustainability because they define the institutional structures and the regulatory, legislative and administrative arrangements that support the system. Each of these needs to provide the appropriate framework for the future operations of the system. The *Biosecurity Act 2015*, for example, provides significant opportunity to substantially transform the way biosecurity business is conducted – it provides flexibility in the way the Commonwealth's regulatory responsibilities can be performed, including opportunities to pursue risk management arrangements in partnership with others and to apply a broad range of enforcement actions that align with the level of risk.

The partnerships approach to biosecurity supports the system's sustainability by sharing responsibility and accountability for biosecurity activities across system participants according to their roles as risk creators or beneficiaries of risk management activities. Conferring greater ownership of biosecurity risk management on non-government participants in the system spreads the investment task and potentially reduces the total investment call on governments, leading to greater financial sustainability of the system.

Engagement and communication activities also support sustainability because they underpin the effective cooperation of participants in the system, including supporting the shared vision for biosecurity inherent in the partnerships approach.

Data and information management is critical to sustainability because it supports the full range of activities in the system, from anticipating emerging risks, to preparing for and responding to national biosecurity threats, and to managing ongoing biosecurity issues. The capacity to aggregate and analyse data informs all aspects of policy development, decision making and performance reporting and enhances the long-term effectiveness of the system by supporting risk management and biosecurity operations.

The capacity to undertake effective evaluation of the performance of the biosecurity system can also strengthen sustainability because it can identify areas of strong performance in the system as well as areas of relative weakness. This can help support decisions about where to invest resources in the system in order to best achieve its multi-layered objectives. The lessons derived from performance evaluation can also assist consideration of the strategic direction of the biosecurity system and inform future and sustainable system design.

9.4 Qualitative assessment of the sustainability of the biosecurity system

A qualitative evaluation of the sustainability of the biosecurity system can be developed using the assessments of experts about system performance against a set of appropriate evaluation criteria.

Evaluation question

Is the biosecurity system sustainable? Does it have the appropriate structures and mechanisms in place to ensure its continued operation over the medium to longer term, taking into account pressures expected to arise from growth in system demands and complexity?

Evaluation criteria

- There is well-developed capacity to forecast changes in biosecurity risk over the medium to longer term
- There are appropriate mechanisms in place to provide a sustainable funding base that will support the biosecurity system into the future
- Training programs are implemented that address the human capability requirements of the biosecurity system
- Research and innovation supports biosecurity priorities and contributes to meeting emerging challenges
- The biosecurity system has the appropriate organisational capacity to achieve its objectives into the future under changing conditions

Similar to the case of resilience, most of these criteria have been addressed in the context of other attributes of health, in particular the capability of the system. The exception is the capacity to forecast medium to long term change in the biosecurity risk profile. A rubric can be constructed that incorporates the scores from previous rubrics, where applicable, as well as new material on forecasting capability (Table 50).

Table 50: Rubric for the sustainability of the biosecurity system

	Performance standards				
	Advanced	Good	Developing	Inadequate	Insufficient evidence
	Performance is clearly very strong or exemplary in relation to the question. Any gaps or weaknesses are not significant and are managed effectively	Performance is generally strong in relation to the question. No significant gaps or weaknesses, and less significant gaps or weaknesses are mostly managed effectively	Performance is inconsistent in relation to the question. Some gaps and weaknesses. Does not always meet minimum expectations or requirements	Performance is unacceptably weak in relation to the question. Does not meet minimum expectations or requirements	Evidence is unavailable or of insufficient quality to determine performance
Evaluation criteria*					
Capacity to forecast medium to long term risk	There is highly developed capacity that is virtually always employed systematically to forecast and analyse the factors that will influence the biosecurity risk profile and the magnitude of the risk management task over the medium to long term. This information is virtually always incorporated into risk management and planning.	There is well developed capacity that is usually employed to forecast and analyse the factors that will influence the biosecurity risk profile and the magnitude of the risk management task over the medium to long term. This information is usually incorporated into risk management and planning.	There is some capacity to forecast and analyse the factors that will influence the biosecurity risk profile and the magnitude of the risk management task over the medium to long term. The information it generates is sometimes incorporated into risk management and planning.	The capacity to forecast and analyse the factors that will influence the biosecurity risk profile and the magnitude of the risk management task over the medium to long term is not well developed and does not inform risk management and planning.	Evidence is unavailable or of insufficient quality to determine performance.
Sustainable funding base	Use score from financial resources rubric				
Human capability	Use score from human resources rubric				
Research and innovation	Use score from research and innovation rubric				
Organisational capability	Use aggregated score from strategy and policy development, partnerships, engagement and communications, data and information management, and monitoring and evaluation rubrics				

*Refer to text for description of the evaluation criteria

10 Issues and implementation strategies

10.1 Introduction

Implementing a performance evaluation framework for a complex system such as biosecurity is a non-trivial exercise. It is complicated by the large number of interrelated activities in the system, the multiple objectives it seeks to achieve, and the range of participants that contribute to its outputs and outcomes. Cooperation between participants and other stakeholders will be critical to the success of an evaluation exercise at the national and system-wide level. Box 16 provides a general high-level guide to the steps that underpin implementation of the framework proposed in this report. It is not intended to be prescriptive but rather to highlight general areas that should be addressed by an implementation team. Specific implementation issues that were surfaced during the project are discussed below, although these are not exhaustive.

10.2 Appropriate level of aggregation

The level at which an evaluation should be performed must be determined. The review of literature undertaken for the project indicates that most evaluations are done at the program or project level. Projects and programs can be large and complicated with multiple components. However, biosecurity is a system – it comprises many individual programs with multiple activities, complex linkages, and a wide range of participants. The framework developed in this report has been designed to evaluate the performance of the whole system at the national level. Hence the KEQ developed in the project have been posed at a high level to encompass whole of system activity and outcomes. This is likely to be appropriate for stakeholders who have a view of, or responsibility for, the overarching system, including ministers, parliaments, biosecurity executives and the engaged community.

Other stakeholders will have interests or responsibilities at a lower level of the system. Managers of individual programs within components of the system, for example, require an evaluation approach that helps them monitor and manage performance within their areas of responsibility. The framework established in this report is able to be applied to evaluation at different levels with KEQ developed to reflect the objectives of particular components or activities within the biosecurity system. For example, in terms of effectiveness, KEQ can be posed at the system level, such as IGAB objective 1; at each component of the system that contributes to that objective, for example, anticipate, prevent and screen; and at activities within each of those components such as environmental scanning, intelligence analysis and offshore surveillance. Similarly, rubrics can be developed that integrate qualitative data at any level of the system. In this project we have developed KEQ and rubrics for the effectiveness of each of the overarching IGAB objectives or system-level outcomes, as well as for each component of the system, or the direct outcomes. They could also be developed for individual activities within those components to provide an evaluative tool for program or project managers. The most important determinant of the level at which the evaluation should be undertaken is the audience for which it is intended and the specific purpose of the evaluation.

Box 15: Recommended steps to implementation

Establish authority

Establish cross-jurisdictional authority for the evaluation project under the NBC
Establish a cross-jurisdictional coordinating team to guide project implementation
Establish reporting lines to the NBC

Plan

Determine jurisdictional readiness to participate
Decide how to sequence implementation
Determine tasks and timelines by jurisdiction
Finalise indicators and measures, including the content of rubrics
For quantitative indicators:

- conduct data rehearsal to determine feasibility of collecting the indicators and measures at the national level
- revise indicators and measures, if necessary, on the basis of data availability and accessibility

For qualitative indicators:

- develop background material for rubrics
- select participants
- select method for administering rubrics
- build online tool to support administration of rubrics and analysis of results

Implement

Collect data and evidence to support quantitative indicators and measures
Administer rubrics to gather qualitative judgments of performance
Consider and/or develop performance benchmarks or targets
Develop the narrative, that is, write the report, including supporting evidence

Review

Provide feedback to biosecurity system participants on outcomes of the evaluation and implications for risk management
Revise the framework, taking into account learnings from the initial implementation

Supplementary issues

Efficiency

If further consideration is to be given to evaluating the efficiency of the biosecurity system, consider establishing a project to determine or review the following:

- current availability of data that support considerations of efficiency, including expenditure by activity, likelihood and consequences of pest and disease incursions, costs of alternative control options, and rates of return to different options
- data gaps
- methods used currently by jurisdictions to allocate resources across biosecurity activities, including tools and models that are used to support budget allocation
- potential to share information, tools and expertise between jurisdictions to build a repository of knowledge on portfolio allocation approaches and to support a progressive approach to implementing such an approach.

Resilience

Consider the costs and benefits of developing a model to measure observed resilience of the biosecurity system before and after a shock. If this is agreed, establish a project to consider alternative forms of a model, data requirements and implementation strategies.

10.3 Gathering qualitative evidence of performance

In proposing indicators of performance of the biosecurity system, the evaluation framework presented in this report suggests that the use of both quantitative and qualitative indicators will lead to a better and richer understanding of outcomes than either quantitative or qualitative evaluation alone. Sets of indicators have been developed for each of the KEQ posed in the report.

We have proposed that qualitative judgments about performance of the biosecurity system should be elicited from stakeholders and experts. To do this, the evaluation team needs to be clear about the appropriate evaluation questions to ask, including the level of the biosecurity system at which they should be targeted. The project proposes the use of rubrics to summarise qualitative information and judgments in a consistent manner that reduces ambiguity. As discussed in chapter 2, rubrics require performance standards or levels and evaluation criteria – the things that are important in considering performance. The performance levels defined in a rubric should be explicit. The project has proposed a generic set of four performance levels – from advanced to inadequate – as well as evaluation criteria and descriptions of performance at each level. In implementing an evaluation process, each of these components of a rubric should be carefully reviewed by the evaluation team to ensure they meet the purpose of the evaluation exercise.

An important consideration in designing a rubric is that the language used to describe performance against an evaluation criterion at a specified level should be as objective and transparent as possible. Linguistic ambiguity may generate unwanted bias in the judgments made but can be mitigated by discussion and feedback in the implementation process that clarifies the language used in the specific context. Given that the rubrics developed in this project are designed to elicit qualitative judgments rather than quantitative measures it is not possible to eliminate all ambiguity but awareness of the issue can help to reduce inherent biases.

A further important step is the selection of experts to participate in the process of gathering qualitative evidence. In the framework proposed in this project, 20 rubrics have been developed to elicit judgments about the performance of the biosecurity system across different sets of activities and against different attributes of performance. There will not be a consistent set of participants with knowledge of all activities in the system. Hence it will be necessary to select a panel of participants for each rubric, although these may overlap.

Participants should include those who are directly involved in the activity as they can be assumed to have deep knowledge about activities undertaken and their intended consequences. However, to restrict participation to this group would result in what is essentially self-assessment without scope to independently verify statements and conclusions. To avoid the biases inherent in this situation, it is necessary to select a panel of participants that can bring a range of perspectives to the area being evaluated and whose knowledge can support informed judgment. As well as those directly involved in system activities, this might include users of the outputs generated, and beneficiaries of system activities. For example, in the case of the Commonwealth's environmental scanning activities, users of its outputs might be members of the department's Trade and Market Access Division who are involved in prioritising the department's program of import risk analyses to support market access, as well as state and territory officials and staff of AHA and PHA who are directly involved in the management of emerging biosecurity risks. In the case of the rubric on the performance of the biosecurity research and innovation system, participants might include representatives of funding bodies, including the Commonwealth and state and territory governments and the Rural Research and Development Corporations; research and innovation providers such as CSIRO; and the beneficiaries of the R&I system represented by AHA and PHA. The most important consideration is to actively consider and manage the potential biases in the selection of participants in qualitative judgment processes and to be transparent about the selections made.

Different methods can be used to implement rubrics, including face-to-face interviews with individual participants, or group-based exercises such as focus groups or workshops, or through remote methods such as web-based surveys. The method chosen will depend on the number of stakeholders and experts included, the circumstances of those involved, including their location and budget considerations, and the scope of the questions to be asked. In general, an approach that facilitates feedback and discussion that reduces linguistic ambiguity in the framing of rubrics and contributes evidence to the issue under question can be helpful. Evaluation teams will need to carefully consider the appropriate method of gathering data for their purposes.

Regardless of the method chosen, preliminary work will be required before the rubric 'instrument' can be administered. This includes the preparation of general background material for each participant on the objectives of the evaluation and the concept of a rubric, that is, how the instrument will be applied and how the results will be derived and used. Specific background material will also be required for each rubric on the activities and outcomes being evaluated. This material could be derived from the relevant sections in this report and updated where appropriate. If the rubric is to be evaluated in a face-to-face environment a facilitator will be required who is familiar with the material and able to guide participants through discussion of the key issues. While sharing of views and evidence can be useful when forming judgments, ultimately it is the judgments of individual participants that are required. These are then synthesised into an overarching score for that rubric. If the rubric is to be administered in a remote environment, for example by online survey, there is unlikely to be the opportunity for group discussion to inform individual judgments unless some form of remote interactive conference can be held. In either environment, an online system to enter responses to the rubric should be developed to facilitate participation as well as supporting the collation and analysis of results. This can be achieved using contemporary applications such as R Shiny app (shiny.rstudio.com).

10.4 Developing performance benchmarks or targets

Developing performance indicators is one of the seven parts of the evaluation framework proposed in chapter 4 of this report. Indicators are important because they are signposts of activity and change and can be used to demonstrate results of activities and programs, including changes over time. However, indicators only indicate; they do not explain (UNDP, 2007). In the context of the biosecurity system indicators can demonstrate a level of performance and whether that level has changed over time but they cannot define whether that level of performance is 'healthy'. Nor does determining that change in the level of performance has occurred tell the story of why it has occurred or of how well it has occurred.

In order to use indicators to monitor and evaluate performance at any level of the biosecurity system, some form of benchmarking or setting of targets is required. This involves defining what a 'healthy' system looks like and setting expectations of future performance. These benchmarks and targets might be set as minimum levels of performance required to be considered healthy, or they could establish stretch targets that would deliver best practice levels of performance. Chapter 5 (section 5.4.2) of this report, provides examples of using targets to measure the performance of the international traveller and mail pathways. It defines three levels of performance – acceptable performance; pay attention; and take action – each of which have different implications for the appropriate management response.

As discussed in chapter 4, different approaches can be used to establish the appropriate performance benchmark or target, including identifying benchmarks from other similar programs or measuring performance for a period to establish a baseline. In the case of the biosecurity system, the appropriate or desired level of system performance should be defined by experts and stakeholders, using the same principles as those used to select participants in the elicitation of qualitative judgments about performance. That is, direct knowledge about the processes being benchmarked should be complemented by those who have broad knowledge of the biosecurity system and understand the practical constraints under which it operates. Transparency in the selection process will help to minimise bias.

Consultation on benchmarks should be revised on a regular basis. This allows the performance evaluation system to strengthen over time as the links between parts of the system are better understood, more meaningful measures of key results are constructed, and more concrete expectations of performance are developed.

10.5 Data issues

Developing a performance evaluation framework for a complex system such as biosecurity is necessarily data intensive. It requires a range of indicators and methods of collecting data to provide appropriate and credible evidence about the performance of the system. However, using a large number of indicators has no merit in itself. The key to good indicators is credibility and utility. Large volumes of data can confuse rather than bring focus (UNDP, 2007). These principles have been observed in the development of the proposed indicators in this project.

All the indicators of performance proposed in this project have been developed with the assistance of jurisdictional staff through workshops and follow-up meetings. Some assurance has been provided that data are available for the proposed indicators or could be collected or curated from existing data sources. However, this has not been validated in practice, with the exception of data required to calculate the approach rate and leakage rate indicators on two pathways. Implementation of a performance evaluation framework such as that proposed in this project would require a rigorous data rehearsal, including testing of data availability, quality and accessibility. This needs to be conducted by each jurisdiction and may result in changes or refinements to the proposed indicators.

Differences in data availability and quality between jurisdictions will have implications for implementation of the framework.

The project has raised some specific examples of data availability in relation to measures of the direct outcomes of prevent and screen activities – the approach rate and the leakage rate. As discussed in chapter 5 of this report, calculation of these measures is dependent on the availability of data from end-point surveys. These surveys are conducted on only three pathways – international travellers, international mail and containerised sea cargo. This means that systematic monitoring of performance using the methods discussed in chapter 5 cannot be undertaken on other pathways.

An alternative to using end-point surveys to calculate approach rates and leakage rates is to elicit measures from experts in formal exercises similar to those undertaken for the RRRA project. Using elicited data could provide valuable insights into the performance of anticipate, prevent and screen activities at a disaggregated level, including on entry pathways characterised by high levels of risk.

Specific data issues have been raised in this project in the context of the case studies. One of these is the link between recorded rates of non-compliance with biosecurity regulations and the actual risk of that non-compliance. In the calculation of the approach rate and leakage rate in this project, non-compliance is defined as any breach of the regulations on that pathway. For example, incomplete documentation is considered a non-compliance although it may not be associated with any actual biosecurity risk. Consequently, the level of actual biosecurity risk cannot necessarily be determined from existing data holdings. This is a significant data issue that can only be addressed by agencies responsible for data and needs to be considered in any assessment of health.

Other limitations with existing data holdings are likely to arise during the implementation of a performance evaluation process. Identifying these issues could help drive improvements in data collection and storage. These improvements will not only support better assessments of biosecurity system health but will also lead to actual improvements in system performance.

10.6 Sequencing implementation of the framework

The evaluation framework is designed to assess the performance of the biosecurity system at the national, system-wide level. In order to derive a view of performance at that level, the framework should be implemented in its entirety at the one time. In reality, this may be difficult, at least in the first instance. Jurisdictions are at different stages of implementation readiness that may make integration of approaches problematic. Victoria, for example, has already developed and implemented a mature performance evaluation process; Queensland has implemented its capability framework twice and developed recommendations for performance improvement. Continual performance monitoring is also one of the aspirations of Queensland's current biosecurity strategy and it is developing an approach that is consistent with that proposed in this report. Other states may not be as advanced in their planning for systematic performance evaluation at this level. In addition, data holdings and capability can vary considerably across jurisdictions and will require different approaches to integration. Non-government participants may also need time to consider the benefits of their participation in the implementation of a national performance evaluation framework.

A pragmatic approach may be to implement the framework initially in a progressive manner in which activities are undertaken by jurisdictions or other participants at a pace that is feasible, under a coordinating umbrella such as the NBC. Where there are activities undertaken principally by one jurisdiction, these could be progressed independently. For example, the Commonwealth has the primary responsibility for pre-border and border activities and holds the appropriate data and evidence on these. It might demonstrate its leadership of the process by undertaking an evaluation of these activities independently of participation by other jurisdictions. This would have the benefit of demonstrating the feasibility and practicality of the framework against those activities, as well as providing a useful test of Commonwealth data holdings. Those jurisdictions, such as Victoria and Queensland, that have implemented system-wide performance frameworks within their states might also wish to demonstrate the applicability of the framework against post-border activities. Because of existing progress, this could be achieved without significant increases in implementation costs for those jurisdictions. Other jurisdictions might benefit from a demonstration of the system and the development of the appropriate evidence base. A national view of performance might be built progressively as individual jurisdictions develop their data and capacity.

Building a national, system-wide framework in a progressive manner will require coordination to ensure that activities are structured, consistent with the agreed framework, and can be integrated when appropriate into an overarching view of system performance. The appropriate authority for this process could be provided by the NBC. Some form of team arrangement might be established to coordinate and report on activities, comprising representatives from the range of participants in the system. AHA and PHA should be important members of such a team and provide a conduit to non-government participants in the biosecurity system.

10.7 Developing a performance narrative

As outlined in the analytical approach to this project, telling the performance story is as important as developing and measuring the indicators of performance. Reporting on performance involves presenting evidence that can be used to assess what has been achieved in relation to the expectations of the system. It should allow those interested in the performance of the system, including ministers, the parliament, participants, the community, to form a view, with sufficient confidence, of how healthy the system is and where improvements in performance can be made.

A variety of data and information – both quantitative and qualitative – is needed to develop a clear and transparent account of performance. This information can be presented through a combination of graphics, tabulation and narrative descriptions. Different layers of information are needed. For example, detailed quantitative information on system outputs will be collected at the activity level while more aggregated information will be generated to assess performance against outcomes. These may be presented in different ways with detailed data in appendices for reference and higher level information encapsulated in dashboards. All levels of information can be used to enrich the performance narrative and to facilitate data use for decision making. The actual form of the final reporting will evolve as the performance evaluation process develops, particularly if implementation occurs in stages rather than as one integrated project. In the absence of an implementation plan, it is not possible to be prescriptive about the appropriate reporting structure.

While telling the performance story can be achieved in different ways, it is important that all participants in the evaluation exercise are able to participate in the process and have ownership of the resulting narrative. There may be sensitivities among participants about the confidentiality of results and the level at which these should be reported. It will require trust to disseminate poor results but explaining these using the relevant evidence is part of a transparent evaluation process designed to provide stakeholders with confidence in the performance of the system.

10.8 Managing expectations

It is unrealistic to expect that an ideal set of performance indicators and related performance expectations will be identified at the first attempt and that a performance measurement system will be implemented in one step that endures unchanged over time. As discussed in chapter 4, the process is often evolutionary and advances through trial and error. This is particularly the case for the biosecurity system given that implementation of a performance evaluation process is likely to be staged rather than occurring at the one time.

The environment within which the biosecurity system operates is constantly changing, and hence ongoing planning and consequent revisions to performance indicators and expectations will be needed. The performance evaluation system should be seen as an evolving construct – it becomes firmer with stronger and better understood links based on evidence; acquires stronger, more meaningful measures of key results; and develops more concrete expectations.

Given this, the evolution of the performance evaluation system should occur in a deliberate manner, rather than as random trial and error. There should be visible built-in adjustment mechanisms that identify the strongest indicators and expectations, that is, those that are most useful to stakeholders for managing the system and reporting. An overarching coordination process under the authority of the NBC will help achieve this and identify the most appropriate opportunities to further develop the system. This can reinforce the importance of deliberate learning based on past experience rather than simply reporting on the gap between expectations and actual performance (Mayne, 2004).

When implemented rigorously and transparently, an evaluation of the performance of the national biosecurity system can help identify, among the many components of the system, areas of strong performance relative to the agreed attributes of health, as well as areas of relative weakness. This can help support decisions about where to invest resources in the system in order to achieve its multi-layered objectives. The lessons derived from performance evaluation can also be a powerful tool to support consideration of the strategic direction of the biosecurity system and to inform future system design.

Glossary

Activity measures: measures that describe the outputs of the activities undertaken in the biosecurity system quantitatively. Activity measures assess the scope and scale of these activities.

Attributes of health: specify the values that will be used in an evaluation. The evaluation literature refers to these values as evaluative criteria (Peersman, 2014).

Components of the biosecurity system: the activities undertaken in the system, grouped into anticipate, prevent, screen, prepare, detect, respond, recover and/or adapt. The grouping is based on the activities listed in the department's corporate plan (DA, 2019b), with the exception of 'screen' which was added to represent activities at the border.

Direct outcomes: short-term outcomes of activities undertaken in the biosecurity system. Direct outcomes are the cumulative results of outputs of activities over time.

Disease: the presence of a pathogenic agent in a host and/or the clinical manifestation of infection that has had an impact (i.e. significant negative consequences) or poses a likely threat of an impact. It includes micro-organisms, disease agents, infectious agents and parasites (Source: IGAB2; COAG, 2019).

Evaluation criteria: a component of an evaluation-focused rubric. Criteria in this context are non-overlapping dimensions or components of quality (Martens, 2018)

Evaluation framework: the analytical approach taken in this project using 7 principles. It includes the indicator framework.

Incursion: the introduction of an organism/agent to a new area, including exotic and established pests and diseases.

Indicator: a measurable characteristic of a system yielding insights transcending its individual parts to answer specific questions relevant for decision-making in policy.

Indicator framework: the set of proposed indicators for the attributes of health. The indicator framework consists of quantitative and qualitative indicators.

Key evaluation questions: high level evaluation questions about overall performance which the evaluation should aim to answer. Key evaluation questions (KEQ) are derived from the purpose of the evaluation (Peersman, 2014).

Logic model: a diagrammatic representation of the conceptual basis for the evaluation (Funnell and Rogers, 2011).

Outbreak: a rapid increase in the abundance and spatial distribution of a pest or disease, including exotic and established pests and diseases.

Pest: any species, strain or biotype of the Kingdoms Animalia (excluding human beings), Plantae, Fungi, Monera or Protista that has had an impact (i.e. significant negative consequences), or poses a likely threat of having an impact, on human, plant or animal health, the environment or social amenity (Source: IGAB2; COAG, 2019).

Priority pests and diseases: exotic and established priority pests and diseases for animals, plants and the environment and community (adapted from IGAB 2; COAG, 2019). The term 'priority' is used in this project based on feedback from stakeholders and the fact that the biosecurity system cannot cater for all pests and diseases. Australia's Appropriate Level of Protection (ALOP) allows for that shortcoming. It is set at a high level of sanitary and phytosanitary protection aimed at reducing biosecurity risk to a very low level, but not to zero.

Qualitative indicator: a characteristic of the system that is measured using qualitative information or judgment. The rubrics developed for the different attributes of health are the qualitative indicators.

Quantitative indicator: a characteristic of the system that is measured using quantitative information.

System-level outcomes: long-term outcomes of activities undertaken in the biosecurity system. System-level outcomes are the objectives of the Intergovernmental Agreement on Biosecurity (IGAB).

Acronyms

AADIS	Australian Animal Disease Spread model
AAHL	Australian Animal health Laboratory
ABARES	Australian Bureau of Agricultural and Resource Economics and Sciences
AFAS	Australian Fumigation Accreditation Scheme
AGMIN	Agriculture Ministers’ Forum
AGSOC	Agriculture Senior Officials' Committee
AHA	Animal Health Australia
ALOP	Appropriate Level of Protection
APEC	Asia-Pacific Economic Cooperation
APSC	Australian Public Service Commission
AQUAVETPLAN	Australian Aquatic Veterinary Emergency Plan
AUSVETPLAN	Australian Veterinary Emergency Plan
BCR	Benefit-Cost Ratio
BICON	Biosecurity Import Conditions
BIIS	Biosecurity Integrated Information System
BIMS	Biosecurity Incident Management System
BIRA	Biosecurity Import Risk Analyses
BITRE	Bureau of Infrastructure, Transport and Regional Economics
BMSB	Brown Marmorated Stink Bugs
CBIS	Compliance-based Inspection Scheme
CC	Consultative Committee
CCVS	Cargo Compliance Verification Scheme
CEBRA	Centre of Excellence for Biosecurity Risk Analysis
COAG	Council of Australian Governments
CSD	Commission on Sustainable Development
CLIA	Cruise Lines International Association
CRC	Cooperative Research Centre
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DA	Australian Government, Department of Agriculture
DAWE	Australian Government, Department of Agriculture, Water and the Environment

Acronyms

DAWR	Australian Government, Department of Agriculture and Water Resources
DEPI	Victorian Government, Department of Environment and Primary Industries
DF	Australian Government, Department of Finance
DFAT	Victorian Government, Department of Foreign Affairs and Trade
DH	Australian Government, Department of Health
DIRD	Australian Government, Department of Infrastructure and Regional Development
EAD	Emergency Animal Disease
EADRA	Emergency Animal Disease Response Agreement
EC	European Commission
EEA	European Environment Agency
EMPPLAN	Emergency Marine Pest Plan
EPP	Emergency Plant Pest
EPPRD	Emergency Plant Pest Response Deed
ERP	Emergency Response Plans
FMD	Foot-and-Mouth Disease
IBIS	International Biosecurity Intelligence System
ICAS	Interstate Certification Assurance Scheme
ICCBA	International Cargo Cooperative Biosecurity Arrangement
IGAB	Intergovernmental Agreement on Biosecurity
IGB	Inspector-General of Biosecurity
IAHER	International Animal Health Emergency Reserve
ILAC	International Laboratory Accreditation Cooperation
IMO	International Maritime Organization
IPPC	International Plant Protection Convention
ISO	International Organization for Standardization
IT	Information Technology
KEQ	Key Evaluation Questions
LEADDR	Laboratories for Emergency Animal Disease Diagnosis and Response
MARS	Maritime Arrivals Reporting System
MRA	Mutual Recognition Arrangement

NAHIS	National Animal Health Information System
NAQS	Northern Australia Quarantine Strategy
NATA	National Association of Testing Authorities
NBC	National Biosecurity Committee
NBCEN	National Biosecurity Communications and Engagement Network
NBRT	National Biosecurity Response Team
NEBRA	National Environmental Biosecurity Response Agreement
NFCSBP	National Framework for Cost Sharing of Biosecurity Programs
NGO	Non-Governmental Organisation
NLIS	National Livestock Identification System
NLTPS	National Livestock Traceability Performance Standards
NMG	National Management Group
NPBDN	National Plant Biosecurity Diagnostic Network
NPHSP	National Plant Health Surveillance Program
NPPRCS	National Plant Pest Reference Collections Strategy
NSW DPI	NSW Department of Primary Industries
NRM	Natural Resource Management
OECD	Organisation for Economic Co-operation and Development
OECD-DAC	Organisation for Economic Co-operation and Development - Development Assistance Committee
OIE	World Organisation for Animal Health
PC	Productivity Commission
PHA	Plant Health Australia
PIMC	Primary Industries Ministerial Council
PSR	Pressure-State-Response
PLANTPLAN	Australian Emergency Plant Pest Response Plan
PMC	Australian Government, Department of the Prime Minister and Cabinet
QRM	Quarantine Regulators' Meeting
RDC	Research and Development Corporation
RD&E	Research, Development and Engagement
R&I	Research and Innovation
RoGS	Report on Government Services
RRRA	Risk Return Resource Allocation

SAC	CEBRA Scientific Advisory Committee
SEMC	State Emergency Management Committee
SMART	Specific, Measurable, Assignable, Realistic, Timely
SOE	State of the Environment
SPHD	Subcommittee on Plant Health Diagnostics
SPS	Sanitary and Phytosanitary
TEU	Twenty-foot Equivalent Unit
UNDP	United Nations Development Programme
USAID	United States Agency for International Development
VPSC	Victorian Public Sector Commission
WHA	Wildlife Health Australia
WTO	World Trade Organization

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Appendix 1: Consultation schedule

Scoping workshop for CEBRA Health (1607B) and Value (1607A) projects
12 July 2016, Canberra

Name	Organisation
Matt Koval	Department of Agriculture
Colin Grant	Department of Agriculture
Karen Schneider	Department of Agriculture
Marion Healy	Department of Agriculture
Raelene Vivian	Department of Agriculture
Kim Ritman	Australian Chief Plant Protection Office
Deb Langford	Department of Agriculture
Barbara Jones	Department of Agriculture
Peter Gooday	Department of Agriculture
Tony Arthur	Department of Agriculture
Ahmed Hafi	Department of Agriculture
Andrew Cupit	Department of Agriculture
Paul Nixon	Department of Agriculture
Paul Pheloung	Department of Agriculture
Julie Goodchap	Department of Agriculture
Haidee Hudson	Department of Agriculture
Alistair Davidson	Department of Agriculture
Chris Howard	Department of Agriculture
Christine Reed	New Zealand Ministry of Primary Industries
Claire McDonald	New Zealand Ministry of Primary Industries
Tom Kompas	CEBRA
Andrew Robinson	CEBRA
Simon McKirdy	CEBRA
Danny Spring	CEBRA

Technical workshop
8 December 2016, Canberra

Name	Organisation
Matt Koval	Department of Agriculture
Lee Cale	Department of Agriculture
Sam Wells	Department of Agriculture
Paul Pheloung	Department of Agriculture
Haidee Hudson	Department of Agriculture
Callum Moggach	Department of Agriculture
Felicity Wood	Department of Agriculture
Victor Zalakos	Department of Agriculture
Teresa McMaugh	Department of Agriculture
Tony Arthur	ABARES
Ahmed Hafi	ABARES
Bertie Hennecke	ABARES
Donna Hawkes	ABARES
Jay Gomboso	ABARES
Christine Reed	NZ MPI
Andrew Robinson	CEBRA

Danny Spring	CEBRA
Aaron Dodd	CEBRA
James Camac	CEBRA
Anais05/11/2020 01:30:00 Gibert	CEBRA
Hannah Fraser	CEBRA

System description workshops
2 & 4 May 2017, Melbourne

Name	Organisation
Hugh Millar	Hugh Millar & Associates Pty Ltd
Simon McKirdy (2 May only)	Murdoch University
Gabrielle Vivian-Smith (4 May only)	Chief Plant Health Officer, Agriculture Victoria
Andrew Robinson	CEBRA
Tom Kompas	CEBRA
Aaron Dodd	CEBRA
Karen Schneider	CEBRA
Hannah Fraser	CEBRA
Libby Rumpff (4 May only)	CEBRA

Biosecurity Research Steering Committee workshop
11 August 2017, Canberra

Name	Organisation
Matt Koval	Department of Agriculture
Kim Ritman	Department of Agriculture
Tim Chapman	Department of Agriculture
Wayne Terpstra	Department of Agriculture
David Ironside	Department of Agriculture
Alistair Davidson	Department of Agriculture
David Mackay	Department of Agriculture
Sam Wells	Department of Agriculture
Paul Pheloung	Department of Agriculture
Kate Mannion	Department of Agriculture
Karen Schneider	CEBRA
Andrew Robinson	CEBRA
Tom Kompas	CEBRA
Aaron Dodd	CEBRA

Workshop 1: Anticipate biosecurity risk. Prevent the entry of exotic pest and diseases
8 November 2017, Canberra

Name	Organisation
Lee Cale	Biosecurity Implementation Branch
Paul Pheloung	Biosecurity Implementation Branch
Callum Moggach	Biosecurity Implementation Branch
Tony Callan	Biosecurity Policy & Response
Greg Hood	Biosecurity Integrated Information System Analytics
JonathanTaylor	Animal Biosecurity
Geoff Grossel	Animal Biosecurity (Biologicals, Evaluations, Avian & Surveillance)
Sonia Gorgula	Animal Biosecurity (Aquatics & Marine Pests)

Sandra Cuthbert	Animal & Biological Import Assessments
Wendy Odgers	Plant Biosecurity
Susie Collins	Plant Health Policy
Leanne Herrick	Pathway Controls
David Mackay	Pathway Controls
Richard Cox	Analysis & Intelligence
Donna Hawkes	Corporate Strategy & Governance
Tony Arthur	ABARES
Sandra Parsons	ABARES
Zoltan Lukacs	ABARES
Andrew Robinson	CEBRA
Karen Schneider	CEBRA
Tom Kompas	CEBRA
Aaron Dodd	CEBRA
Edith Arndt	CEBRA

Workshop 2: Screen goods, conveyances and people at the border to detect non-compliance
28 March 2018, Canberra

Name	Organisation
Tony Arthur	ABARES
Callum Moggach	Biosecurity Policy and Implementation Division
Dale Bycroft	Biosecurity Operations Division
David Nehl	Service Delivery Division
Donna Hawkes	Corporate Strategy and Governance Division
Greg Hood	Biosecurity Policy and Implementation Division
Helen Walker	Biosecurity Animal Division
James Cracknell	Biosecurity Operations Division
Jessica Sibley	Biosecurity Plant Division
Lee Cale (intro only)	Biosecurity Policy and Implementation Division
Linda Jennings	Compliance Division
Mark Tuttle	Biosecurity Policy and Implementation Division
Mark Whattam	Biosecurity Plant Division
Nathan Jamieson	Biosecurity Animal Division
Paul Pheloung	Biosecurity Policy and Implementation Division
Rama Karri	Compliance Division
Richard Cox	Compliance Division
Rose Lenertz	Biosecurity Operations Division
Sindy Ramanadhan	Biosecurity Policy and Implementation Division
Teresa McMaugh	Compliance Division
Christine Reed	NZ MPI
Steve Hathaway	NZ MPI
Andrew Robinson	CEBRA
Edith Arndt	CEBRA
Steve Lane	CEBRA

Workshop 3: Prepare, Detect, Respond and/or Adapt (Commonwealth)
27 September 2018, Canberra

Name	Organisation
Karina Keast	Biosecurity Policy and Implementation
Tony Callan	Biosecurity Policy and Implementation
Vanessa Burgess	Biosecurity Policy and Implementation
Monica Finlayson	Biosecurity Policy and Implementation
Justine Gilbert	Biosecurity Policy and Implementation
Chris Clowes	Biosecurity Policy and Implementation
Brett Herbert	Biosecurity Animal
Sam Hamilton	Biosecurity Animal
Ariella Hayek	Office of CVO
Sarah Hilton	Biosecurity Plant
Martin Coates	Biosecurity Plant
Patricia Voigt	Biosecurity Plant
Melissa Dodd	Biosecurity Plant
Andre Mayne	Biosecurity Plant
Con Goletsos	Australian Chief Plant Protection Office
Linda Baker	Biosecurity Operations
Tony Arthur	ABARES
Paul Pheloung	Biosecurity Policy and Implementation
Callum Moggach	Biosecurity Policy and Implementation
Carina Moeller	Biosecurity Policy and Implementation
Edith Arndt	CEBRA

Workshop 4: Prepare, Detect, Respond and/or Adapt (States and territories)
20 November 2018, Canberra

Name	Jurisdiction/Organisation
Alison McInnes	Environment, Planning and Sustainable Development Directorate
Stephen Hughes	Environment, Planning and Sustainable Development Directorate
Alex Murray	NSW, Department of Primary Industries
Dianna Watkins	NSW, Department of Primary Industries
Sarah Corcoran	NT, Department of Primary Industry and Resources
Nancy La Monaca	QLD, Department of Agriculture and Fisheries
Sarah Goswami	QLD, Department of Agriculture and Fisheries
Cleopas Bamhare	SA, Biosecurity SA
Maria Salvatico	VIC, Department of Economic Development, Jobs, Transport and Resources
Mia Carbon	WA, Department of Primary Industries and Regional Development
Kathleen Plowman	Animal Health Australia
Greg Fraser	Plant Health Australia
Andy Sheppard	CSIRO
Veronica Blazely	Australian Department of the Environment & Energy
Tony Arthur	ABARES
Matt Koval	Department of Agriculture
Con Goletsos	Department of Agriculture
David Spencer	Department of Agriculture
Elyse Herrald-Woods	Department of Agriculture
Robyn Martin	Department of Agriculture
Sarah Hilton	Department of Agriculture
Tony Callan	Department of Agriculture

Callum Moggach	Department of Agriculture
Carina Moeller	Department of Agriculture
Aaron Dodd	CEBRA
Edith Arndt	CEBRA
Karen Schneider	CEBRA

Consultation meeting with New Zealand Ministry of Primary Industries
28 March 2019, Wellington

Name	Organisation
Christine Reed	Biosecurity New Zealand, MPI
Janet Chambers	Policy and Trade Branch, MPI
Elaine Taylor	Biosecurity New Zealand, MPI
Claudia Recker	Compliance and Governance Branch, MPI

Appendix 1: Consultation schedule

Appendix 2: Synthesise the results of rubrics

Using rubrics to elicit qualitative evidence from stakeholders and experts can generate significant quantities of data in the form of ratings made by many participants across multiple evaluation criteria. Synthesising or combining these data points into an overall rating is an essential step to using the data for evaluative purposes. A method for analysing the data proposed in this report is described below.

As discussed earlier, rubrics have two key components – evaluation criteria and performance standards. The performance standard component is a 'categorical' variable, because it has a measurement scale consisting of a set of categories. In the examples provided in this report these are 'advanced, 'good', 'developing' and 'inadequate'.

The use of categorical scales is widespread in the social sciences and frequently used to measure attitudes and opinions. If categorical variables only have two categories, for example success/failure or high/low, they are called binary variables. The performance standards proposed in the rubrics in this project consist of four categories and are considered *ordinal variables*. Ordinal variables are not strictly qualitative because they have a quantitative feature – an underlying order of magnitude, meaning that each category has a greater or smaller magnitude of the characteristic than another category. For ordinal variables, the distance between categories (for example between excellent and good, or between good and adequate) is not defined. The order of magnitude often leads analysts to assign numerical scores to the categories or to assume an underlying continuous distribution (Agresti, 2013).

Assigning numerical scores to categories and then performing statistical operations such as averaging them requires an assumption to be made about the distance between categories, for example, that the difference between 'advanced' and 'inadequate' is three times greater than the difference between 'advanced' and 'good'. In this project we assume equal distances between performance standards and clearly define the meaning of the different performance standards.

Statistical methods and models can be applied to categorical data, although cautiously. A basic analysis of rubric data uses simple counting of scores, as shown in Table A2.1. It involves calculating the total scores given by assessors across the different evaluation criteria (columns) in the rubric and presenting them as a proportion of the maximum total score that could have been achieved by each criterion and as a percentage. To investigate how scoring varies among assessors the same could be done across rows.

Table A2. 1: Summarising the results of the performance assessment using rubrics

Assessor	EC1	EC 2	EC3	EC4	EC5	EC6	EC7	EC8	EC9	EC10	Median
1	4	3	1	4	3	4	3	4	1	2	
2	4	3	4	4	3	2	4	4	4	4	
3	4	4	2	4	3	4	4	4	3	4	
4	4	4	4	4	3	4	4	4	1	4	
5	4	2	2	4	3	4	4	2	4	4	
6	4	4	2	4	3	4	4	3	4	4	
7	4	4	2	4	4	2	4	2	4	3	
8	4	4	2	4	4	4	4	4	4	4	
9	4	4	1	4	3	4	4	4	4	3	
10	2	2	2	4	3	4	4	4	2	3	
Total	38/40	34/40	22/40	40/40	32/40	36/40	39/40	35/40	31/40	35/40	
%	95	85	55	100	80	90	98	88	78	88	**88**

Note: This table is an example only and shows arbitrarily assigned ratings for ten assessors across ten evaluation criteria (EC1-10). The last column contains the proportion of total scores of individual ratings.

Aggregation of scores across individual evaluation criteria is the next step as the overall performance of the subject of the rubric (for example, the effectiveness of prevent activities, or the resilience of the biosecurity system) is our main interest. Evaluation criteria can be treated equally or weighted differently if one or more are perceived to have more influence on the overall performance. If individual criteria are weighted differently, weighted scores are calculated prior to aggregation.

In order to reduce the influence of outliers on the final score we propose to use the median of the scores to aggregate across evaluation criteria. The presence of outliers is possible because the data are based on personal judgements made by different assessors. The median is the middle value of a range of values arranged in ascending or descending order. It is more robust and useful for small sample sizes than the mean as it is less affected by outliers and skewed data (ABS, 2019).

To determine an overall rating for the subject of a rubric the calculated median score is compared with a grading system that specifies the cut off points between final ratings (Table A2.2).

Table A2. 2: Grading system for determining the overall performance rating

Overall performance rating	Median score
Excellent	>0.8
Good	0.65 – 0.8
Adequate	0.5 – 0.65
Poor	<0.5

In the example in Table A2.1 the median unweighted score across all ten evaluation criteria is 88%. This means that the overall performance rating for the subject of this example rubric would be ‘excellent’ as the mean proportion is above the lower cut off point for this performance rating (Table A2.2).

The development of a grading system that synthesises the evaluation results into an overall performance rating is best performed by the evaluation team and should reflect targets or expectations of performance that have been agreed with stakeholders.

Analysis of rubric results using the method described above can determine an overall performance rating against a key evaluation question, as well as for individual evaluation criteria. Plotting Table A2.1 as a heat map, using darker shades for higher scores, can highlight visually any patterns in the results. In Table A2.1, for example, it would highlight the low scores for EC3 and might indicate that this is a potential area of risk that requires management.

The same approach to aggregation can be used to synthesise the results of multiple rubrics – the results from different rubrics can be aggregated by calculating the median of the rubric medians. If weightings are applied, weighted scores would be determined prior to calculating the final median.