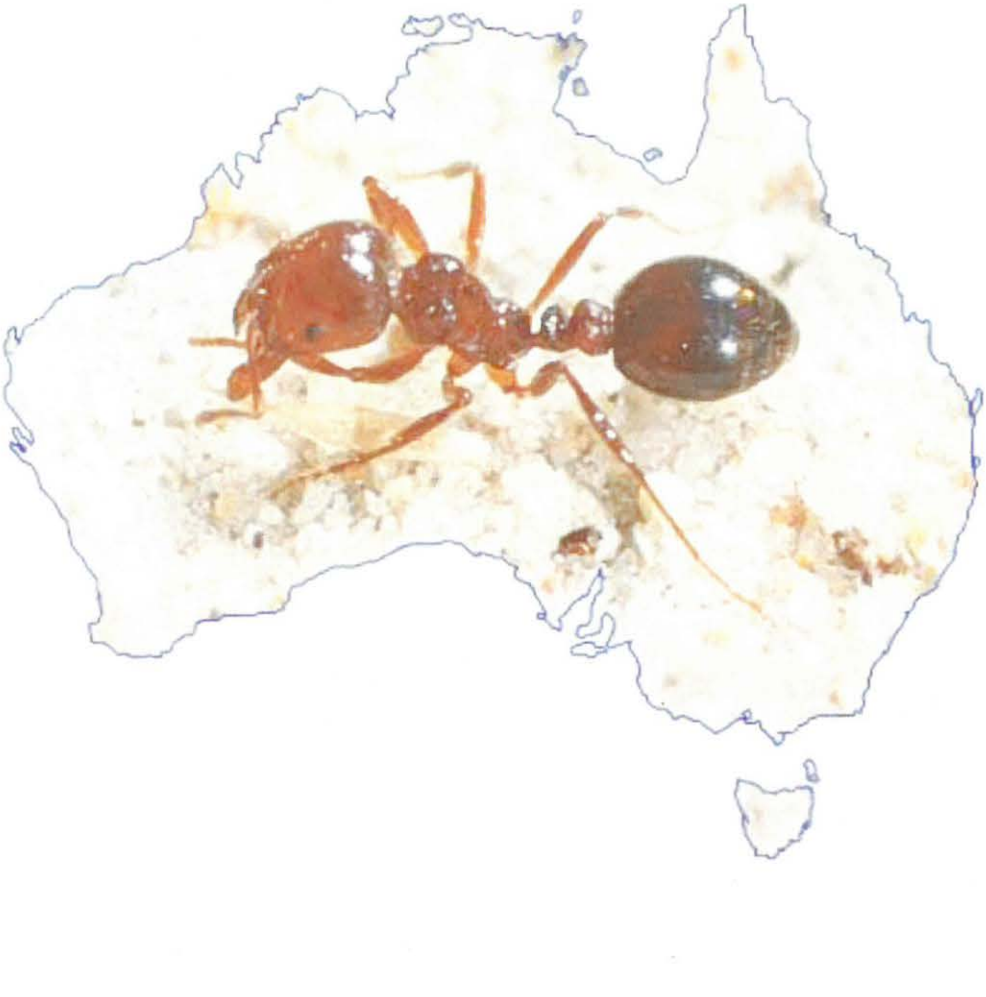
Report of the Independent Review Panel

Independent Review of the National Red Imported Fire Ant Eradication Program



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Acknowledgements

The panel would like to acknowledge the generous contribution of time and supporting information from all staff in the Biosecurity Queensland Control Centre located at Moggill, Brisbane and Richlands, Brisbane. The Director, Ms Sarah Corcoran and all the program managers and staff involved in the eradication program have been most helpful in responding to all information requests from the panel members throughout the review. They have also shared first-hand knowledge and provided the panel with practical demonstrations of treatment and surveillance practices, community engagement activities and scientific research to support the eradication program.

The panel has also noted the extensive assistance that the Biosecurity Queensland Control Centre has provided to other State biosecurity agencies involved in responses to Red Imported Fire Ants and other tramp ant incursions. This reflects the significant national investment made in the eradication program since the original detections in 2001 and highlights the need to preserve this expertise well into the future to respond to the ongoing threat to Australia posed by tramp ants.

The panel also acknowledges the work of Daniel Spring and Luke Croft from the School of Biological Sciences at Monash University who undertook simulation modelling of fire ant eradication to support the review.

Of particular note, the panel is indebted to Ms Sharon Janssen, Principal Policy Officer, Biosecurity Queensland Control Centre, who has provided the secretariat for the review and done an outstanding job in supporting the Chair and all panel members. This has included the provision of all supporting documentation from previous reviews, scientific papers, coordination of panel meetings and managing deadlines for panel members in the preparation of the report. Ms Janssen has been assisted by Ms Jenny Logan who has taken care of travel arrangements and other vital administrative support to the panel.

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Executive Summary

In December 2014, the Agricultural Ministers' Forum agreed to commission and fund an independent review of the National Red Imported Fire Ant Eradication Program (SEQ Program), outlining options for achieving eradication or long-term containment of red imported fire ant (RIFA) in South East Queensland (SEQ).

Previous reviews of the SEQ Program have consistently shown that RIFA is a pest of national significance and that eradication remains technically feasible, efficient and cost beneficial. The impacts in Australia have been estimated to be between AU$5.3 billion and AU$45 billion over 20 to 70 years (Hafi et al. 2014 and Antony et al. 2009). The SEQ Program has effectively prevented these impacts from being realised in Australia.

An Independent Review Panel was appointed in 2015 to review the current operations of the SEQ Program, provide advice on the success of the program's efforts to delimit the SEQ infestation and provide advice on strategies for the future direction of the SEQ Program. The membership of the Independent Review is detailed below:

Bill Magee	Independent Consultant	Chair
Dr David Oi	Research Entomologist, United States Department of Agriculture (USDA)	RIFA Expert
John Parkes	Independent Consultant, Kurahaupo Consulting	Eradication Expert
Dr David Adamson	Senior Research Officer, School of Economics, The University of Queensland (UQ)	Agricultural Economics Expert
Nin Hyne	Director, Department of Agriculture	Australian Department of Agriculture representatives
Deborah Langford	Assistant Secretary, Biosecurity Policy	
Royce Holtkamp	Strategy Leader Invasive Species, Biosecurity NSW	NSW Department of Primary Industries representative
Prof Simon Lawson	Associate Professor in Forest Health, University of the Sunshine Coast	Queensland Government Representative

The panel has examined the operational, scientific and program management elements of the SEQ Program including field visits in 2015 to view firsthand the treatment processes, surveillance activities and community engagement elements of the eradication program. The interaction between the panel members and specialist staff in the SEQ Program has consistently revealed a highly professional and intelligence led approach to the challenging task of eradicating RIFA.

The first assignment for the panel was to provide advice on the success of the program's efforts to delimit the SEQ infestation and provide preliminary advice on the future direction of the program. These findings are summarised below and are the subject of more detailed discussion in the report.

- **Delimitation:** The SEQ Program has completed the surveillance of areas adjacent to the recorded distribution of RIFA in 2012 to delimit the extent of the infestation. Evidence of delimitation was provided by Monash University which estimated that there is a 99.9% probability that the invasion is contained within the boundary corresponding with the area that has had remote sensing completed (Keith & Spring 2015).

- **Remote sensing:** Remote sensing has contributed to the delimitation of the SEQ RIFA infestation. The development of the remote sensing system, including the supporting technological innovation, is ground-breaking technology.

- **Containment:** The area of infestation has been contained to SEQ and no colonies have been reported outside the initial 30 km boundary set as a trigger for reconsideration of the plan to eradicate RIFA in the approved National Red Imported Fire Ant Eradication Response Plan 2013–18 (Response Plan).

- **Suppression:** A marginal increase in the area of infestation within the core has been reported. However, the panel considered that this was largely due to the reallocation of SEQ Program resources towards the delimitation work and that the marginal increase in area within the core does not affect the feasibility of eradication.

- **National interest to eradicate:** The Review Panel considered that it is in the national interest to eradicate RIFA. In arriving at this conclusion, the Review Panel noted that the eradication of RIFA meets the national interest criteria aimed at reducing potential environmental, social, economic and health impacts.

- **Technical feasibility to eradicate:** The eradication of RIFA remains technically feasible and the SEQ Program has the necessary tools and skills to achieve this, provided that the tools are applied correctly in a timely way across the area infested and with sufficient intensity to remove the last colonies.

- **Benefit-Cost Analysis**: The Review Panel considered that with an expected benefit-cost ratio return of $25:1 (Kompas & Che 2001), the on-going expenditure to eradicate RIFA is justified. The Review Panel believes that this stated value actually underestimates the true national benefits from the eradication of RIFA.

Based on the outcomes from Part 1 of the review that eradication is technically feasible, in the national interest and cost beneficial, the panel commissioned Monash University to model scenarios to determine the optimal treatment and surveillance budget to achieve eradication in a ten-year timeframe. The outcomes from the modelling are summarised below.

- **Current budget**: the current budget provided to the SEQ Program is insufficient to achieve eradication.
- **Future treatment and surveillance budget**: a treatment and surveillance budget of $24M will provide a 95% probability that eradication will be achieved, in 10 years. By increasing the treatment and surveillance budget to $24M, the SEQ Program will be able to increase the current treatment area significantly (approximately double the current area).
- **Constant budget**: a constant budget (long-term budget commitment) is needed to introduce efficiencies and optimise plans to achieve eradication.

TOTAL BUDGET FORECAST

In addition to the modelling work, which focused on treatment and surveillance activities, the panel considered the overall budget needed to achieve eradication. The Panel estimates the overall cost of the Program to be **$38M** per annum for up to 10 years, comprised of: **$24M** for treatment and surveillance activities; and **$14M** for other critical eradication activities undertaken by the program.

The figure of **$24M** for treatment and surveillance includes the costs for: wages, bait, aircraft hire (for aerial treatment), all-terrain vehicles, direct nest injection, vehicles for field staff, fuel and estimated remote sensing surveillance costs including cameras, manual analysis, aircraft, and cost of ground follow up.

The figure of **$14M** for other eradication activities includes the costs for: community engagement; science and research and development; compliance/movement controls; business support; accommodation and site infrastructure; policy and legislation; information and spatial services; and increased number of odour detection dogs.

Wider benefits

At all times the panel has been mindful that since 2001, the work of the SEQ Program has represented a considerable investment by cost shared partners. The return on this investment for the nation is evident from the advances made in treatment technologies, remote sensing surveillance, community engagement and most importantly building national capacity to respond to other RIFA and tramp ant incursions in Australia. New technologies and innovative methodologies have delivered significant positive impacts for the SEQ Program and other national biosecurity programs, which also have the potential for international benefits. Consequently, substantial and practical returns on investment for the cost-share partners have been gained, in addition to the SEQ Program objectives.

Secure funding window

One of the greatest challenges of this long-term eradication program has been the absence of a secure funding window which has constrained the SEQ program in the areas of long-term planning, achieving cost efficiencies in the purchase of inputs and difficulties in retaining specialist staff. The panel has noted the importance of a clearly agreed schedule of funding over consecutive years to ensure a sustainable eradication program and to enable continuity of the staff and expertise needed for success.

Permanent governance body

In order to preserve the accrued knowledge, scientific skills and expertise which has been developed since 2001, the panel has recommended that AGMIN consider the establishment of a permanent governance body to oversight the program implementation and preserve the capacity of government to respond to future tramp ant threats.

Impacts

The program has so far prevented many of the impacts which are evident in other countries where RIFA has established. In the absence of an adequately funded and effective eradication program, the impacts of RIFA will surpass the combined effects of many of the pests we currently regard as Australia's worst invasive animals (rabbits, cane toads, foxes, camels, wild dogs and feral cats – which cost Australia an estimated $964M each year in 2015 values (McLeod 2004).

United States experience

In the United States, RIFA can occur in very large densities, around 60 colonies per hectare. (Some authors prefer to describe it as mounds per hectare. For example Barr (2002) cites 506 mounds per hectare). Treatment and damage costs in 1998 in Texas alone were $US581M (Lard et al. 2001). In this situation, residents cannot use their backyards, or their local parks, or play sports. In the United States, there have been at least 85 and up to 100 deaths from RIFA since they first became established there. Based on information from the United States, if we are not successful in eradication in Australia, people (and our healthcare system) will bear the cost of about 140,000 medical consultations and 3,000 anaphylactic reactions, estimated each year (Solley et al. 2002).

Conclusion

The panel has concluded that there is only a small window of opportunity left to eradicate RIFA and that this review sets out a compelling case for unified national action to fund the continuation of the eradication program in South East Queensland. The Port of Brisbane and the 2006 Yarwun incursion eradications have for the first time demonstrated the effectiveness of the insect growth regulator (IGR) baiting and direct nest injection techniques in an eradication program for RIFA. The on-ground application of these treatments in the SEQ Program has now provided practical evidence of the treatment strategy's efficacy. The proven efficacy of these tools, combined with the modelling results, are key factors underpinning the Panel's recommendation that eradication remains technically feasible. The attributes of RIFA as an invasive pest combined with the devastating potential impacts on agriculture, the environment, human health and social amenity support the case for decisive action now.

Summary of Recommendations

A summarised list of key recommendations is provided below:

- The panel considers that it is still technically feasible and in the national interest to eradicate RIFA and recommends the continuation of the eradication program.
- The panel also notes that there is only a small window of opportunity left to eradicate RIFA.
- The panel considers that to achieve eradication, an overall cost of the SEQ Program would be approximately $38 million per annum for up to 10 years comprised of:
    - $24 million for treatment and surveillance activities and surveillance activities (inclusive of Remote Sensing Surveillance (RSS) operations); and
    - $14 million for other critical eradication activities undertaken by the SEQ Program.
- The panel considers that the value of the Monash Modelling is to estimate a quantum of funding required for the SEQ Program to achieve eradication and recommends that the SEQ Program develop the specific treatment and surveillance actions (what, where and when) to be implemented as the part of the development of a new response plan.
- The panel considers that the SEQ Program should invest in updated remote sensing technologies.
- The panel considers that additional investment in odour detection dog surveillance will be required to help validate RSS and declare eradication/proof of freedom. The panel recommends that the detection dog surveillance unit be increased to 22 dogs over the next three years.
- The panel recommends that the SEQ Program tests and validates the effectiveness of the RIFA identification kit in Australia.
- The panel notes that monitoring the development of experimental water resistant baits may eventually yield further improvements to RIFA treatment.
- The panel recommends that the SEQ Program investigate bait application via Unmanned Aerial Vehicles (UAVs), when the technology becomes available and is cost effective.
- The panel recommends that the SEQ Program have access to Next Generation Sequencing (NGS) equipment, as it would significantly expand the positive impact that the genetics research and application has had on the success of the program.
- The panel recommends that the permanent capacity of the program to access and use technological advances in the field of genetics be increased.

- The panel recommends that fipronil (for direct nest injections) and pyriproxyfen (for baits) should remain the focus of the program's treatment practices for the foreseeable future. However, it would be prudent to keep a watching brief on new chemicals as they become available and evaluate the efficiency of using fast-acting baits instead of fipronil injections.

- The panel recommends that the SEQ Program monitor developments in the use of parasitic flies and pathogens to control RIFA, but suggests that any serious consideration of their use in Australia would only be necessary should eradication fail and if the program were to then transition to management (or aggressive containment).

- The panel recommends that the SEQ Program maintain a watching brief on further developments with potential biopesticides, although again this is a potential control methodology that may need to be more seriously considered only should it prove effective in the field in the United States and eradications fail in Australia.

- The panel recommends that the program seek wider engagement with Universities and seek to participate in appropriate research programs and projects, for example engaging PhD students to work on specific projects, or providing data and/or advice to collaborators.

- The panel considers community engagement activities should be increased and coordinated with the proposed increased treatment operations, where community engagement is implemented just prior to scheduled treatments in an area to help delineate local infestations for treatment (as is currently done).

- The panel recommends that community engagement should be maintained in high risk areas for new incursions and around the edge of the infestation.

- The panel recommends that the SEQ Program has the capacity to increase the number of compliance officers to ensure there is coverage of the whole infested area.

- The panel recommends that the SEQ Program's Information Technology (IT) systems need to be maintained and improved to enable real-time reporting.

- The panel recommends that, subject to acceptance of the Review Panel's report, cost sharing partners sign off on a whole of life response plan.

- The panel recommends that AGMIN consider the establishment of a permanent governance body to oversight program implementation and preserve the capacity of government to respond to tramp ant threats.

- The panel recommends that alternative funding options need to be further considered and scoped to work toward a more appropriate funding balance between risk creators and risk beneficiaries (specific and general) for the SEQ Program.

  This should include consideration of general and specific risk beneficiaries (local governments, private landholders) as well as risk creating entities (utility companies, land development interests).

- The panel recommends that the triggers, which would necessitate a review by Tramp Ant Consultative Committee (TACC) to determine if the risk profile had changed to such an extent that National Management Group (NMG) should be notified of a threat to the program objectives, should be high level, triggering an activation only when the Program's eradication objectives are compromised.
- The panel recommends two review triggers for the future eradication plan:
  - Trigger 1 – New infestation discovered that is beyond the capacity of the SEQ Program to treat. For example, this might include a large number of multiple infestations detected in a local government area that has not previously been infested.
  - Trigger 2 – There is a significant reduction in the efficacy of the baits used by the Program, as demonstrated by Science monitoring trials, and there are no alternative effective baits available.
- The panel recommends a process for declaring successful eradication including repeat surveys and spatially explicit models, noting the SEQ Program has the data collection systems available to validate success.

1. Background

1a. History of the SEQ Program 2010-2016

1a. i Summary

Solenopsis invicta, commonly known as the red imported fire ant (RIFA), is regarded as one of the world's worst invasive ant species. It is native to the South American countries of Brazil, Paraguay, Uruguay and Argentina (Tschinkel 2006), but has spread to and become an established pest in the southern United States, Taiwan, mainland China, Puerto Rico, the Virgin Islands, the Bahamas, Antigua, Trinidad, the Turks and Caicos Islands, the Cayman Islands, Hong Kong and Malaysia. There are also reports of infestations in Macau and the Philippines. RIFA remains under eradication in Australia.

The impacts of RIFA on agriculture, infrastructure, the environment, social amenity and human and animal health are well documented, with the United States Department of Agriculture (USDA) estimating the cost at $US7 billion per annum. In addition, in the United States alone, 14 million people are stung annually and there have been more than 85 reported deaths from anaphylactic shock (Rhoades et al. 1989; deShazo et al. 1999, 2004). Worldwide figures are difficult to estimate due to poor reporting in many infested countries.

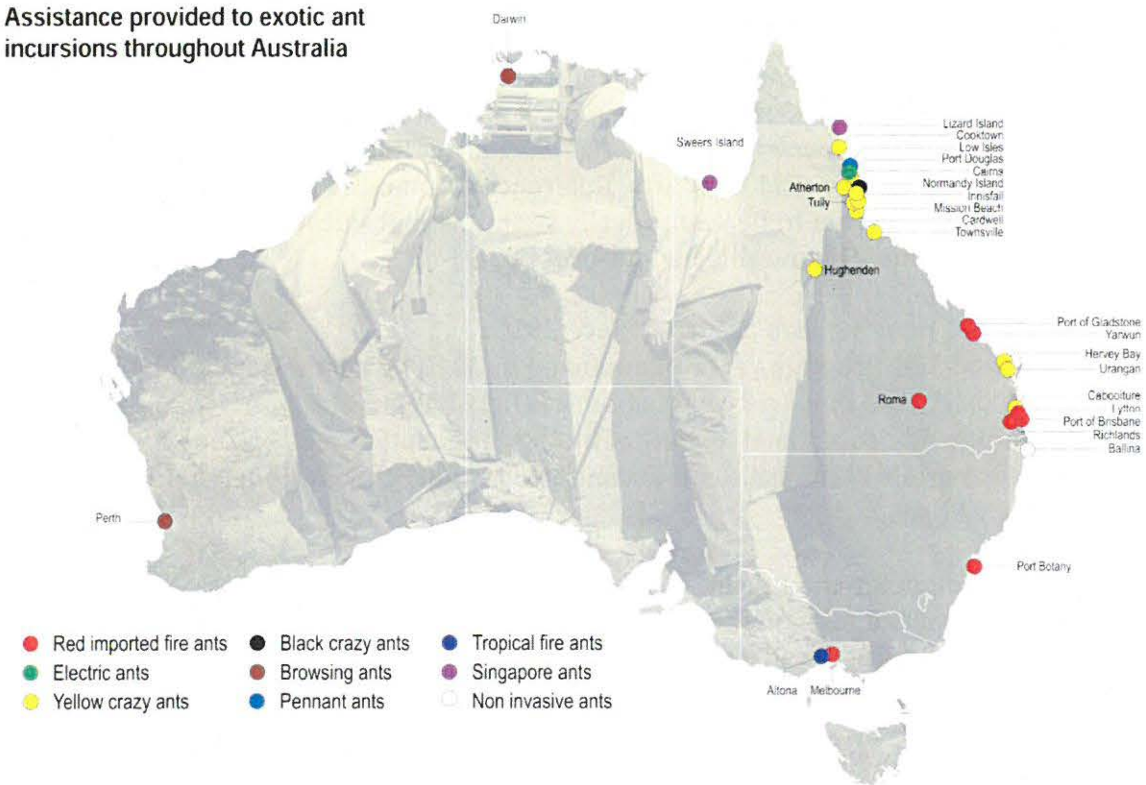
Over the last 20 years, RIFA are known to have entered Australia at least 16 times. Of these known entry events, RIFA was not immediately detected on six occasions resulting in establishment at the Port of Brisbane (2001), the south western suburbs of Brisbane (2001), Yarwun (2006 and 2013), Port Botany (2014) and the Brisbane Airport (2015). RIFA has been successfully eradicated from the Port of Brisbane (2001) and the Yarwun (2006) infestations. It is currently under eradication in the Brisbane area and Yarwun (2013), which has been shown by genetic analysis to be completely unrelated to the earlier Yarwun infestation. The Port Botany (2014) incursion was detected at an early stage and is believed to consist of only a single nest. This infestation has been treated and surveillance is ongoing.

RIFA did not establish as a result of three post-quarantine detections in Queensland at the Port of Brisbane (2004), Lytton (2009) and Roma (2011) as the infestations were detected and eradicated prior to establishment. The detection at Roma was on a shipment of goods bound for Western Australia.

The remaining seven entry events consist of known quarantine intercepts at the Port of Brisbane (2009 and 2014), Darwin (2007), Melbourne (2006 and 2015), South Australia (2009), and Western Australia (2011).

RIFA are the most well-known of all tramp ants, but there are many other ant species moving in international trade. *Figure 1: Assistance provided to exotic ant incursions throughout Australia* shows the incursions for which the SEQ Program has provided assistance.

Figure 1: Assistance provided to exotic ant incursions throughout Australia



The National Red Imported Fire Ant Eradication Program (SEQ Program) is a national cost-shared eradication program which began in 2001 being run by Biosecurity Queensland (BQ) in the Queensland Department of Agriculture and Fisheries (DAF). The budget for the SEQ Program has been in excess of $18 million per annum since 2013–14. Funding for the SEQ Program is provided by the Commonwealth of Australia and all States and Territories under a National Environmental Biosecurity Response Agreement (NEBRA)-like arrangement. However, the Western Australian Government has not contributed funding since 2013–14.

Climate modelling conducted by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) using CLIMEX for the SEQ Program has shown that RIFA has the potential to inhabit most of the major coastal areas of Australia, and extensive areas of the tropical north. Vast areas of the continent's natural environment, including world heritage areas and national parks, are prone to RIFA invasion (Sutherst & Maywald 2005).

Each of the three benefit-cost analyses commissioned to review the SEQ Program have stated that their estimated benefit-cost ratios are conservative. Despite this underestimation, the expected return for each dollar allocated to the SEQ Program is expected to generate between $17 and $496 in benefits. Consequently, the continued funding of the SEQ Program is justified and as discussed in the recent white paper on agricultural productivity, the SEQ Program has delivered national benefits (Commonweath of Australia 2015b).

Since 2002, the SEQ Program has undergone 13 external reviews in addition to a process of regular review by the Tramp Ant Consultative Committee (TACC). These comprise six scientific reviews, three operational reviews, one efficiency audit, one financial audit and a movement control audit conducted by the Interstate Plant Health Regulation Working Group. There has also been a Senate Inquiry in 2004: *Turning back the tide – the invasive species challenge* (conducted by Environment, Communications, Information Technology and the Arts References Committee). All of these reviews showed the SEQ Program to be scientifically sound with eradication technically feasible and with an extremely favourable benefit-cost ratio.

Three scientific reviews have occurred since 2010:
- A whole of SEQ Program review conducted in 2010 by a Panel chaired by Professor Rick Roush of the University of Melbourne (Roush review);
- A Scientific Advisory Panel Review of molecular genetics in 2011; and
- A SEQ Program Technical Review conducted in 2012 by an Independent Scientific Advisory Panel.

Immediately following the release of the Roush review report in January 2010, the SEQ Program commenced planning to address science gaps and operational issues identified in the report and recruited additional staff into the science area. Areas addressed included: assessing the efficacy of the SEQ Program broadcast bait treatments; RIFA spread modelling; assessment of the value of passive surveillance (voluntary searching by the public) to the SEQ Program; remote sensing diagnostics; refinement of the RIFA Habitat Model; and development of the Disturbance Model.

The SEQ Program provided data to modellers on dispersal patterns and efficacy of treatment and surveillance, dating back to the start of the SEQ Program in 2001. This, together with the incorporation of remote sensing into the model, resulted in improvements to modelling of spread patterns, and allowed further refinement of the balance between search and treatment options (Spring 2010; Spring et al. 2011; Rasmussen & Hamilton 2012).

Two workshops on remote sensing were held: one in February 2012 and the second in December 2012. In addition to TACC members and SEQ Program staff, organisations represented included the Centre for Applications in Natural Resource Mathematics, The University of Queensland (UQ); Australian Centre for Field Robotics, University of Sydney; Australian Centre of Excellence for Risk Analysis, University of New England (UNE); Australian National University (ANU); Monash University; CSIRO; Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES), National Information and Communication Technology Australia (NICTA), and Outline Global.

These workshops found that remote sensing technology can detect RIFA at levels that would support delimitation and concluded that the overall surveillance package (including remote sensing and community engagement) would enable the SEQ Program to know within three years whether the infestation has been delimited or not. Based on the findings from these workshops, the *Fire Ant Future Program for 2012-2015* was endorsed by TACC and National Management Group (NMG).

The SEQ Program collaborated with the United States in the development of the camera systems and in capturing mound imagery for training of the detection algorithm. Development and refinement of the algorithm was a joint effort between the Australian Centre for Field Robotics and BQ.

Research was conducted on a variety of subjects based on the recommendations of the reviews. This included a series of field trials between 2010 and 2012 with indoxacarb to determine its efficacy under Australian conditions and compare results with overseas trial results. However, results were so variable that its use by the SEQ Program was discontinued (Biosecurity Queensland Control Centre (BQCC) unpublished data). Research also showed that baits used for RIFA had little adverse impact on native ant fauna and that native ants remained to provide some biological resistance to RIFA (McNaught et al. 2014). An investigation into the persistence of RIFA in market gardens was also conducted over the period January to June 2010, suggesting that the combination of frequent crop watering, soil disturbance and constant pesticide use causes broadcast baiting to be less effective, and that direct nest injections should be applied to nests found on these properties (BQCC unpublished data).

An updated benefit-cost analysis for the control and potential eradication of RIFA was conducted, including analysis to determine key areas (e.g. regions) where containment and/or suppression is likely to be most cost effective (Hafi et al. 2014).

The Roush review also recommended that to protect the cost-sharing partners' investment in the eradication of RIFA, a cost-effective containment strategy to suppress RIFA populations and control the potential human-mediated movement of RIFA for 18–24 months be developed and implemented. It also recommended that key research be completed to demonstrate the successful use of remote sensing for surveillance, and improved control efficacy of pesticide treatments. After that time, another review should be undertaken to determine feasibility of eradication in light of any new advances. This strategy was incorporated into the Response Plan and its efficacy and the success of the associated research is the subject of the current review.

1a. ii Funding

The SEQ Program has now been funded for 14 years. This timeframe rapidly becomes a focus for those external to the process, and logically questions about the on-going nature of the program will be raised. As the Review Panel will argue, this timeframe is in part due to: the perception that RIFA were controlled; the shortfall between the budget required to achieve eradication and funds received; the reallocation of funds away from eradication to delimitation; the temporary removal of resources (e.g. odour detection dogs, staff) from the SEQ Program to other RIFA and tramp ant eradication campaigns; and the time taken to learn about RIFA and build a suite of management tools and resources required to eradicate RIFA.

Biosecurity invasions can be slow moving events; for example, cane toads were introduced in 1935 but it took until 2009 before the first cane toad was detected in Western Australia. Intergenerational problems can be difficult to fund as they face the dual problems associated with discounted future benefits conflicting with immediate opportunity costs of funding issues impacting on society now. For example, why would a state allocate funding to control RIFA in another State when there is an immediate need to provide increased funding for some other public service? One is a current political issue and one is a future problem that someone else will have to deal with.

An exotic biosecurity event can be a negative externality derived from engaging in international trade or a natural consequence from migrating exotic species. In the case of international trade, often, but not always, the individual/s who benefited from importing the good are not the same group that is adversely impacted by the externality. The provision of public goods (i.e. public funding to eradicate biosecurity events) is used to correct the market failure derived from the negative externalities associated with international trade. As this report will argue, society as a whole (its population, private and public return on capital investments, and its ecosystem) benefits from not having exotic species like RIFA present and in particular cases free riders will emerge and benefit from public funding. Consequently, there will always be a tipping point at which the continuing funding of public goods to correct market failure exceeds the public expectations, making on-going policy justification difficult.

Funding justification becomes hampered by the choice of discount rate used to evaluate returns on investment and when inequality in the beneficiaries exists. As the discount rate increases, projects with delayed benefits are inequitably penalised when compared to projects that have immediate returns. When different groups benefit at different times (i.e. one group benefiting now and other groups will only benefit in the future); or there is an inequitable share of total quantum of benefits received by each group, questions of individual rather than national benefits are raised. Biosecurity funding must deal with both of these issues.

The role of the Review Panel was to firstly identify if RIFA could be eradicated in SEQ, determine the limitations and binding constraints that may hinder eradication and recommend options for eradicating RIFA in SEQ.

During the review, the panel noted that the economic story was incomplete and has extended its inquiry to explore the wider national benefits from the eradication of RIFA in SEQ. The SEQ Program has delivered real and tangible economic benefits to Australia by developing techniques, technologies, training, and research findings that have been instrumental in helping:

- Eradicate RIFA in the Port of Brisbane, the first incursion in Yarwun (detected in 2006) and the current eradication program in Yarwun (detected in 2013);
- The NSW Government in its RIFA eradication campaign in Port Botany;
- Eradicate electric ants, *Wasmannia auropunctata*;
- The Northern Territory Government deal with browsing ants, *Lepisiota frauenfeldi*; and
- Prevent RIFA from entering other states.

Apart from the Port of Brisbane eradication, these national benefits are outside the initial remit of SEQ Program. These national benefits have arisen from research spill-overs and having a core group of professionals who have the skills and expertise that have reduced the program costs and increased the probability of eradicating other tramp ant species throughout Australia (see *Figure 3: Spillover benefits to other eradication campaigns*). If the SEQ Program was to be dismantled these skills are likely to be lost, which may increase future national biosecurity costs when another tramp ant species biosecurity event occurs.

On examining these national benefits, the Review Panel has the belief that RIFA eradication is possible in SEQ. This finding has guided the second stage of the review which is designed to increase the effectiveness of the eradication program by: examining the current obstacles facing the eradication campaign; examining if there are positive modifications that would enhance the design and implementation of the current eradication strategy; providing incentives to ensure that individuals do not either accidently or deliberately contribute to the dispersal of RIRA; and facilitating efficiencies to reduce the time taken to successfully eradicate RIFA in Australia.

During the review, the panel has noted that the failure to achieve eradication is not due to the science, but rather due to missed opportunities: the limitations of short-term funding, and a reallocation of funding from eradication to delimitation in recent years in accordance with the Response Plan.

The current annual funding model used to support the SEQ Program has introduced financial inefficiencies and operational constraints into the eradication campaign.

A lack of a secure funding window prevents the SEQ Program from engaging in long-term planning, placing transaction costs on the program. Presently, around 63% of budget is allocated to treatment and surveillance activities and around 37% on other eradication activities (community engagement, customer service, compliance and movement controls, directorate and management, accommodation and site infrastructure, odour detection dogs, policy, science, research and development, information and communication technologies management (IT), spatial information management, human resources, finance, workplace health and safety, administration and declaration of proof of freedom). Efficiency dividends could be achieved as with guaranteed multi-year funding and would:

- Allow the SEQ Program to purchase inputs at least cost (e.g. purchase of bait);
- Provide the SEQ Program with the ability to negotiate better terms on fixed annual costs (e.g. accommodation rates);
- Reduce transaction costs associated with staff employment. The annual funding model does not provide staff with certainty about their employment window. This uncertainty about short term prospects has resulted in the loss of well-trained staff. Consequently, with a secure funding window, it is anticipated that the retention of staff may significantly reduce the costs of hiring and training new staff; and
- Provide the opportunity to implement long-term eradication strategies. The annual funding cycle has in some cases prevented follow-up control, allowing RIFA to re-establish in areas that may have been cleared if the SEQ Program had funding certainty. (See *Table 1: SEQ Program Funding*).

A changing budget forces the SEQ Program into reprioritising its strategies and abilities to eradicate RIFA. This process leads to resource waste and increases the time to eradicate RIFA as the funds no longer match the eradication campaign. While funding is limited and has an opportunity cost, if the national goal is to eradicate RIFA, the difference between funds requested and funds provided prevents the SEQ Program from maximising the eradication benefits from past expenditure.

Additional benefits would be gained from a known multi-year budget if the SEQ Program had the ability to introduce flexibility with the way expenditure occurs. By providing the SEQ Program flexibility to forward spend or conserve funds on a given calendar year, it then has the opportunity to take advantage of opportunities when RIFA are climatically vulnerable (i.e. years of low spread), or quickly eradicate new areas of infestation if RIFA are rapidly spread by flood events in the SEQ corner.

While prior review recommendations were helpful in determining if RIFA had been contained, no additional funding was provided to examine the delimiting question. Subsequently, funding earmarked for eradication was reallocated towards the delimiting program. This reallocation of funding has allowed RIFA to re-establish in areas it had been eradicated.

Table 1: SEQ Program Funding

Year	Cost-shared funding expended	Supplementary QLD funding	Total expenditure
2001-02	27,878,000		27,878,000
2002-03	37,259,290		37,259,290
2003-04	41,905,680		41,905,680
2004-05	32,273,507		32,273,507
2005-06	23,270,729		23,270,729
2006-07	12,757,033		12,757,033
2007-08	12,609,660		12,609,660
2008-09	12,240,526		12,240,526
2009-10	14,465,546		14,465,546
2010-11	14,688,843	5,908,225	20,597,068
2011-12	15,628,117	5,944,249	21,572,366
2012-13	15,433,708	2,818,816	18,252,524
2013-14	14,923,492	3,000,000	17,923,492
2014-15	14,363,134	3,000,000	17,363,134
2015-16	15,567,000	3,000,000	18,567,000[1]
TOTAL	**$305,264,265**	**$23,671,290**	**$328,935,555**

There is an opportunity cost imposed on the SEQ Program when it provides support to NSW, NT and other eradication campaigns. The temporary transfer of staff, equipment and dogs to other areas reduces the effectiveness of the SEQ Program. While current services are charged at 'cost[2]', this process is removing critical capital and skills from the SEQ Program. It must be noted that if there is increasing pressure on the SEQ Program to provide these resources (time, labour and capital) that some form of compensation (i.e. funds greater than costs to engage in programs outside their remit and/or an increase in the expected time to eradicate RIFA in SEQ) should be considered.

1a. iii Has the infestation been contained and suppressed?

Containment

Yes. The sum of surveillance efforts strongly suggests only a few RIFA colonies had established outside the area known to be infested in 2012. All known colonies within the Remote Sensing Zone (RSZ) were treated.

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[1] Approved budget only as year not finished at time of report completion.

[2] Costs are calculated based on direct costs incurred for travel and accommodation of staff and dogs; hourly rate for staff and dogs. However staff positions are usually not backfilled.

The area of infestation has been contained to SEQ and no colonies have been reported outside the 30 km limit set as a trigger for reconsideration of the plan to eradicate RIFA in the approved Response Plan. Other RIFA incursions in Australia did not originate from the current SEQ infestation as determined by genetic analysis, and this suggests that the current protocols have contained the SEQ infestation.

Surveillance was conducted in a zone around the known SEQ RIFA population infestation area from 2012–2015. This buffer was thought to more than cover the known maximum mating-flight distance of queen ants of about 5 km. Aerial remote sensing confirmed by ground searches around suspicious sites located 38 RIFA nests at 23 sites within the RSZ.

All colonies found in the RSZ were treated either by direct nest injection or by wider application of IGR baits around detections, so in this sense the infestation has been contained.

The public also independently reported some of the colonies detected by remote sensing as well as new colonies – one for example leading to an extension of the RSZ.

These different types of observations from the RSZ surveillance together suggest the infestation has been delimited. The Bayesian model developed by Keith and Spring (2015) essentially captures all these surveillance results, as well as management outcomes and land characteristics, to assess whether boundaries for the RIFA distribution can be inferred with various degrees of probability given certain assumptions around the detection capacity of remote sensing and colony founding rates. They show that the current operational boundary for the RSS corresponds roughly with the 99% probability boundary inferred from their model.

It is not a surprise that RIFA had spread beyond the known risk areas given the dispersal mechanisms of the ants, but this appears to have been limited in extent and with few new colonies – which were all removed.

However, a caveat is that to be 100% sure no RIFA occur outside the core or buffer area, searches must be made across a much wider area with a perfect detection system. The absence of public reports from elsewhere in Queensland gives some confidence that the risk that RIFA are present outside the RSZ buffer area is low.

Overall, most (70%) of new detections of RIFA come from reports by the public (SEQ Program samples data). However, this method has low sensitivity. Therefore, relying on public reports alone suggests many colonies will be missed, especially in rural areas – with implications for ongoing surveillance in the areas covered by the remote sensing and beyond.

Suppression

No. New areas infested have increased.

The total area of infestation has increased by 31.6% since 2014. The area of infestation is calculated by summing the area of 50 m around each active colony (colony undergoing treatment). This area has increased from 2334 hectares at 30 June 2014 to 3072 hectares as at 30 June 2015.

The increase of RIFA infestation may be due to the reallocation of SEQ Program resources to the delimitation survey and therefore a reduction in treatment and/or a reduction in post-treatment validation surveillance. However, it may also be due to increased responses from the public following publicity campaigns.

The feasibility that the core population of RIFA can be eradicated is not much affected by the spread into the RSZ buffer (now managed), or by the relaxation of actions while the infestation was delimited.

1b. Success stories

1b. i Port of Brisbane

The Port of Brisbane was one of the two initial detections of RIFA in 2001. The five-year eradication plan developed at the start of the SEQ Program involved baiting the entire infested area 3–4 times a year for three years. The infested area was delineated by drawing a boundary 2 km out from all known infested properties.

Another boundary was drawn at 5 km and all of the area between the 2 km and 5 km boundaries received surveillance once a year for three years. Following the three years of baiting, the treatment area received two rounds of surveillance over two years to confirm that eradication had been successful (Jennings 2004). The baits used consisted of defatted corn grit soaked in soybean oil and infused with one of two insect growth regulator baits (IGRs) (methoprene or pyriproxyfen) or a metabolic inhibitor (hydramethylnon). These were delivered by granular spreaders that are hand held, mounted on ATV quad bikes, or on helicopters for large areas (Jennings 2004).

The total area treated using the regime described above was 14 000 hectares. This area included the 2 km buffers around the edge of the infestation. Over the period November 2001 to April 2004, 12 aerial bait treatments were applied. The last nest found was in February 2005.

All areas at the port itself (Fishermans Island) were surveyed by RIFA odour detection dogs in 2010 and no RIFA found.

Following consultation with the TACC in December 2011, the Port of Brisbane was removed from the Restricted Area and movement controls lifted in December 2012. This was recognition that the Port was free of RIFA. Given that the Port and Richlands populations remained distinct and that the Port genotype has not been detected since 2005 despite regular surveillance, eradication of the Port population is claimed over a known infested area of 8300 hectares (Wylie et al. 2016).

1b. ii Yarwun (near Gladstone, Queensland)

In March 2006, a worker at a commercial chemical manufacturing plant in Yarwun, near Gladstone in Central Queensland, reported a suspected RIFA nest and samples were sent to the SEQ Program for identification. The sample was confirmed as RIFA, and found to be genetically unrelated to the Brisbane incursions (Ascunce et al. 2011). Delimiting surveillance resulted in the detection of infestation on a second land parcel, a mineral refining plant, approximately 1 km from the first detection. Further genetic analysis showed that there was a direct parental link between RIFA present on both infested land parcels.

Following delimiting surveillance, a national three-year strategy to eradicate RIFA at Yarwun commenced. This involved movement controls, tracing to identify possible human-assisted spread out of the Restricted Area, the destruction of all known colonies by direct nest injection with fipronil, repeated treatment of the infested area and surrounds with IGRs, surveillance to determine that the treatment had been effective, and surveillance of the area 18 months after the final treatment to confirm eradication of the pest from the area.

A treatment area was established with buffers of between 500 metres and more than one kilometre from the known infested area where suitable habitat was present; this area totalled 1028 ha. Between May 2006 and November 2007, seven aerial bait treatments were applied to the treatment area using IGRs. The two industrial plants were treated by ground application using hand spreaders because aerial treatment at these sites was not permitted.

Post-treatment validation surveillance was conducted on each infested land parcel and the last RIFA was found in September 2006. Approximately 18 months after the final treatment, surveillance was conducted in May and June 2009 over all suitable habitats within the treatment zone plus an additional buffer of at least 2 km around the boundary of the treatment area and again no RIFA was detected. In 2010, surveillance by odour detection dogs was conducted at the two infested land parcels with the same result. Staff at both commercial properties received training in 2006 in RIFA identification and designated personnel conducted surveillance of the properties in the years following the detection with no further reports of the ants. In September 2010, the TACC and the NMG supported the proposal that Yarwun is now a pest-free area for RIFA and that this incursion had been eradicated.

1c. Remote sensing surveillance

Following detections of RIFA beyond the Brisbane metropolitan area and into peri-urban and rural areas, a key focus for the SEQ Program was the development of effective and efficient remote sensing technology and its operational deployment. This occurred in order to meet the Roush review requirement that the RIFA infested area in SEQ be delimited by June 30 2015.

In 2012, RSS commenced. The RSS consists of utilising two helicopter-mounted camera pods to capture images of land in three frequency bands (visible, near-infrared and thermal). These images were then downloaded, georeferenced and orthorectified in Brisbane and then an algorithm developed by the Australian Centre for Field Robotics at the University of Sydney was applied over the imagery to generate potential RIFA mound targets. Manual analysis was then undertaken to review the targets and create points of interest (POI) for ground-truthing.

Refinement of this algorithm was a key part of the SEQ Program over the three years that RSS operated, greatly reducing the number of potential mounds to numbers that are manageable for ground-truthing by surveillance teams. As at 30 June 2015, approximately 218,000 hectares of RSS has been completed (i.e. image capture, algorithm, manual analysis and Point of Interest (POI) surveillance) on 285,000 hectares of captured imagery, with 38 RIFA colonies identified at 23 sites. In addition, approximately 100 colony point detections can be attributed, at least partially, to this surveillance through increased public reporting of mounds following overflights by surveillance helicopters.

The first generation camera technology used in the SEQ Program has been superseded. The SEQ Program has plans to evaluate replacement image capture and aerial deployment technologies (including higher resolution imagery, use of different spectra and drone aircraft) with an eye on providing cost and efficiency gains. The roll out of this new technology would help aid the verification of eradication, as the SEQ Program moves back into full eradication mode. Additionally the RSS could gain further efficiency by refining the detection algorithm to remove the need for manual screening of POI.

1c. i Has the SEQ Program successfully delimited the SEQ RIFA infestation?

Yes. The SEQ Program has completed the surveillance of areas adjacent to the recorded distribution of RIFA in 2012 to delimit the extent of the infestation.

From 2012 to 2015, the SEQ Program planned to cover 100,000 hectares each year using aerial remote sensing cameras. As of the end of June 2015, about 285,000 hectares of captured imagery had been taken within a 'remote sensing zone' (RSZ) around the known extent of RIFA colonies. Some areas were imaged more than once over the period to check if small nests had been missed. Of this area, over 218,000 hectares had RSS undertaken (i.e. image capture, algorithm, manual analysis and POI surveillance).

Passive surveillance by the public within the RSZ and out to the 30 km limit set in the Response Plan was also encouraged in the 'Beyond the Edge' campaign.

The last areas were assessed by the remote sensing method at the end of June 2015 and the planned target met.

1c. ii Did remote sensing contribute to delimitation of the SEQ RIFA infestation?

Yes. Remote sensing cameras on aircraft detected 23 sites containing 38 RIFA colonies within the RSZ.

The development of the remote sensing system (cameras, an algorithm to screen for POI, human input to further screen these, and eventual validation in the field) is ground-breaking technology.

Detection rates for the remote sensing method depend on the sensitivity setting of the algorithm used to screen POI. When the latest algorithm was implemented the cameras detected 58 POI per hectare. Most were false positives as manual screening followed by field searches reduced these to 0.47 POI per hectare.

The data on detections from the remote sensing project formed an important component of the delimitation model developed by Keith and Spring (2015).

The panel considered the proportion of the ongoing budget that is retained for surveillance in the RSZ and beyond, and whether broadscale remote sensing is the best way to deploy this effort. An adaptive allocation of resources to buffer surveillance is recommended based on progress within the core and any evidence of ongoing occurrence outside it.

Accurate costs for remote sensing, active surveillance using dogs and passive surveillance by the public across areas with different predicted risks (i.e. within the urban areas, within the RSZ and within the 30 km limit) were assessed to support decisions on the best strategy to be followed.

1d. Disturbance and habitat modelling

The development of a Habitat Model for RIFA in SEQ has been essential in assisting delimitation of RIFA infestations by directing surveillance to cover the highest risk sites. This model was highly integrated with the RSS and has been used to drive selection of areas targeted by RSS. The disturbance model has the potential to be integrated with future RSS activity.

The Habitat Model was first developed in 2004 (George 2004) and integrated into the IT system being used at the time. The model is software applied to landsat to define likely areas of suitable habitat for RIFA, and initially effective in doubling the success rate of surveys compared to random sampling efforts.

Further refinement through addition of a Disturbance Model (Alston 2014) has increased the efficiency in identifying RIFA habitat by eliminating 85% of the area within the Restricted Area that is unsuitable habitat. The disturbance model is software applied to land satellite imagery (landsat) to identify changes in land use (soil disturbance) over time. Newly mated RIFA queens prefer disturbed land to establish their nests.

The current model utilises four landsat image bands (visible red, mid infrared, soil brightness index and lower mid infrared) to define suitable fire ant habitat. In essence, the model helps the program know where RIFA are likely to be now and where they are going to be in the future.

1e. Genetics

A thorough understanding of the genetics of RIFA populations has been critical to the SEQ Program in many ways, including population assignment, colony assessment, relatedness between colonies, bottleneck analysis, and the geographical source of incursion. Genetics has also been able to determine that the incursions of RIFA in Australia have been separate incursions.

Of particular use in the recent delimitation of the RIFA population in SEQ has been the ability to determine the source of new colonies (natural spread or human movement) and to detect a developing genetic bottleneck and splintering in the population, indicating that treatments of the RIFA population, particularly at the front edge, have been effective in severely reducing population size and isolating breeding populations. This has been another tool that has been used to demonstrate technical feasibility of eradication.

While the basic techniques used in these genetic analyses are now commonplace, the SEQ Program has demonstrated for the first time the power these techniques can have when used in a management program, even down to the level of identifying the number of founding colonies and their family trees derived from the genetics of RIFA colonies at the most recent incursion in Yarwun, Queensland (illustrated in *Table 2: Area Infested, genetic fitness and budget breakdown by year*).

1f. Odour detection dog systems

Odour detection dogs are commonly used in many situations around the world, notably in Australia at airports to detect illegal importation of drugs and agricultural produce and in New Zealand for ant and other pest and weed detection.

The SEQ Program has trained and deployed odour detection dogs for RIFA since 2007 with these dogs capable of detecting levels of infestation down to single ants. Detection dogs are deployed strategically in the surveillance part of the SEQ Program. Dog teams can be deployed in high-risk areas to detect new colonies (this ability was demonstrated during the Review Panel visit) and are also used to assess the effectiveness of colony treatments, being deployed at sites of treated colonies 24 weeks following treatment to determine if active ants remain at the site.

Contingent on funding, the SEQ Program hopes to increase the number of detection dogs (currently ten) to strengthen their critical role in surveillance and confirmation of treatment effectiveness/eradication.

Table 2: Area Infested, genetic fitness and budget breakdown by year

Year	Budget	Key statistics (as reported)		Genetic Fitness[3]		Explanatory Notes
	TOTAL (million)	Area of Infestation (ha)[4]	Area treated (ha)	Sterility[5] (measured by calendar year not financial year)	Fragmentation[6]	
2011–12	$21	1401[7]	73,525[8]	1.8% (6/333)	3 populations	Unusually wet treatment season.[18] Imperative to remove cleared areas. RSS commenced.
2012–13	$17.9	1959	20,073[9]	1.7% (7/412)	3 populations	
2013–14	$18	2334	34,100[10] (32 214 preventative & 596 new infestation)	2.1% (8/373)	3 populations	36% increase in public reporting (from 2013–14) possibly due to 3 major CE campaigns
2014–15	$18.005[11]	3072	55,192[12] (53 300 preventative & 1890 new infestation)	3.3% (12/365)	3 populations	SEQ experienced a marked increase in the number of detections. The wet weather including the one-in-2000 year rain event experienced in early May 2015 teamed with cooler conditions gave rise to highly visible mounds. The 'Beyond the Edge' campaign may also have been a contributing factor. Publicity surrounding high profile detections such as Queensland University of Technology (QUT), Gardens Point campus and New Farm Park may also have contributed to the increased number of detections.

Refer to Annex B for a full budget, area infested and genetic fitness breakdown by year since 2001.

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[3] *The expectation for a RIFA incursion after 10 years is that there would be no decrease in genetic variation and limited sub-structuring of the population due to genetic mixing via natural mating, migration and human-assisted transport. The opposite of this is observed in Queensland, which strongly suggests the eradication program is being effective.*

[4] *Actual area of infestation (AOI) year by year is not a good measure of progress unless we have the capacity to do 100% surveillance, which is not currently possible. AOI is affected by temperature (affects mound construction and detection); rainfall (more mounds visible, easier to find); drought (no mound building); policy (balance between surveillance and treatment; no imperative to clear areas until recently); community engagement (CE) campaigns; evolving nature of program.*

[5] *Measured by % of males collected and tested that are sterile. Males have been collected only when easily available (only since 2009). Diploidy in monogyne males is used as indicator of sterility. Rate of diploidy has been seen to increase. By comparison, in the United States, diploid sterile males in a normal monogyne population is only approximately 1% (Tschinkel 2006). NB: no split into clusters, listed by calendar year. Numbers are low but trend seems to be consistently increasing.*

[6] *Measured by number of sub-populations in SEQ (Australian National Red Imported Fire Ant Eradication Program, Science Advisory Panel for Molecular Genetics, Introduction, Data, Collection Methodology and Workflow). This is not observed elsewhere.*

[7] *Area of infestation has been calculated retrospectively for 2011–12 and 2012–13 using current methodology for calculating AOI as used for reporting in 2013–14 and 2014–15. It is based on active colony points since 1/7/2008 to end of current financial year, excluding overlap.*

[8] *SEQ Program Annual Report 2011–2012*

[9] *SEQ Program Annual Report 2012–13*

[10] *SEQ Program – SEQ Annual Report 2013–14*

[11] *In 2014–15 RSS is estimated to have cost approximately $5M.*

[12] *SEQ Program – SEQ Annual Report 2014–15*

1g. *Proof of treatment efficacy*

The Port of Brisbane and the 2006 Yarwun incursion eradications have for the first time demonstrated the effectiveness of the IGR baiting and direct nest injection techniques in an eradication program for RIFA. The on-ground application of these treatments in the SEQ Program has now provided practical evidence of the treatment strategy's efficacy. Previous work in the United States using these treatments was more theoretically based and so the work carried out in Australia establishes sound operational proof of this theoretical underpinning. In addition, the SEQ Program has demonstrated that the application of six baiting treatments (over two years) is highly effective in killing off nests. These findings will be of benefit in potential future responses to further RIFA incursions in Australia and internationally.

1h. *Community engagement*

Effective community and other stakeholder engagement has been a highly important part of the response to RIFA in SEQ. Since the first detection in 2001 (from a public report) the methods used to engage with stakeholders have undergone continual change, adapting to the digital revolution that has occurred during this time. The SEQ Program has led the way within the Queensland Government in actively investing in social media in particular to increase stakeholder awareness of RIFA, along with more traditional communication activities.

The fact that 14 years after the first ant detection, 95% of people in Brisbane are aware of RIFA (Queensland Treasury and Trade 2013), and almost 70% of new colony detections are initially reported by the public (SEQ Program samples data), is testimony to the effectiveness of these engagement strategies, as is the strong in-kind support generated by a large number of stakeholders (e.g. councils).

Most recently, communication strategies have been essential in assisting to delimit the RIFA infestation through the 'Beyond the Edge' campaign which actively engaged stakeholders on the edge of the infestation, complementing the RSS. The learnings from the SEQ Program in pushing the boundaries of what is achievable within a government agency should be readily transferable to other State agencies in Australia that require high-levels of stakeholder engagement in, and acceptance of, eradication campaigns.

2. *Can RIFA still be eradicated?*

2a. *Technical feasibility*

2a. i Is it still technically feasible to eradicate RIFA?

Yes. The SEQ Program has the control tools necessary and can eradicate RIFA provided the tools are applied correctly in a timely way across the area infested, and with sufficient intensity to remove the last colonies. A major impediment to technical feasibility is not the tools and techniques, but rather the uncertainty in the funding.

There are two ways to judge whether a particular population of an invasive species can be eradicated: the first is from precedents where the same or similar species have been eradicated elsewhere, and the second is by assessing whether the obligate rules for success can be met and various case-specific constraints can be avoided, mitigated or managed (applicable to all eradication projects).

2a. ii Meeting the rules and managing constraints

There have been several attempts to identify these obligate rules, but the latest and most parsimonious set are given in Parkes and Panetta (2009):

1. The average annual long-term rate of removal in source populations must be greater than the annual intrinsic rate of increase. This implies that all viable populations must be put at risk, killed faster than they can replace their losses at all densities, the invasion is delimited, and the project must be resourced to achieve these conditions.
2. There must be no immigration of individuals that can breed.
3. There must be no net adverse effects – from the control methods on, for example, non-target species, or if the removal of the invasive species itself has adverse flow-on effects.

Meeting these rules usually requires a series of constraints and problems that need to be identified and overcome, including having the right control tools. For Brisbane's RIFA population, the first rule listed above is the most pertinent, and clearly there are many issues that have to be resolved before it can be met (*Table 3: Technical issues that may constrain the feasibility of eradication for RIFA in Queensland*).

The fact that there have been three post-border detections and seven quarantine intercepts of RIFA in Australia suggests the need for effective early detection/rapid response systems to avoid the costs of dealing with established populations and to meet the second rule.

2a. iii Precedents

The precedents for RIFA eradication are from the successful eradications at the Port of Brisbane (2001–2012) where several hundred colonies were treated and killed over 8300 hectares, and Yarwun (2006–2010) where at least 11 colonies[13] were removed over 71 hectares. By 2004, the Richlands infestation, excluding at the time an unknown western population, was on the brink of eradication. An incursion at Port Botany (detected in 2014) is also nearly eradicated and another incursion at Yarwun (2013) is in the process of being eradicated. The National Electric Ant Eradication Program (electric ant program) is on the cusp of eradicating electric ant from the Cairns region; however, there have been recent detections, which are not unexpected of the tail-end of an eradication program. The Review Panel noted that all the obligate rules for eradication can be met and most of the constraints surrounding these rules overcome (*Table 3: Technical issues that may constrain the feasibility of eradication for RIFA in Queensland*).

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[13] Genetics showed that there were a minimum of 11 colonies present but could have been more if inbreeding occurred. Parts of the infestation were diffuse in loose gravel and no formed mounds.

Table 3: Technical issues that may constrain the feasibility of eradication for RIFA in Queensland

Constraint	Has it been resolved?	Comments
Control tools that kill all ant colonies	Yes	But see below
Infestation delimited	Yes	But ongoing risk of spread until core population removed – see this review
Access to all sites to apply control	Yes	Program can access legally however enforcement may be required
Kill rate = timeframe to success	No	Being addressed as a recommendation from this review
Ability to detect all colonies	Unclear	But may not need to inside core infested area if control treatment applied correctly
Ability to validate absence	Yes	Need to use SEQ Program data to measure this probability
Funding sufficient	No	Being addressed as a recommendation from this review
Benefits outweigh costs	Yes	By a large amount
Adverse consequences	No	Minor effects of some control methods

These separate incursions show eradication is feasible at least at these smaller scales. However, attempts at larger scales in the United States have failed (Lofgren 1986, Oi & Drees 2009) showing at least that success in the current attempt in Brisbane is not a foregone conclusion based on precedence.

2a. iv Technical feasibility: the control tools

Some pests can be eradicated by a single application of a control tool, while others are reduced to zero by applying a sequence of control events often using several different control methods. Eradication of RIFA in SEQ is largely of the latter type (*Table 4: Advantages and limitations of current RIFA control tools*) as it uses IGR baits that must be applied on several occasions over two years. The acute lethal method (fipronil injections into nests) requires that all colonies are located and be accessible to treatment(s).

Biological basis of eradication treatment with baits is based on the foraging and food sharing behaviour of RIFA, which is a very efficient way to deliver insecticidal active ingredients to the entire ant colony.

Table 4: Advantages and limitations of current RIFA control tools

Control method	Advantages	Limitations
IGR baits (2 products in use)	Target specific, can be broadcast aerially or from ground without precise knowledge of RIFA locations	Colonies die slowly[14], current protocol requires several applications over several years for increased efficacy; can only be applied in warmer months
Fipronil injection	Kills colonies quickly	Must locate all nests
Toxic baits (2 products registered, others available)	May kill colonies with single application; kills faster than IGR baits	May not kill 100% of colonies; efficacy needs retesting in Queensland
Biocontrol (pathogens & parasitic flies	Ongoing benefit for initial costs to establish	Does not kill colonies 100%; needs RIFA to persist

The IGRs and the faster acting nerve or metabolic inhibiting active ingredients used in RIFA baits are very effective in eliminating RIFA colonies. IGR baits interfere with the production of the worker caste and it may take several weeks to months before colony death occurs. The efficacy of RIFA baits has been verified by numerous laboratory and field studies and the use of these are a standard RIFA control recommendation in the United States (Williams et al. 2001; Nester 2013).

The 2–4 IGR bait applications per season used in SEQ seems sufficient to achieve eradication when logistical criteria are met (e.g. property access, fresh bait, thorough bait application, appropriate weather for ant foraging). This is supported by the successful eradication of RIFA at the Port of Brisbane and Yarwun.

The injection of fipronil into RIFA nests results in faster RIFA death than IGR baits. In addition, fipronil has residual activity which can eliminate foraging ants that were absent from the nest during injection. However, the cost and labour to treat individual nests limits this type of treatment to accessible areas with visible nests.

Operational feasibility has been demonstrated, with aerial (helicopter) and ground (All-Terrain Vehicle) bait application equipment working consistently and their deployment (including mapping) well-coordinated. This is a critical component for successful eradication, because excellent control tools (i.e. bait and other treatments) are useless without consistent, efficient, and thorough application. Having a quality treatment operation in place is an important logistical challenge that has been met.

The SEQ infestations are spatially fragmented resulting in dispersed pockets of infested and likely to be infested land. The infestations are within the 341,000 hectare infestation delimitated area determined from passive and RSS. Due to the large area of delimitation, only known and likely to be infested areas are targeted for treatment.

[14] Queen is sterilised and workers die of old age

2b. *Strategic feasibility: applying the control tools in space and time*

A major concern of this and previous Review Panels is determining the SEQ Program's ability to eliminate RIFA infested sites and maintain elimination at a rate greater than the sites can be re-infested. The SEQ Program was in a suppression and containment phase the last three years during the RSS delimitation. The relatively stable (but increasing) area of infestation suggests the treatment regime is adequate for containment and can be a foundation, with refinement, for eradication.

This is supported by the sustained elimination of pockets of RIFA populations. Of the 69 localities that have eliminated RIFA and are currently not infested, 58% have been RIFA free for at least two years (*Table 5: Number of localities that have been treated for RIFA and the current duration they have remained RIFA free*).

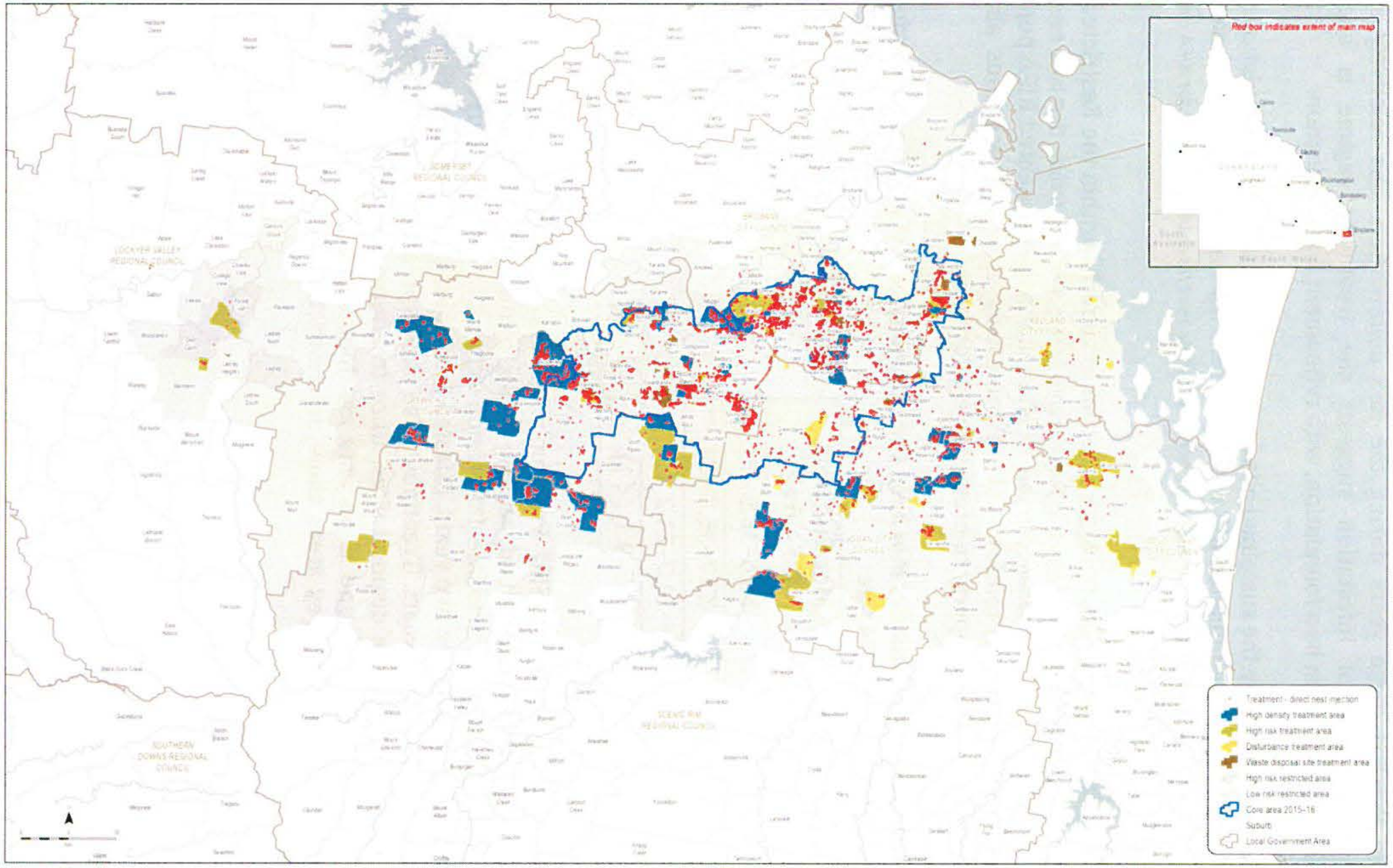
Many of the RIFA-free locations are adjacent to suburbs within the Restricted Area that have many active colonies (*Figure 2: Suburbs with known RIFA infestations that have been treated but not yet had final clearance validation* . Sustained elimination of fragmented RIFA populations is critical to prevent the reinfestation of previously cleared areas, thus allowing the hectares of infested property to progressively decrease.

Table 5: Number of localities that have been treated for RIFA and the current duration they have remained RIFA free

No. of Localities	Months (yrs) RIFA free
29	35.6–36.5 (3)
11	23.7–35.2 (2)
7	11.7–21.2 (1)
22	3.8–9.1 (< 1)

In accordance with the SEQ Program's current workplan, all colony points have undergone at least one round, and up to six rounds, of treatment. The core area is highlighted within the blue line. Infestation within the core area currently receives two rounds of treatment for two years. Infested areas outside the core receive three rounds of treatment for two years. Treatment also occurs in areas of high density, high risk, disturbance and waste disposal sites. Once treatment has been completed validation surveillance will occur and if no ants are found, the area will become cleared or 'inactive'. The shaded grey areas show the restricted area where movement controls apply.

Figure 2: Suburbs with known RIFA infestations that have been treated but not yet had final clearance validation undertaken



As at 10 May 2016

3. Should Australia continue to eradicate?

3a. Is it still in the national interest to eradicate RIFA?

The Review Panel considers that it is in the national interest to eradicate RIFA. In arriving at this conclusion, the Review Panel noted that the eradication of RIFA meets the national interest criteria aimed at reducing potential environmental, social, economic and health impacts as defined by the National Environmental Biosecurity Response Agreement (NEBRA).

3a. i National interest

The Review Panel has adapted the definition of 'national interest' from NEBRA – an agreement between the Commonwealth, States and Territories under the Intergovernmental Agreement on Biosecurity. NEBRA aims to reduce the impacts of pests and diseases on Australia's environment, people, social amenity, business activity (including primary production) and establish national response arrangements where there are no pre-existing arrangements. Therefore, the Review Panel defines 'national interest' within environmental, social, economic and health terms.

The NEBRA also seeks to maintain Australia's favourable international reputation for biosecure business activity and the retention of diverse ecosystem sustainability. When viewed in this context, the continued efforts to eradicate RIFA are in the national interest.

RIFA was determined to have the potential to impact native Australian fauna and flora, and was listed as a key threatening process on 2 April 2003 under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. The Tramp Ant Threat Abatement Plan developed by the Commonwealth Government, in consultation with State and Territory governments and other key stakeholders, lists ten endangered; fifteen vulnerable; and fourteen unlisted species recognised by the Environment Protection and Biodiversity Conservation Act 1999 that may be adversely affected by RIFA.

The 2015 White Paper into Agricultural Competitiveness has noted that:

> *"...[t]he response to red imported fire ants has been long and protracted and has already cost $411[15] million (2001–2012). However, without any government funded biosecurity activities, red imported fire ants could cause losses of $8.5 billion over a 70-year period (Hafi et al. 2014)" (Commonwealth of Australia 2015b).*

3a. ii Strategic feasibility: applying the control tools in space and time

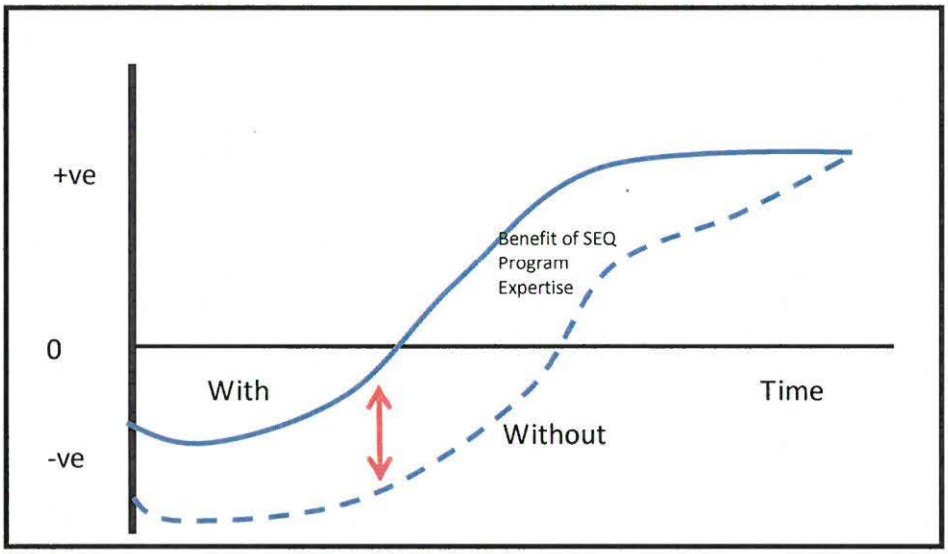
The SEQ Program has raised awareness about RIFA and developed tools and techniques that have contributed to the:

[15] Note: actual SEQ Program expenditure totals approximately $329 million.

- Eradication of RIFA at the Port of Brisbane (2001) and Yarwun (2006);
- Early identification and prevention of RIFA establishment in Lytton (2009), Roma (2011) and Melbourne (2015);
- Early identification and current RIFA eradication campaigns in Yarwun (2013) and Port Botany (2014); and
- Electric ant program in Far North Queensland.

The skills, process, platforms, equipment and animal training skills developed by the SEQ Program have already provided real benefits to Australia. The SEQ Program has reduced the cost of subsequent eradication campaigns by reducing the time to identify RIFA (genetics); decreasing the time to determine the distribution and density of RIFA (odour detection dogs, RSS and spread models); and by having the capacity to transfer skills and equipment and techniques where needed. This national benefit can be illustrated by *Figure 3: Spillover benefits to other eradication campaigns*, where the cash flow of a new eradication campaign moves from the dashed 'Without'[16] line to the solid 'With' line.

Figure 3: Spillover benefits to other eradication campaigns



The panel believes that the spillover benefits from the SEQ Program extend beyond Australia's borders and, if carefully implemented, may provide subsequent pre-border benefits for the Australian economy. RIFA is an international problem and the technology developed by the SEQ Program may have value to the rest of the world. This benefit could take the form of international aid (e.g. training and transfer of skills and techniques) and/or an exchange of information and/or ideas with Australia's major trading partners. This spillover may help provide international goodwill and if the approaches are adopted, it could reduce the possibility of future RIFA incursions (i.e. pre-border) and subsequent private and public costs derived from trade externalities.

[16] 'Without' refers to in the absence of the research and skills developed by the SEQ Program

3b. Economic, environmental and social implications

3b. i Is there an acceptable benefit: cost to eradicate RIFA?

Yes, with a minimum expected return of $25:1, on-going expenditure is justified. The panel believes that this value underestimates the true national benefits to Australia from the eradication of RIFA.

The three analyses of the SEQ program (*Table 6: Estimates of benefit-cost ratios from eradicating RIFA*) have stated that their benefit-cost ratios are underestimates; despite this the return for each dollar invested is still expected to be between $17 to over $496. This wide margin of returns is explained by the objectives of each report, the issues and industries analysed and the techniques applied. The Review Panel noted that Antony et al. (2009) comes closest to understanding the true national costs (economic, social and environmental) associated with RIFA. The available estimates on returns from the SEQ Program justify the continued funding of the program due to the national benefits provided, as discussed by the recent white paper on agricultural productivity (Australian Government, 2015b).

Table 6: Estimates of benefit-cost ratios from eradicating RIFA

Report	Benefit-cost ratio		
	Minimum	Expected	Maximum
Kompas and Che (2001)		$25:1	
Antony et al. (2009)	$289:1	$390:1	$496:1
Hafi et al. (2014)[17]	$17:1	$25:1[18]	$66:1

While all analyses of the SEQ Program have explored the wider national benefits of eradicating RIFA (including: financial returns, capital investments, environmental goods and services and some social benefits), the Review Panel noted that prior analyses have not included:

- The technical and research spillover benefits to Australia;
- Cost of protecting national public infrastructure;
- Other social benefits; and
- The analyses are more financial rather than economic in nature as they fail to include capital costs. (Refer to 3b iii).

[17] All values rounded to the nearest dollar
[18] Mode used from all scenarios

3b. ii Impacts on people, social amenity and business activity

RIFA can also affect industries, schools, households and human health. Agricultural impacts include damage to crops and equipment, restrictions on the movement of agricultural produce in interstate and international trade and increases in crop pests and diseases. RIFA sting people, stock and pets and induce anaphylactic shock in some people. Over 85 deaths have been reported in the United States as a result of RIFA stings.

RIFA can be a serious problem in lawns, sporting fields and golf courses, which can have economic impacts. RIFA's foraging activities and nesting materials can cause expensive damage to sensitive electrical equipment, including in hospitals and other critical infrastructure.

They can also affect the tourism industry and the export trade of high-risk materials with RIFA-free countries. Twenty-one sectors of the economy have the potential to be adversely affected by RIFA.

RIFA can significantly affect the agriculture sector. Newborn or hatching animals are particularly prone to attacks that can lead to death. Ants can make it impossible for animals to reach food or water without being seriously stung, which can lead to starvation and dehydration. RIFA sometimes feed on seeds, and can fatally damage some plants by tunnelling through roots and stems. They protect some species of pest insects that produce honeydew. This downgrades the quality of produce, helps spread some diseases, and reduces plant health more generally. Mound-building behaviour can interrupt or destroy equipment, such as irrigation systems, and can also damage machinery during harvesting operations. In addition to costs incurred through loss of crop yield, plant mortality, damage to equipment and infrastructure and medical expenses, RIFA can also lead to increases in labour costs due to increased penalty rates.

3b. iii Economic impacts

A financial analysis examines only the direct costs of managing RIFA and the residual production losses. An economic analysis includes the financial analysis and then examines if these changes would alter the profitability of farming systems. If farming systems become unprofitable, then private and public investment is at risk if producers have to reallocate their resources of land, water, labour and capital.

All reports undertaken by ABARES (Kompas & Che 2001; Hafi et al. 2014, 2015) only examine the direct financial impacts associated with RIFA and all assumptions of farm costs and production losses are based on overseas estimates. None of these analyses have examined how farmers will adapt to RIFA.

Hafi et al. (2015) estimated that Australia's biosecurity services increase an average farmers profit from between $12,000 to $17,500 per annum. Within this report the SEQ Program is estimated to provide savings for a range of broadacre producers from between $2,081 to $7,468 every year. They suggest that if RIFA was present, the gross margin of broadacre based enterprises would decrease by:

- 10% in cropping and mixed farming enterprise systems;
- 20% in mixed livestock enterprises; and
- 40% in beef based enterprises.

These biosecurity efforts then allow Australian farmers to maintain returns on their investment over time.

The Hafi et al. (2015) analysis is useful in helping to understand the risks posed to some production systems, but in some cases the message may not be as clear as needed. For example, RIFA are a major problem for poultry farms in the United States. RIFA invade sheds, they kill chicks, stress birds, damage equipment, and decrease egg production as poultry will not eat infested feed (Hall et al. 1999). Due to this production risk and clear benefits to an individual producer, Hafi et al. (2015) assume that all producers will eradicate RIFA on their land. Consequently, cost to an industry is low as they assume a producer has perfect knowledge, the cost to eradicate is low, control is successful and there is no lost production. In this case the benefit of a public biosecurity program is estimated as $25 per poultry producer.

In reality, the benefit of on-farm eradication of RIFA may not be realised until one or more producers was infested by RIFA. In this case, while the industry may not suffer, the cost to those individuals initially infested could be significant and may result in significant economic loss (i.e. return on capital investment).

Poultry is the most valuable agricultural commodity in the greater Brisbane region, followed by vegetables, nurseries, fruits and nuts, and hay (see *Figure 4: Value of agricultural production, Greater Brisbane region (2012-13)*, from (ABARES 2015); the economic impact on those commodities are not examined. Importantly, RIFA have been stopped from establishing in 'Australia's salad bowl' the Lockyer Valley.

The Lockyer Valley has a comparative advantage for producing vegetables[19,20] and due to the nature of these irrigation production systems they provide an ideal habitat for RIFA. Irrigation farming systems are high input, high output production systems that can be vulnerable when operating conditions (climate, market, biophysical and policy) change (see *Figure 5: Vegetable farm business profit in Queensland*, source Valle 2014).

[19] See Annex C which based on Queensland and Australian data. The assumption being that in the absence of local data that the Queensland values are applicable for the Lockyer Valley

[20] https://www.daf.qld.gov.au/plants/fruit-and-vegetables/vegetables/vegetable-production-in-south-east-queensland

Figure 4: Value of agricultural production, Greater Brisbane region (2012-13)[21]

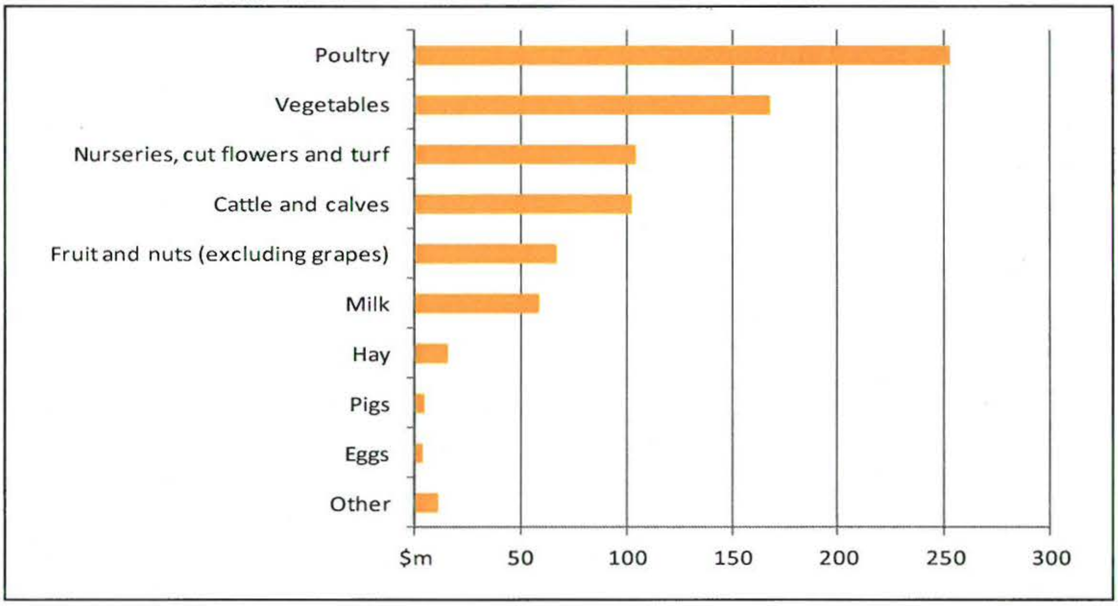
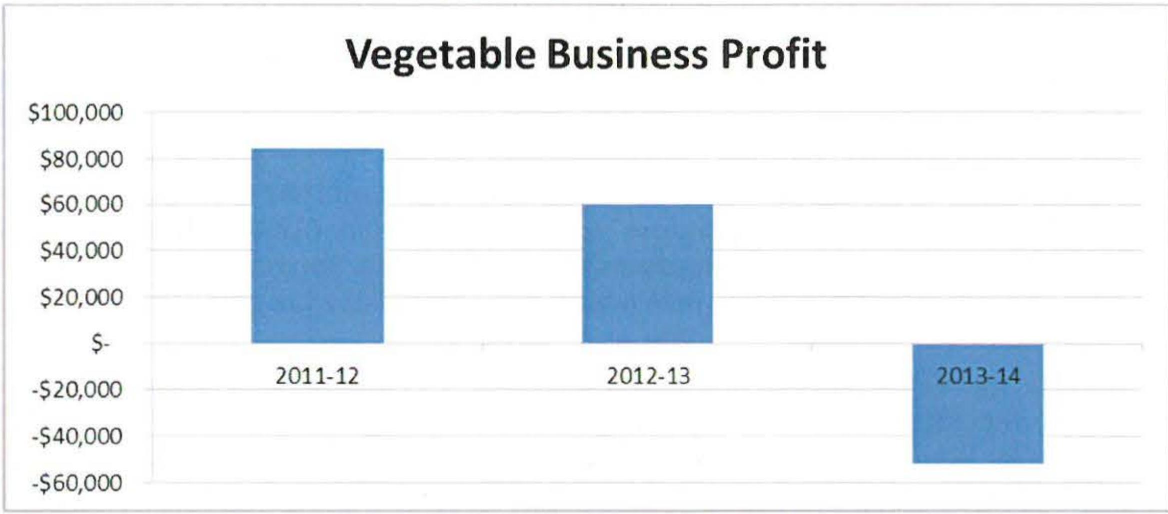


Figure 5: Vegetable farm business profit in Queensland



The presence of RIFA (see case studies below) forces farm management to adapt to reduce the risk posed by RIFA, thereby increasing the costs of managing RIFA on a property and reducing profit made from existing production systems. If the presence of RIFA changes the variable and fixed costs of a business enterprise to the point at which farm equity is compromised, it should be expected that farmers will reallocate their resources (land, water, labour and capital). If this resource reallocation occurs, then the second round economic impacts (general equilibrium) associated with RIFA could be underestimated.

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[21] ABARES (2015)

The panel noted that the lack of detail concerning the true impacts of RIFA on business activities is underestimating the costs posed by RIFA.

3b. iv Case study examples

Generally, biosecurity risks to capital are not investigated. This in part stems from the World Trade Organisation Agreement on the Application of Sanitary and Phytosanitary Measures, article 5.3 which states:

> *"In assessing the risk to animal or plant life or health and determining the measure to be applied for achieving the appropriate level of sanitary or phytosanitary protection from such risk, Members shall take into account as relevant economic factors: the potential damage in terms of loss of production or sales in the event of the entry, establishment or spread of a pest or disease; the costs of control or eradication in the territory of the importing Member; and the relative cost-effectiveness of alternative approaches to limiting risks."*[22]

This article then discourages investigating what may occur to on-farm capital investments from a pre-border risk analysis. However, once a biosecurity event is at the border or post border, policy makers must understand the economic impact (i.e. impacts on capital and operator labour) of the event to allocate resources correctly. The following two case studies provide examples of how RIFA may not only alter production management systems but force a reallocation of capital investments.

Vegetable producer

Once present on a property, RIFA are rapidly dispersed over the productive land when the paddocks are prepared for planting from the act of ploughing. This combination of disturbed soil and moisture then provides ideal habitat for RIFA. RIFA poses a threat to irrigation equipment (pipes, pumps and electrical systems) and farm labourers. In the United States, farm labourers are paid penalty rates when RIFA are present (Jetter et al. 2002).

During a field trip, the panel engaged with a horticultural producer who specialised in producing green leafy produce (lettuces, cabbages, etc.) for a large supermarket chain. In order to meet the supermarkets needs for constant supply, the producer had established a washing and packing plant (cost unknown) so that they could engage with other local producers to meet this demand.

The RIFA management plan on this farm was developed with the aid of SEQ Program staff and had to contend with the problems of:

- A two week planting cycle that operated over 10–11 months of the year;
- The lack of registered compounds for direct application over a growing crop; and
- The need to place bait between rows and between the crops' irrigation requirements.

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[22] https://www.wto.org/english/res_e/booksp_e/analytic_index_e/sps_02_e.htm

To overcome these constraints, the SEQ Program staff liaised with the grower to apply baits to individual fields in the fallow period between crops. This resulted in a 'mosaic' of treatment applications.

Currently, the cost to develop and implement these management strategies are subsidised by the SEQ Program. Additionally, the limitations[23] of registered chemical compounds for controlling RIFA prevent farmers from engaging in active management and/or in extreme cases could encourage farmers to use chemicals off label, posing risks and compromising domestic and international market access.

If RIFA could not be adequately controlled on this farm, then the producer's investment in the washing facility may be compromised. Supply chains would be disrupted, increasing commercial losses and resulting in loss of reputation. Furthermore, Australia is being referred to as 'Asia's delicatessen', so production of pest- and chemical-free[24] produce is a distinct commercial advantage for producers. Assuming that the repayment of fixed costs (i.e. loan to establish the washing facility) remains constant, when RIFA is present gross income declines (negative impacts on yield and price received per unit of output) and variable costs increase (management costs and labour penalty rates). This combination of decreased income and increased costs then reduces the returns from investing in the washing facility. If the returns from investing in the washing facility approach the opportunity cost of capital, the farmer may reallocate resources towards other activities. If the producer closed the washing facility, then investments by other local growers would be at risk and the existing arrangements with the supermarket may no longer apply.

Hay production

Hay bales are 'magnets' for RIFA: they provide shelter, temperature control and are a source of food. Hay bales left in the field can become infested within one day of bailing. Hay producers pose a high risk to eradication campaigns as they can act as nodes of dispersal for RIFA throughout Australia.

If a hay producer's property is heavily infested with RIFA (especially with polygyne colonies), they face the risk of having their property placed into 'quarantine': movement restrictions are put in place until the producer can meet production requirements. Once in quarantine the producer may not actively engage with the market and this may prevent them from maximising the price they receive. A quarantine embargo reduces the total supply of fodder for sale and may contribute to higher hay prices (good for unaffected sellers but bad for buyers).

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[23] Registered products are available but their application is limited by label instruction. Also there are no registered toxicants commercially available for RIFA treatment apart from fipronil.

[24] Pest- and chemical-free in trade terms means that at the point of entry (i.e. into the importing country) that there are no visible live pests and that all residues detected are at or below the agreed maximum residue level (MRL).

Commercial hay producers have adopted risk management strategies to reduce the chance of this occurring, but the implementation of these plans requires compliance costs in the way fodder is produced and stored. When hay is produced, the producer's variable costs increase as to prevent RIFA from being baled; it is recommended that the hay is turned twice within 24 hours before it is rowed-up, baled and removed from the paddock within 24 hours of the last turn[25]. The removal of the hay within 24 hours of the baling can be difficult if farmers don't have adequate storage (especially for round bales).

Producers are encouraged to store hay off the ground and in sheds. However, if hay is to be stored on the ground, there needs to be an impenetrable surface (e.g. concrete, bitumen or chemical hard stand) between the hay and the soil. But not all hay producers have been able to afford these facilities and the production methods are difficult to monitor.

With Queensland experiencing an historic drought and Australia experiencing another El Niño phase, the demand for fodder is high. Presently, the greatest risk to the distribution of RIFA in hay bales is not from known hay producers but either from opportunistic hay producers and buyers, or altruistic individuals donating fodder, who are unaware or uncaring about the risk they pose to spreading RIFA (especially outside the containment zone).

3b. v Benefits to public capital expenditure

While prior reports have utilised cost estimation of management and repair that RIFA pose to electrical equipment and other public capital infrastructure, these reports have yet to consider the impact RIFA could pose to the country's largest current infrastructure spending: the National Broadband Network (NBN). RIFA[26,27] pose a threat to all electrical and communication equipment. The NBN is a $30 billion[28] public investment which aims to enhance the nation's productivity.

The current combination of the roll out of the NBN and the expansion of new estates in the core and the RSZ provide new opportunities to disperse RIFA. The proactive treatment and delimiting of RIFA by the SEQ Program, combined with approved risk management strategies for telecommunication companies[29], is protecting this public investment in our economic future.

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[25] In other words, if a producer turned the hay once before it was bailed, it is now turned twice. The additional variable costs would include labour charges and machinery costs (fuel and repair and maintenance costs)
[26] http://www.extension.org/pages/30057/ants-and-electrical-equipment#.VYJQBPmqpBc
[27] http://www.rainbowtech.net/products/docs/c51ce4107047eb1b2dc/Ants%20in%20OSP%20Equipment.pdf.pdf
[28] http://www.nbnco.com.au/assets/documents/nbn-co-corporate-plan-6-aug-2012.pdf
[29] http://www.austcomsolutions.com.au/recent-projects.html?news_id=29

3b. vi Environmental impact

Evidence from the United States shows that RIFA are able to consume a range of insects at any stage of development from egg to adult, and feed on predatory arthropods and on other invertebrates. Due to their prevalence and aggressive behaviour, RIFA may control the balance of species within an invertebrate community more than other arthropod predators, which can lead to an overall decrease in insect biomass diversity (Porter & Savignano 1990; Gotelli & Arnett 2000). This has the potential to indirectly affect other insectivorous species and threaten ecological processes such as seed dispersal, pollination and germination.

RIFA are also reported to affect native vertebrate wildlife in the United States by consuming soft-shelled eggs, hatchlings, newborn and dependent young and sometimes adults of certain species (Vinson 2013). In Australia, iconic birds like the bush stone-curlew, plumed frogmouth, rufous scrub-bird, superb lyrebird and black-throated finch are at significant risk. RIFA have been reported to attack the eggs or nestlings of several species, including turtles, lizards and water birds and are associated with a decline in nesting success of ground-dwelling birds.

In the United States, RIFA are reported to negatively affect small mammal densities (Vinson 2013; Wojcik et al. 2001). Australian mammals such as the short-beaked echidna, spotted-tailed quoll, reptiles such as Brisbane short-necked turtle, Bunya Mountains sun skink, Cooloola blind snake (and snakes, skinks and turtles generally), frogs, several native freshwater fish and butterfly species are at risk of high impacts. Species that are stung by RIFA may be killed outright and those stung non-lethally may exhibit reduced weight, loss of digits, obscured vision or blinding and an inability for normal movement. Species such as small mammals that already have a reduced home range due to threats by other introduced predators and land clearing could be put at greater risk through pressure on habitat use from RIFA infestations.

3b. vii Social costs

The detection of nests in New Farm, QUT and UQ raised public awareness of the impacts that RIFA pose to recreational and professional sporting activities. The presence of RIFA in Australia has shut down sporting grounds[30] and associated activities. Before the 2015 Cricket World Cup commenced, RIFA were found on a cricket oval at UQ, closing the oval. The subsequent trace back of the infestation sparked a search of cricket ovals in Queensland (including 'the Gabba') and NSW.

While RIFA have not disrupted a major sporting event in Australia, local games have been cancelled[31]. The precedent for preventing play is based on experiences in the United States where games have been cancelled[32] due to the risk of and actual loss of life[33] and the liabilities for organisations (Vinson 2013).

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[30] http://www.uq.edu.au/update/index.html?page=218125&pid=3684

[31] http://www.thereporter.com.au/news/fire-ants-cancel-tigers-fixture/493101/

[32] https://livingwithinsects.wordpress.com/2011/09/28/delay-of-game/

[33] http://www.nbcnews.com/news/other/texas-town-outraged-after-middle-school-football-player-dies-attack-f4B11188611

While it is impossible to link the growing trend of Type 2 diabetes and declining participation of sporting activities[34] to RIFA in Australia, if RIFA was to establish, more people may be discouraged from engaging in physical activity and add to the nation's health bill. Current research shows that for every 1% increase in moderate physical activity in the Australian population, 122 deaths per year from coronary heart disease, diabetes and colon cancer would be avoided, saving the Australian health care system around $3.6 million per year (Stephenson et al. 2000). Another health-related impact is the loss of productivity due to persons seeking and requiring medical attention, adding pressure to already stretched health care services.

Vinson and Sorensen (1986) found that the use of public parks for social activities, recreation and sporting activities declined if they were infested with RIFA. In Australia, the 2015 Anzac service at Goodna would have been cancelled if SEQ Program staff had not contained and quarantined a RIFA incursion[35].

The threat to social events and activities is real, and these have direct economic costs for health, expenditure for councils, sporting clubs and community activities if RIFA was to establish in Australia. The funding model used for the SEQ Program is unfortunate as it prevents a greater understanding of the social, environmental and economic consequences, but there is currently a nationally agreed, viable alternative through NEBRA.

As Lard et al. (2001) estimated, RIFA costs Texas over US$1.2 billion per annum, yet agriculture only accounted for US$90 million per annum. However, the Lard et al. (2001) report didn't include the costs to the environment, which is why the report by Antony et al. (2009) is pertinent to discussions as they estimated the environment ecosystem loss within a 2.6 million hectare zone at $9 billion per annum.

3b. viii RIFA impacts on health

In the United States, where RIFA have been established for over 80 years, their ubiquitous presence in populated areas creates tragic cases of death. A 1988 survey of physicians (n=2506) resulted in reports of 83 deaths (32 confirmed) being attributed to fatal anaphylactic reactions to RIFA with victims ranging from infancy to 65 years of age (Rhoades et al 1989). With an estimated 50–89% of inhabitants of RIFA-infested areas being stung annually (deShazo et al. 2014), anaphylaxis and death continue to occur (deShazo et al. 1990, 1999, 2004; Nester et al. 2015).

[34] http://www.abs.gov.au/AUSSTATS/abs@.nsf/Lookup/4156.0.55.001Main+Features4June%202013?OpenDocument#PARALINK2
[35] http://www.theaustralian.com.au/news/latest-news/fire-ants-almost-cancel-qld-anzac-service/story-fn3dxiwe-1227319927174

Many RIFA attacks occur in nursing homes resulting in litigation and settlements in excess of $US1 million (Oi 2008). Protocols to prevent RIFA attacks at these facilities are recommended or even mandated (Goddard et al. 2002). In response to a 2013 RIFA-associated death of a 13-year old student during a football game, proactive RIFA management programs were implemented across several Texas school districts and legislation introduced to allow the use of epinephrine auto-injectors at school events for life-threatening reactions (Nester et al. 2015).

Outside of the United States, RIFA invaded countries have also reported severe reactions and deaths attributed to stings. In mainland China, soon after the RIFA incursion (1999–2004), reports documented nearly 3% of those stung (n=406) being hospitalised and/or having severe reactions such as anaphylaxis (1%) (Zhang et al. 2007). Later surveys covering 2005–2011 (Xu et al. 2012) again reported nearly 1% of sting victims experiencing systemic allergic reactions, and disturbingly, around a third of the population in infested areas have been stung. In Taiwan, several cases of severe RIFA sting reactions have also been reported (Chen et al. 2005; Lee et al. 2014) and hospitalisations associated with RIFA totalled 129 cases from 2012–2014 (C-C. Yang, personal communication, Taiwan National Red Imported Fire Ant Control Centre). Even an isolated shipment of RIFA-infested wood in Spain has resulted in anaphylaxis and a death (Fernández-Meléndez et al. 2007).

Solley et al. (2002) estimated that in the United States, 40 million people live in areas where RIFA are present and over 14 million people are stung annually. Approximately 25% of all individuals stung will develop sensitivity to the toxin produced by RIFA. This sensitivity ranges from a rash to an anaphylactic shock. An anaphylactic shock is a severe and potentially life threatening allergic reaction. Approximately 1.9 people per 10,000 are treated for anaphylaxis shock to RIFA in the United States every year. If this data was extrapolated to Australia, it is anticipated that ...

> *"...about 140 000 consultations and 3000 anaphylactic reactions are to be expected each year by 2030 if RIFA eradication is not successful" (Solley et al. 2002).*

McCubbin and Weiner (2002) estimate that the rate of anaphylaxis due to RIFA in the United States is between 0.6%–16%. This uncertainty associated with the true rate of anaphylaxis due to RIFA suggests that there will be some form of health burden places on the country if RIFA was to become present. While anaphylaxis is rarely fatal these days (0.3% of cases), people in the United States are becoming more susceptible to developing anaphylaxis (Ma et al. 2014) and RIFA may increase demand on the public health system.

Salin et al. (2000) evaluation across five cities in Texas suggested that out of the total economic burden associated with RIFA ($US581) over $US47 million was allocated on medical expenditure. While this study did not investigate the costs of resources allocated in hospitals towards dealing with RIFA, the survey concluded that households would bear the greatest total medical expenditure. It is difficult to extrapolate this data to Australia as at that time the United States did not have universal health care, which would bias the true public costs downwards.

However, they estimated that schools would face the greatest medical costs per individual institution (household, school or golf course), see Table 7: Medical Costs in Texas by Institution (Household, School and Golf Courses). When reviewing these numbers it is important to remember that these are the costs borne per individual institution under active management.

Table 7: Medical Costs in Texas by Institution (Household, School and Golf Courses)

Medical Costs attributed to	Weighted Average Expenditure Across 5 Cities in Texas
Household ($US/household)	$US9.48
Infrastructure ($US/school)	$US22
Golf course ($US/golf course)	$US7.62

Data from Salin et al. (2000)

3c. Senate Inquiry

On 13 May 2015, the Senate Standing Committee on Environment and Communications handed down its Report and Recommendations on Environmental Biosecurity (Commonwealth of Australia 2015a).

In accordance with the established process for all Senate Inquiries, the Australian Government is presently considering the recommendations from the report and will respond in due course.

Amongst the 22 recommendations listed in the Inquiry, there are two areas examined in the report that are very pertinent to the current cost-shared SEQ Program. Firstly, the Senate report makes specific reference to the special attention needed to address the ongoing threat posed by tramp ants, (Recommendation 16) particularly via the cargo pathway. This finding is reflective of the comprehensive public submission process throughout the inquiry, and highlights the need for heightened awareness from everyone involved in the import supply chain to the threat posed by tramp ants and the need for swift and effective response if detected.

Secondly, is the recommendation on the need for further investment to support scientific expertise (Recommendations 12 & 13) to maintain Australia's biosecurity science capacity. The SEQ Program has contributed to the development of new science and technical expertise that can be utilised in response to future biosecurity response activities for RIFA and other tramp ants but also potentially for other biosecurity surveillance and response activities.

Reference in the Senate report to the threat posed by tramp ant incursions supports the view that the continued efforts to eradicate RIFA are in the national interest.

4. Determining an appropriate level of funding for the SEQ Program

4a. Summary

In order to maximise the possibility of eradicating RIFA and to optimise a whole of life eradication plan, the Review Panel commissioned modelling to determine the optimal strategy, funding needs and timeframe, and has suggested possible mechanisms for cost sharing designed to incentivise the immediate beneficiaries of the SEQ Program to ensure that eradication occurs quickly.

To assist in determining the future cost of the SEQ Program, the Review Panel engaged the services of the Monash modelling team of Daniel Spring and Luke Croft (Monash Model) to help determine the feasibility, time required and cost of a series (four) of alternative treatment and surveillance scenarios to achieve eradication. The Monash Model was chosen due to their familiarity with the problem and to provide consistency with other work commissioned by the program and other stakeholders (Spring 2010; Spring et al. 2011).

4b. Optimisation modelling results

4b. i What is the Monash Model ?

The Monash Model attempts to determine when and where RIFA colonies will be present through time. The model utilises both known and unknown colony points and predicts how the future distribution and density of RIFA changes in response to alternative management options. Modelling was undertaken to determine how alternative eradication strategies could be maximised across alternative treatment and surveillance efforts (e.g. treatment (aerial baiting, ATV baiting, ground baiting and direct injection of nests, and surveillance), ground teams, and remote sensing). The model did not estimate the SEQ Program's entire eradication effort, only the treatment and surveillance component.

4b. ii What does the model do?

The Monash Model starts with the given known locations of RIFA colonies in SEQ and then estimates a number of unknown colony points. The unknown colony points introduce the underpinning element of all eradication campaigns: uncertainty. If all colony points were known, eradication would be guaranteed and the time required is short as all colony points could be targeted at once and the population eradicated. The model uses a time step approach to model the impact of eradication and how untreated and surviving colonies then disperse before the next round of eradication efforts occur.

The model optimises its treatment and surveillance management strategy by allocating resources on a cost-effectiveness approach. In other words, the model allocates the first dollar amount (i.e. cost of alternative eradication effort) to where it receives the greatest impact (i.e. $/colony points) and then allocates the next dollar amount to the next area which has the second highest impact and so on until all funds are allocated.

Once an area is treated, the model identifies a probability of eradicating all colonies within that area. These survivors (i.e. post-eradication effort) and all untreated colonies (known and unknown) then act as nodes of dispersal across the landscape, inclusive of recolonising an area that was treated in the prior round.

The model then repeats the funding optimisation and the eradication response cycle until the probability that RIFA are eradicated reaches a predefined level of success (e.g. 95%). A probability of eradication success then provides the model with a degree of uncertainty to account with not finding and destroying the last colony.

4b. iii Limitations of the model

While all care has been made to introduce a given level of risk and uncertainty about the effectiveness of the RIFA eradication campaign, this model just like all models is limited by heuristics and the methodology used. Heuristics in modelling is derived from the developers subjectivity, preferences, knowledge, the limits of the methodology used and what the model was set up to achieve. If we had perfect knowledge modelling is not required. Models provide a platform to list what is known and to test what is not known but the solution may give the impression of certainty when in fact the outcome is derived from a simplified overview of the problem and a set of binding assumptions.

Optimisation is a mathematical process that can define the optimal allocation of resources to achieve an objective (maximum profit or to minimise costs) when we have perfect knowledge. However, rarely do we have certainty about the future and often the underlying risks and uncertainties about the modelled solution are forgotten once a solution is found. All care must then be taken to interpret the solutions presented in the findings to prevent an overly optimistic timeline to eradication, a new eradication campaign, or a fixed budget number from being adopted and preventing the eradication of RIFA from occurring.

The model merges biological sciences with cost data (i.e. costs of control per hectare) to define the cost-effectiveness approach to determine how to spatially allocate resources to eradicate RIFA. Due to the complexity and limitation associated with recursive optimisation, the current SEQ Program's approach to eradicating RIFA cannot be modelled. In this case the modelled output provides guidance on an appropriate budget and strategy and not necessarily the optimal approach.

The model allocates funding on an annual basis by prioritising areas to treat and survey. However, the SEQ program determines where it attempts to eradicate and introduces a two-year treatment cycle. In other words for a given hectare of land:

- The model may lead to a situation where it will only treat that area in one year and then reallocates funding to the next area; and
- The SEQ Program will treat that unit of land six times over two consecutive years.

Despite these limitations, the Monash Model was commissioned by the Review Panel as it was decided that:

- These results would provide consistency with past commissioned work;
- It was the best available model; and
- That the time and resources required to commission, parameterise, and calibrate a new model, as well as error check the new model, would prevent the Review Panel from meeting its time constraints and consume more funding that the Review Panel had at its disposal.

4b. vi Scenarios modelled

To provide a considered opinion, the Review Panel commissioned scenarios as listed in *Table 8: Scenarios Commissioned by the Review Panel*. These case studies were designed to provide guidance for the Review Panel to examine:

- If it is possible to eradicate RIFA within a 10-year timeframe;
- The level of funding that would be required to achieve eradication; and
- If new expenditure on RSS could help achieve eradication.

To examine the issue of funding, the Monash Model was used in a two stage approach. Firstly, preliminary analysis was undertaken to examine the budget required to achieve eradication within a 10-year period with and without having RSS available. Based on those preliminary findings, the scenarios were subsequently refined to investigate the value of the RSS towards eradication with greater accuracy. In essence this process has provided the Review Panel with four scenarios, one where RSS is not utilised by the SEQ Program and three scenarios exploring the benefit of RSS.

For each of the four scenarios, a minimum number of two annual treatment and surveillance budgets were examined. After preliminary results the 'No RSS' was limited to examine only two treatment and surveillance budgets ($24 and $30 million per annum and only 40 simulations were examined). The number of simulations defines the number of times the model was run to examine the range of outcomes (i.e. time take to achieve eradication) possible from this approach. A number of simulations are required because:

- A binding budget constraint can cause the model to have a number of alternative starting points (i.e. it is too expensive to attempt to eradicate all RIFA colonies in one year, so the cost-effective nature of the model may result in forcing the model to choose between two alternative areas with the same benefit, if there are insufficient funds); and
- RIFA respond to any management actions taken (i.e. change to the distribution and density of that cell and neighbouring cells post management), including the choice not to implement management.

The decision to limit the 'No RSS'; scenario to examine only two budgets and 40 runs of each was due to the preliminary findings suggesting that RIFA was unlikely to be eradicated if RSS was not adopted. To explore the value of the RSS technology, the Review Panel examined three with RSS options, two options where RSS could be ready to operate within a year, with alternative levels of sensitivity in detecting RIFA colonies, and a scenario where the new RSS would take two years before it was operational. The 'RSS, 38%, 1 Year delay' scenario assumes that the technology purchased had identical abilities as the RSS technology that has been phased out.

The 'RSS, 50%, 1 Year delay' scenario assumes that the technology advances in RSS would provide the SEQ Program with a better sensitivity rate (i.e. 50% versus 38%). The 'RSS, 50%, 2 Year delay' assumes that an additional year will be required to further research and develop RSS technologies/platforms to gain the additional resolution benefits. To add rigour and check the sensitivity of the model, these three adopt 'RSS technology' scenarios were examined against 11 alternative treatment and surveillance budgets, starting at $15 to $30 million in $1.5 million increments, and that for each scenario and alternative budget the model undertook 200 simulations. Assumptions used for each scenario are listed in *Table 9: Assumptions Used for Each Scenario*.

Table 8: Scenarios Commissioned by the Review Panel

Scenario Names	Description	Annual Treatment and Surveillance Budget Runs
No RSS	RSS technology is not used to eradicate RIFA	$24, $30 million
RSS, 38%, 1 Year Delay	RSS technology is used to eradicate RIFA. It takes 1 year to get RSS technology ready for operation. The model uses a 38% sensitivity rate, which was the actual rate of past RSS	$15-$30 million in $1.5 m increments
RSS, 50%, 1 Year Delay	RSS technology is used to eradicate RIFA. It takes 1 year to get RSS technology ready for operation. The model uses a 50% sensitivity rate, which is the estimated sensitivity rate of the latest RSS technology	$15-$30 million in $1.5 m increments
RSS, 50%, 2 Year Delay	RSS technology is used to eradicate RIFA. RSS improves detection by 50%. It takes 2 year to get RSS technology ready for operation. The model uses a 50% sensitivity rate, which is the estimated sensitivity rate of the latest RSS technology	$15-$30 million in $1.5 m increments

The Scenario names are used within the results section to identify the findings.

Table 9: Assumptions Used for Each Scenario

	No RSS	ALL RSS Scenarios
Assumptions Used	- 50% budget used for treatment - 50% of budget used for surveillance - Re treatment, priority is given to areas where ants are most dense, without any priority given to proximity to the edge Re surveillance, equal priority is given to abundance and proximity to edge	- 50% budget used for treatment - 50% of budget used for surveillance (30% RSS budget and 20% other surveillance) - Re treatment, priority is given to areas where ants are most dense, without any priority given to proximity to the edge - Re surveillance (both RSS and other), equal priority is given to abundance and proximity to edge
Number of Simulations	40	200

4b. iv Model results

Key to the results is determining when (in years) all of the simulations for each of the scenarios reached 100% eradication. An upper bound of 10 years funding has been used to lock in a funding timeframe that is realistic. A fixed time frame provides clear signals that the funding will be guaranteed for a given amount of time.

The outputs from the model have been reformatted by the Review Panel to examine in which year 50%, 95% and 100% of all simulation have been eradicated, as illustrated in *Figure 6: Monash Modelling Results*. The Review Panel chose to use full year funding as a cut off to provide some clarity for this discussion. In some cases rounding to the nearest year may under or overestimate the time required to obtain a given level of eradication. Therefore the 50% line represents the year in which 50% of runs have successfully eradicated RIFA, the 95% line represents the year in which 95% of the runs have successfully eradicated and 100% indicates that all runs have eradicated in that year for a given level of funding..

From *Figure 7: Percentage of Simulations per Scenario by Budget that did not have 100% eradication by year 10*, all scenarios could achieve a point where 95% of all simulations were eradicated. For the 'No RSS' 95% eradication could only occur if $30 million was spent annually on treatment and surveillance. That the 'No RSS' scenario was not able to eradicate all the results, suggests that without investing in the RSS, eradication is not possible within 10 years.

Figure 6: Monash Modelling Results

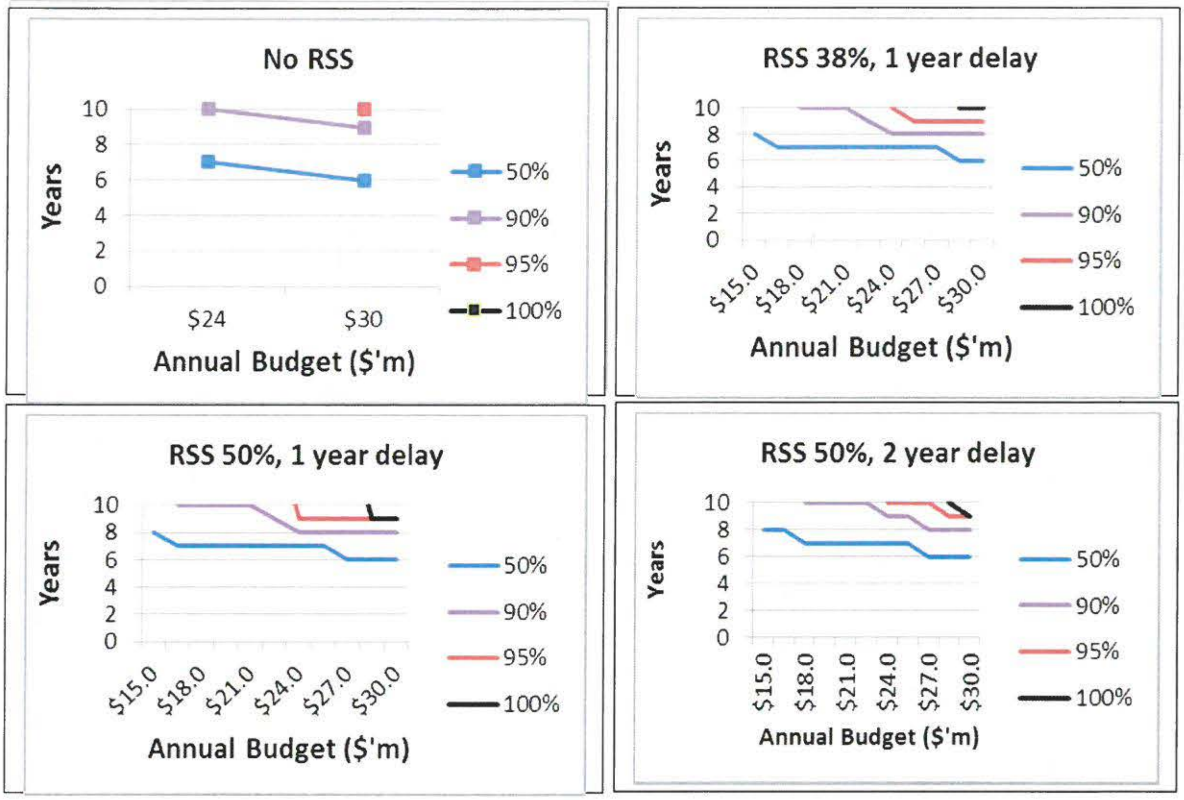


Figure 7: Percentage of Simulations per Scenario by Budget that did not have 100% eradication by year 10, helps interrogate this finding by presenting the percentage of model simulations that were not eradicated after 10 years by scenario and by budget. The trends in these findings can be explained as follows. Even if $30 million per annum was allocated to treating and surveying RIFA for 10 years, without the RSS, the Monash Model suggests that 5% of all simulations have not been eradicated.

This data is presented in *Figure 8: Comparing the two budget points – Percentage of Simulations by Scenario, by budget that did not have 100% Eradication by Year 10* to highlight the outcome from all scenarios for the same budgets.

For the RSS scenarios, a higher sensitivity (i.e. the RSS 38%, 1 year delay versus the RSS 50%, 1 year delay) logically leads to more of the scenarios being eradicated for the same level of funding. The additional year delay in getting the RSS operational (i.e. RSS 50%, 1 year delay versus RSS 50%, 2 year delay) at small budgets has a greater number of simulation not being eradicated.

Figure 8: Comparing the two budget points details the data for the consistent budget analysis for all case studies highlighting the outcomes from allocating an identical budget to different scenarios.

Figure 7: Percentage of Simulations per Scenario by Budget that did not have 100% eradication by year 10

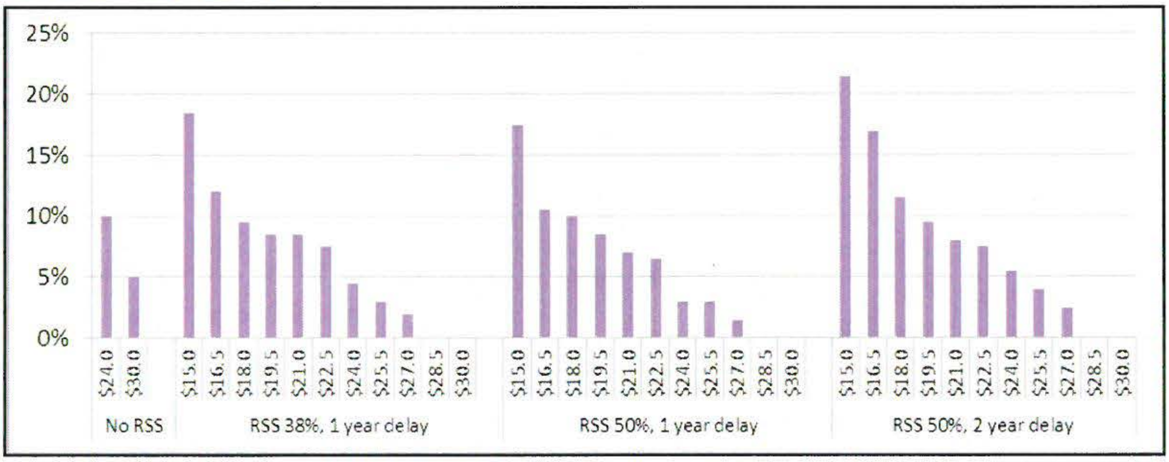


Figure 8: Comparing the two budget points – Percentage of Simulations by Scenario, by budget that did not have 100% Eradication by Year 10

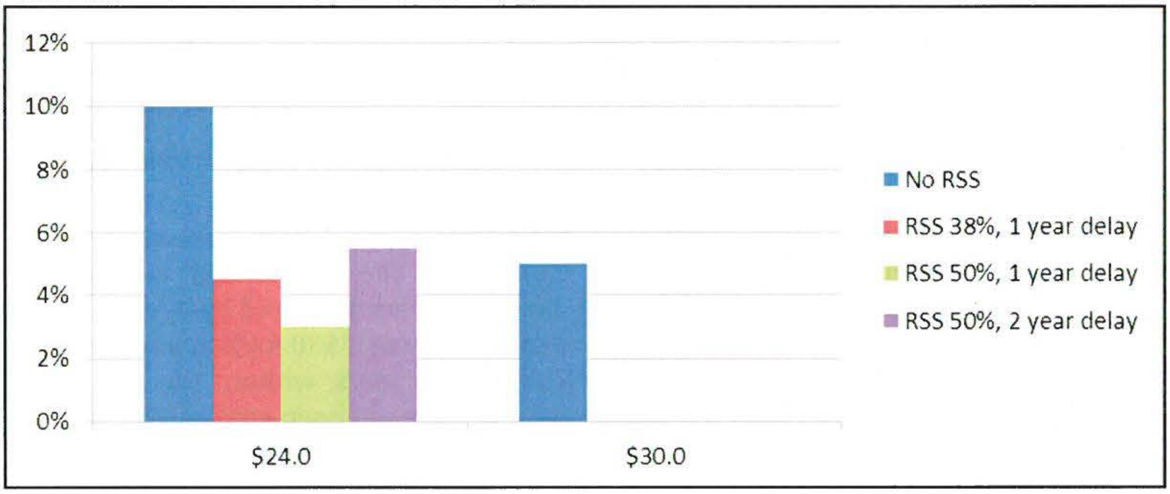
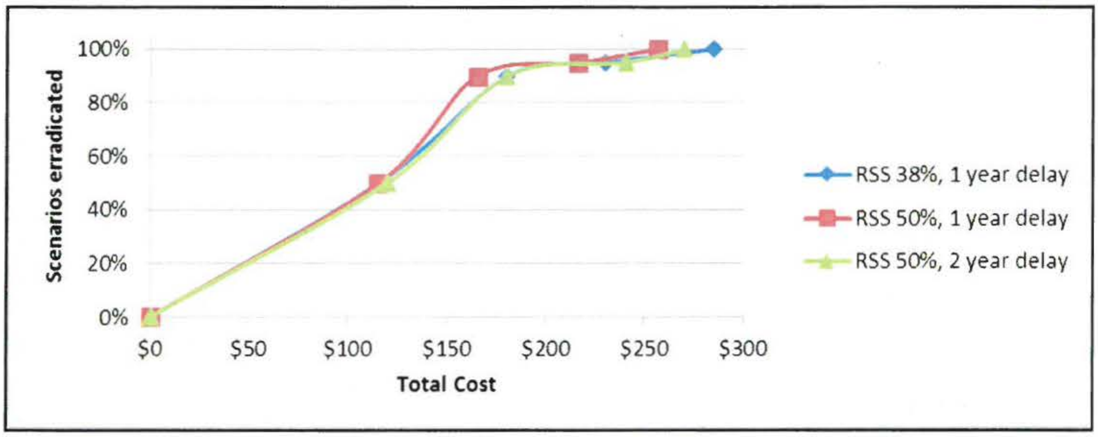


Figure 9: Eradication and Diminishing Marginal Returns highlights the problems associated with eradication as the cost to eradicate the last individuals in an invasive species rapidly increases. The total cost is the product of the number of years to eradication and the annual budget. The diminishing marginal returns from the project budget can be expressed as follows. For approximately $120 million, 50% of all scenarios are eradicated for all three with RSS scenarios. For an additional $60 million, for the RSS 2 year delay scenario, an additional 40% of all scenarios reach eradication (i.e. for about $180 million 90% of all simulations are eradicated) but it then takes another $70 million to achieve 95% of all scenarios eradicated (to a total of $240 million).

Figure 9: Eradication and Diminishing Marginal Returns



4b. iv. Concluding comments regarding the Monash Model results

The Monash Model is the model that has been used to review the SEQ program in the past and helped provide insights into issues associated with the delimitation program. Like all models the focus should be on the story it tells. The modelling should be used to compare options run by the same model. The results from this analysis are logically broadly consistent with Hafi et.al. 2014 in that in order to achieve RIFA eradication:

- The current budget is insufficient;
- A constant budget is needed to optimise plans;
- Better detection equipment (RSS) would help reduce the time required for eradication;
- The optimal funding mix between treatment and surveillance is open for debate; and
- An investment of time is required, which is possibly more or less than the model predicts.

It should be noted that these results provide guidance only. No model can be used to prove something will happen. It is impossible for any model to provide with 100% certainty that RIFA has been eradicated from an area in 1 to 20 years in the future.

The most optimistic point of the model results is approximately $22-24 million per annum. This is consistent with the cost of the program at the highest level of funding in the past (assuming a proportion of additional costs for other eradication activities).

5. Recommendations for the Future of the Program

5a. Summary

Based on the recent distribution and density of RIFA in SEQ and the model outcomes, the current level of funding is insufficient to eradicate RIFA.

The panel has worked with the program to determine an indicative cost for other eradication activities taking into account the current split in budget (63%/37%), but also the increases in these activities needed as a result of the increased treatment and surveillance budget to $24 million. The program has provided a breakdown of the budget to be included in the development of a detailed eradication plan in the future. (Refer to Annex D).

Based on the modelling results ($24 million for treatment and surveillance) combined with the $14 million for other eradication activities, the panel considers that a budget of $38 million per annum for up to 10 years is necessary to achieve eradication.

The modelling indicated that with a $24 million treatment and surveillance budget, a significant amount of the infestation should be eradicated within 5 years. Specifically, with a $24 million treatment and surveillance budget, within 5 years there is a 91.96% reduction in the number of infested areas.

Although the number of infested areas is greatly reduced the area requiring search and/or treatment is not proportionately reduced. This is best explained by noting that the majority of infestations will be easier to find and remove because they are near known infestations. These are the 91.96% of infestations removed in the first five years. Once they have been removed, the remaining nests require a larger search area per infestation because they are further from known infestations and more difficult to find.

The panel considers that to maximise the chance of eradication, the SEQ Program should have some flexibility within this budget to either carry over funds for a subsequent year (if the ramping up takes longer than expected) and/or forward spend if there are key advantages in doing so.

Recommendations

The panel considers that it is still technically feasible and in the national interest to eradicate RIFA and recommends the continuation of the eradication program.

The panel also notes that there is only a small window of opportunity left to eradicate RIFA.

Recommendations cont.

The panel considers that to achieve eradication, an overall cost of the SEQ Program would be approximately $38 million per annum for up to 10 years comprised of:

- $24 million for treatment and surveillance activities and surveillance activities (inclusive of RSS operations); and
- $14 million for other critical eradication activities.

5b. Treatment and surveillance

Currently, the SEQ Program is focusing on repeated rounds of treatment of areas outside the core infested area (which is a specified subset of suburbs in the Restricted Area). Outside the core receives 3 treatments per year for two years, while inside the core receives 2 treatments per year for two years. The areas being proactively treated include known high density infestation and high risk areas (disturbed land, waste facilities and polygyne infestation). All confirmed reports of new infestation are treated as they are found.

The SEQ Program currently focuses on surveillance around areas of newly detected infestation outside the core area, high risk areas outside the core and post-treatment validation. Specifically, surveillance activities are directed towards:

- Post treatment validation surveillance – supporting the removal of movement controls in areas that are no longer infested;
- Passive surveillance – reporting of suspect ants by members of the public;
- Sentinel sites – areas of land used to monitor for the presence or absence of RIFA;
- Odour detection dogs – validation surveillance of infestation outside the core area, and delineation surveillance of new outlier infestations; and
- Delineation of new infestations – surveillance undertaken around the known area of infestation to determine its extent.

The way to stop spread would be to eradicate all nests in the infested area. The problem is that this cannot be done instantaneously so some ongoing component of the surveillance program has to consider spread risks. The Modellers recognised that the large size of the delimited area, makes it infeasible to apply bait or surveillance effort over every hectare of land within the area. Therefore, treatment and surveillance efforts were modelled over the areas estimated to be most likely to contain RIFA.

The model's 'optimal operational strategy' aims to simultaneously find and remove infestations in areas where RIFA are most expected to occur, and reduce the risk of invasion boundary expanding. The model strategy includes baiting confirmed detections (based on areas that have been predicted to have the highest abundance/density first), ground searching the immediate vicinity and then undertaking further RSS around the detections (in rural areas).

The Model allows for 'speculative' RSS to occur near the estimated invasion boundary (area estimated to contain 90% of RIFA infestation), based on the estimated likelihood of ants spreading to that area, to mitigate the risk of the infestation boundary expanding. The larger the budget, the more RSS 'speculative search' will occur. All the strategies modelled involved much larger areas of surveillance than previously undertaken by the SEQ Program, particularly in rural areas.

Although only an estimate, the modelling indicates that with a $24 million treatment and surveillance budget:

- Treated areas = between 50,000 and 150,000 hectares/year;
- RSS area = 100,000 hectares/year; and
- Ground search area = 17,000 hectares/year.

In 2015–16, the SEQ Program is aiming to complete 90,000 hectares of treatment. In 2014–15, the SEQ Program treated 55,192 hectares (mostly aerial) (whilst doing RSS to determine the boundary of the infestation). It would be safe to infer from the modelling results that with double the current treatment and surveillance budget, the SEQ Program would be able to significantly increase the current area treated for RIFA. It would also be possible for the SEQ Program to undertake up to 6 treatments of all known infestation to achieve a 99.9% likelihood that no RIFA remain. It would not be necessary to use different treatment and surveillance practices for inside and outside the core.

As at the end of March 2016, the SEQ Program had completed 5,130 hectares of delineation, 120 hectares of targeted and 870 hectares of validation surveillance (majority by dogs). In total, 6,120 ha of ground surveillance was undertaken from July 2015 to end March 2016. It would be reasonable to say that based on the modelling, ground search would also increase, although not significantly.

The SEQ Program is no longer undertaking RSS. Based on the modelling, the panel recommends that the SEQ Program recommence RSS to undertake broadscale surveillance. At a $24 million treatment and surveillance budget, the modelling allowed 100,000 hectares per year to be surveyed using RSS. The SEQ Program completed 84,986 hectares of RSS in 2014–15 (however this was for delimitation purposes). Therefore, a 100,000 hectare target per year would be reasonable.

The Modellers also suggest that that it would be beneficial to the SEQ Program to combine its expert knowledge on RIFA eradication with mathematical spread modelling as a tool for informing when, where and how treatment and surveillance should occur using predicted RIFA spread. The model used to undertake the analysis for this report has been provided to the SEQ Program to enable model runs to be completed periodically using latest program data. Development of this type of tool to inform future planning may be something the SEQ Program could investigate further.

Recommendation

> The panel considers that the value of the Monash Modelling is to estimate a quantum of funding required for the SEQ Program to achieve eradication and recommends that the SEQ Program develop the specific treatment and surveillance actions (what, where and when) to be implemented as the part of the development of a new response plan.

5c. Future research and development - new technologies and wider benefits to other Biosecurity Programs

5c. i Summary

The SEQ Program has invested in and developed new innovative technologies and methodologies that have delivered significant positive impacts for the SEQ Program. These processes and technologies have subsequently spilled over to other national biosecurity programs providing national benefits to the economy. The Review Panel considers that these approaches could be further leveraged for the national benefit by engaging in international technology transfer either via international aid programs (including training) and reducing the pre-border biosecurity risk of reinfestation. This outcome demonstrates a substantial and practical return on investment to all cost-share partners.

In addition to our specific responses to the terms of reference (Sections 3–6), the Review Panel noted that the tools, techniques and applications developed by the SEQ Program had been utilised by other biosecurity programs. On reflection, the Review Panel noted that while some outputs had already been adopted, providing realised benefits (i.e. costs savings from the transfer of outputs) to Australia, the full suite of outputs could potentially be applied to future incursion/eradication responses both in Australia and internationally. The Review Panel considered these impacts to include:

- Remote sensing surveillance (RSS) technology and operational systems;
- Habitat and disturbance modelling;
- RIFA genetics and its application in identifying the origin of new incursions and in spread modelling;
- Development and application of odour detection dog teams;
- Proof of treatment efficacy;
- Effective community engagement strategies; and
- Enabling rapid response and cost reductions for other RIFA and tramp ant incursions.

We review each of these aspects below, but in effect all these facets of the SEQ Program are integrated and mutually dependent.

The science program has contributed significantly to the successes to date of the SEQ Program and is needed to do so into the future. The habitat and disturbance modelling developed by the program has enabled cost-effective targeting of surveillance and community awareness efforts by concentrating these in high-risk areas, while genetics research has given the program important insights into how RIFA is spread and the effectiveness of the control effort (e.g. evidence for splintering of populations and reduced genetic fitness). The program is considering further refinements to these focus areas and potential improvements in these and other science areas are outlined below.

Increased treatment and surveillance (as suggested by the modelling) along with campaigns to increase passive surveillance (asking the public to check for RIFA) will increase the number of diagnostic samples received by the SEQ Program. This would require additional scientific technicians to confirm ants, better equipment, better facilitated labs and colony rooms. There is also the potential for new diagnostic technologies to be utilised and developed.

5c. ii Remote sensing surveillance technologies

The panel has observed the RSS technologies and analysis used by the program and found them to be an effective tool for large-scale area surveillance in comparison to other types of surveillance methods available.

The adoption of modern RSS technology has the potential to provide cost savings and improved aerial imagery, detection sensitivity and application compared with the previous RIFA RSS program.

The Monash Modelling commissioned by the Review Panel found that the continued utilisation of RSS technologies as a surveillance technique would have significant cost savings and efficiencies for the SEQ Program. The modelling also found that any future program strategies that don't utilise RSS technologies are vulnerable to the risk that undetected infestations exist in rural areas. Based on the outcomes of the modelling work, and the budgetary considerations, the panel's view is that it would be extremely difficult to achieve eradication if the program does not invest in new RSS technologies and continue its usage as soon as practical.

The SEQ Program anticipates improving the efficacy of RSS through further research and development of available and innovative RSS technologies to increase the level of sensitivity and accuracy. This may include using previously unused technologies, such as light detecting and ranging (LIDAR), 3D modelling, stereo photography, UAVs, biological probes, and odour detection equipment. The utilisation of UAVs could also allow for an initial treatment of a suspect mound to inhibit/restrict further spread once detected.

RSS with the level of sensitivity achieved in the past or a greater level of sensitivity and accuracy, and when used in combination with the existing dog and other on-ground surveillance methods, will enable the SEQ Program to achieve the best possible results and the most cost effective budget for RIFA detection and eradication.

The algorithm used in the previous iteration of RSS provided a sensitivity sufficient for the primary task of delineation. The panel has noted that there is now an opportunity to improve the current (or develop a new) detection algorithm to increase the detection rate and reduce false positive output. There is also an opportunity to capture additional examples for algorithm training by conducting off-season (warmer months) training using infested areas of similar environment and weather conditions (such as Pensacola, Florida – previously used for training the existing algorithm).

There is an opportunity to incorporate existing models and data (such as habitat, disturbance, spread) to ensure the most efficient use of the technology.

To achieve significant improvements on the previous RSS technology, an extensive investigation and potential collaborations with multiple organisations, including private enterprise and universities, will be required. This lead-in and development phase may therefore take between 1–2 years before a new solution is able to be made operational. The panel has noted that the delays to identify new technologies will need to be carefully weighed against the need to recommence RSS as soon as practical, even at the current levels of sensitivity.

However, unless there are significant new technology advances which enable RSS to occur in warmer months, it is unlikely that full operational implementation of remote sensing will be able to commence before May 2018. As RSS has only been successful in the winter months in the past, and allowing for the time to develop the new technology, Australian trials would not realistically be able to occur until May–September 2017. This assumes RSS Research and Development would be able to commence in 2016, off-season trials could occur in the United States by early 2017, and the trials are successful with no problems occurring that would impede operations.

Wider applications of the methodology could also be considered in future incursions of other pests and pathogens by tweaking the spectral 'signals' and algorithms used to automate detection.

The RSS methodologies developed as part of the SEQ Program have potential future usage in delimiting more quickly and efficiently any future incursions of RIFA (and potentially other tramp ant species) in Australia. The Review Panel noted that Australia should expect to experience a greater rate of new RIFA incursions from its trading partners for two reasons.

First, RIFA continues to colonise new areas in the United States and RIFA is now present in Taiwan and southern China. Second, the recent findings by the Senate inquiry into Biosecurity (Commonwealth of Australia 2015a) noted that over the past decade the volume of air passengers has grown by 80%, sea containers by 82% and bulk cargo increased by 16%. RIFA is a negative externality of trade and as RIFA expends its range and density internationally, and as trade volumes grow, the rate of new incursions will increase.

However, by engaging with our international trading partners and sharing (potentially at cost and/or as a form of development aid) the outputs from the SEQ Program, the future risk from new incursions may be reduced. If the outputs from the SEQ Program are successfully adopted by other countries and they lead to a reduction in the density and/or distribution of RIFA, then Australia benefits from engaging in pre-border quarantine measures.

The panel considered whether the SEQ Program should undertake surveillance in the RSZ and beyond, and whether broadscale remote sensing is the best way to deploy this effort. An adaptive allocation of resources to buffer surveillance is recommended based on progress within the core and any evidence of ongoing occurrence outside it.

Recommendation

The panel considers that the SEQ Program should invest in updated remote sensing technologies.

5c. iii Rapid response and cost reductions for other incursions

A clear benefit of the SEQ program has been that the infrastructure, staff, community engagement and public relations and IT systems that have been developed and subsequently utilised by other programs, enabling much more rapid responses to new incursions and eradications. This has been particularly the case for the two Yarwun eradications of RIFA, the more recent response to RIFA at Port Botany, in the electric ant program in Far North Queensland, browsing ant in Northern Territory and Western Australia, and for detections of Asian honeybees and yellow crazy ants (whilst funding was provided). These responses would not have been possible had this capacity and experience not been available (Refer to *Figure 1: Assistance provided to exotic ant incursions throughout Australia*).

5c. iv Wider application of odour detection dogs

Techniques used to train and deploy the odour detection dogs used for find RIFA have also been applied in the electric ant program in Far North Queensland, where dogs trained to detect both electric ant and RIFA have successfully been deployed. *Figure 10: Wider application of odour detection dogs* shows where the SEQ Program's odour detection dogs have undertaken operational activities.

Figure 10: Wider application of odour detection dogs

Currently, the electric ant (or little fire ant) program at the University of Hawaii is exploring the possibility of using odour detection dogs on islands where electric ants are not endemic (C. Vanderwoude, personal communication, 30 June 2015). Detector dogs have also been used in the Argentine ant (*Linepithema humile*) programs in New Zealand to detect ants.

The SEQ Program currently has 10 operational dogs, which includes one dog used for community engagement. A further three dogs are in training to replace existing dogs. The working life of the dogs is on average 6–8 years; however, this can sometimes be a lot less if the dog becomes sick or ceases to work effectively. The unit currently operates at full capacity and is often deployed to assist in other incursions, detracting from the program's ability to deliver on SEQ operations. The dogs have proven to be a valuable marketing tool.

There are a number of positive reasons for increasing the capacity of the odour detection dog team, including:

- Dogs are used to delineate high risk infestations (i.e. public areas such as parks, schools etc.) and to undertake validation surveillance to confirm areas are clear from RIFA (to enable clearance around infested sites). If more areas are to be treated, more dogs will be required;
- Dogs are a multipurpose and highly sensitive surveillance tool (99.9%), available all year round and able to operate in a variety of environments and conditions;

- Dogs can be used in a variety of surveillance situations including proof of freedom surveillance to demonstrate treatment/eradication efficacy, active detection, delimitation and clearance of risk materials (nursery stock);
- Dogs would be critical for proof of freedom to confirm eradication success at the end of the program; and
- Aside from providing a highly sensitive detection tool (RIFA and electric ant detection dogs offer a surveillance sensitivity of a minimum of 99%), the use of dogs is an excellent stakeholder engagement and public relations tool creating profile and public support.

The cost of the odour detection dogs used for validation and delineation surveillance as well as community engagement was not considered in the modelling. If treatment were to increase significantly as suggested by the modelling, there would need to be a corresponding increase in the odour detection dogs in order to complete the required delineation, validation and community engagement activities.

Recommendation

The panel considers that additional investment in odour detection dog surveillance will be required to help validate RSS and declare eradication/proof of freedom. The panel recommends that the detection dog surveillance unit be increased to 22 dogs over the next three years.

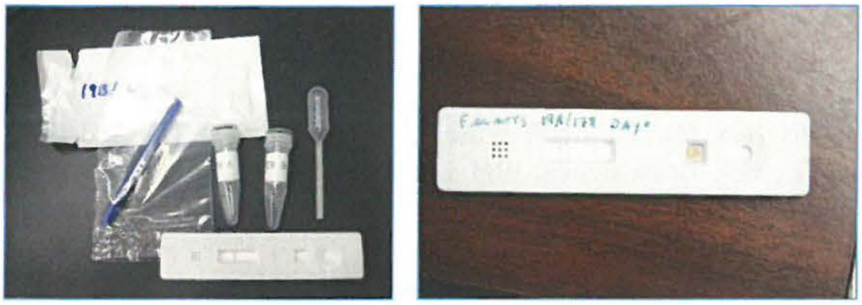
5c. v Field Ready Kit

Lateral flow immunoassay kit has been developed in the United States for field identification of RIFA (*Figure 11: RIFA Identification Kit*). Five individual ants are needed to obtain consistent results in 10–15 minutes. To date, over 40 species (from a variety of subfamilies) have been tested including other *Solenopsis* species. A field-ready kit that can be used by staff or quarantine inspectors to quickly verify the presence of RIFA can vastly improve surveillance efforts that are critical for the eradication process. Sample kits are available for validating its ability to distinguish RIFA from Australian ants.

The technology will be available through a non-exclusive biological materials license via the USDA, Office of Technology Transfer. The biological materials license is utilised for unpatented biological materials with an execution fee that generally ranges from $US2,000 to $5,000 depending on the material and use. Royalty payments are also due if a product is sold. A preliminary estimated cost of $2–$10 per kit has been suggested by the inventor. Commercially available plant pathogen detection kits, for example a tomato spotted wilt virus immunoassay kit sells for $US5–7 (Agdia ImmunoStrip® ISK 39300). However, an end user who licenses the technology will be able to contract a manufacturer or produce an identification kit in-house, thus actual costs are not known.

Figure 11: RIFA Identification Kit

RIFA Identification kit: Components fit within an 8 x 15 cm bag (L). RIFA positive test with two red lines (R).



Recommendation

> The panel recommends that the SEQ Program tests and validates the effectiveness of the RIFA identification kit in Australia.

5c. vi Bait efficacy

RIFA baits typically consist of either a toxicant or an IGR bait dissolved in a food attractant, such as soybean oil, which is then absorbed onto a corn grit carrier that results in a granular formulation that can be broadcast by seeders or fertilizer spreaders (Lofgren et al. 1975, Williams et al. 2001). However, this formulation degrades in wet conditions when the carrier absorbs water, becomes mushy, and is not foraged upon by the ants. This reduces the efficacy of these types of baits in irrigated lands such as golf courses and market gardens, and during rainy seasons (Barr et al. 2005; Souza et al. 2008; Hara et al. 2014). Thus, effective RIFA bait applications currently must avoid water exposure to maintain the integrity of the bait.

Efforts have been made to decrease the effects of precipitation on corn-grit carrier. Kafle et al. (2010) replaced the corn-grits with dried distiller's grains solubles (DDGS). Water-soaked RIFA bait that utilised DDGS as a carrier caused greater RIFA mortality than water soaked commercial RIFA bait. The DDGS formulated RIFA bait is produced by Chung Hsi Chemical Plant, Ltd (Taipei, Taiwan) and contains the active ingredient pyriproxyfen. In an attempt to protect the corn-grit carrier, the corn protein zein was sprayed on standard bait, resulting in decreased water absorption and improved bait performance; however, this bait formulation is not commercially available (J. Chen, personal communication).

A bait containing metaflumizone demonstrated effectiveness against the electric ant after 7 and 14 days of weathering (including rain). This product is currently marketed as 'Siesta' (BASF) but its efficacy against RIFA after rain exposure requires evaluation. Prolonging the physical stability and palatability of RIFA baits exposed to water could markedly advance the ability to control RIFA under wet conditions and simplify the scheduling bait applications.

Another approach to improve ant baits is the use of water-absorbing, polyacrylamide hydrogels (e.g. Miracle-Gro® Water-Storing Crystals, The Scotts Company LLC, Marysville, OH; Deco Beads, JRM Chemical, Cleveland, OH) as a carrier for aqueous insecticidal active ingredients mixed into sugar solutions (Boser et al. 2014, Buczkowski et al. 2014a,b; Rust et al. 2015) (*Figure 12: RIFA on Hydrogel Bead*). Because hydrogels absorb water, it is hypothesised that irrigation or rain would rehydrate desiccating baits and prolong their palatability to RIFA. This type of moisture laden bait formulation was readily accepted by Argentine ants in arid habitats (Boser et al. 2014).

Figure 12: RIFA on Hydrogel Bead

Water soluble active ingredients, such as thiomethoxam, formulated as liquid or gel ant baits have been mixed into sucrose solution and absorbed into hydrogels. This resulted in a more convenient field dispensable delivery method of liquid bait. Using this method, significant reductions (94–99%) of field populations of Argentine ants have been reported (Boser et al. 2014; Buczkowski et al. 2014b). Other active ingredients of varying water solubility have reported efficacy against other non-lipid feeding pest ants such as the tawny crazy ant, *Nylanderia fulva* and the yellow crazy ant, *Anoplolepis gracilipes* (D. Oi, unpublished data, S. Kropidlowski, personal communication). The above three active ingredients formulated as a sucrose solution bait have not been evaluated against RIFA. Boric acid in sucrose solution can cause significant worker and brood reductions in laboratory RIFA colonies when provided continuous bait access for several weeks (Klotz et al. 1997).

Water tolerant RIFA baits could extend the availability of baits by maintaining their integrity through irrigation or precipitation. In addition, the hydrogel formulations with their moisture retaining properties, have the potential to enhance consumption by RIFA at the soil/bait interface under dry, hot conditions. Currently, hydrogel formulations are not sold commercially, but instead formulated by researchers.

Evaluating commercially available water resistant baits and incorporating effective baits in the SEQ Program has the potential to improve the efficiency of RIFA baiting operations.

Recommendation

The panel notes that monitoring the development of experimental water resistant baits may eventually yield further improvements to RIFA treatment.

5c. vii Improving treatment applications

RIFA bait applications by Unmanned Aerial Vehicles (UAV) are being tested in Taiwan (Hung et al. 2015). Broadcasting bait by UAV may improve the efficiency of treating terrain inaccessible by ground equipment. When the technology is available the efficiency of UAV bait applications should be compared to current bait application equipment for both accessible and difficult terrains.

Recommendation

The Panel recommends that the SEQ Program investigate bait application via UAV, when, the technology becomes available and is cost effective.

5c.viii Habitat and Disturbance Model

Both the Habitat Model and the Disturbance Model could be used for future incursions of RIFA in Australia to help direct surveillance efforts to delimit infestations. Given that the incursions in Brisbane were detected some years after ants had originally established, incursions elsewhere in Australia may follow the same pattern and face the same challenges. Also, given mining machinery has been directly implicated in several RIFA incursions, future incursions may well be first detected in remote areas where only risk modelling integrated with RSS will be able to accurately delimit the extent of spread efficiently and economically.

As with the RSS system, this modelling could potentially be adapted for use in management and eradication programs for RIFA internationally.

As detailed in Section 1d, this modelling uses landsat imagery to define suitable RIFA habitat. It helps the program know where RIFA are likely to be now and where they are going to be in the future. There are still some improvements that could potentially be made to enhance its efficiency and ease of deployment.

A Bayesian mixture model has been used with the current model, which had issues integrating with the spatial systems used in the RIFA program. A better spatially-integrated model would assist in improving operational efficiencies. This would be especially useful as the program moves back into a focus on eradication and where rapid identification of potential RIFA habitat will be critical in directing surveillance, public awareness campaigns and prophylactic treatment.

Additionally, the model was only developed for urban situations and has had to be adapted to rural areas, and the model may require further refinement to improve its effectiveness in these situations, especially given the low density of nests in rural areas. The panel notes that the SEQ Program investigate the use of PhD scholarships to undertake this task.

Recommendation

The panel considers that it may be useful to examine if there are other approaches to modelling that could utilise the knowledge gained so far, but which are more easily integrated with operationally deployable Geographic Information Systems.

5c. ix Genetics

A thorough knowledge of the genetics of RIFA colonies has been a key part of the science underpinning the program so far and will continue to be so into the future. The tools developed to analyse RIFA genetics are used in a number of ways to enhance program outcomes. Operationally, these have involved identifying the geographical source of new colonies using colony relatedness, thereby determining if a colony has dispersed naturally (and how far it has spread from a pre-existing colony) or via human-assisted movement. This is based on a selective targeted sampling system (and so identifying potential non-compliance with movement restrictions), as well being able to differentiate between reinfestation or persistence in treated areas.

In more recent years, genetic tools have also been used to assess the effectiveness of the program by identifying the degree of splintering and lowering in genetic fitness (inbreeding leading to male sterility) of the SEQ population. This has provided vital independent feedback that the strategies being employed by the program do work to eliminate a very high proportion of RIFA colonies. This work will continue to provide critical feedback as to the success of the program.

Routine genetic testing is used to determine whether RIFA colonies are monogyne (single queen colonies) or polygyne (multiple queen colonies). Early knowledge of this status has important practical and operational implications. Monogyne colonies tend to occur at low densities but have high dispersal abilities (they can fly up to 5 km) which translates operationally in the need to draw wider restriction boundaries around such nests. On the other hand, polygyne colonies can occur at very high densities but have rather poorer dispersal capabilities, meaning that smaller restriction boundaries can be drawn around these nests. Because polygyne colonies have multiple queens, they are also more likely to be dispersed via human-assisted pathways, which translates operationally to greater emphasis on movement controls and tracing around such colonies.

The field of molecular genetics is progressing at an extremely rapid pace and the program should take advantage of new technologies in this field as they develop where appropriate. For example, 'Next Generation' Sequencing (NGS) enables much higher throughputs of genetic information and would be beneficial to the program in expanding the genetic data available for rapid operational decision making. BQ approved the purchase of NGS equipment in April 2016. This equipment will have broader application and benefit for the management of biosecurity responses within Queensland.

So far the SEQ Program, through BQ, has been able to access the required molecular biological expertise needed to run these systems and correctly apply and interpret the data generated. Currently, this expertise resides in a single individual, so there are some risks to the program in this regard. It would be highly beneficial to the SEQ Program to increase the spread of permanent capacity in this field to address this risk.

Recommendation

The panel recommends that the SEQ program have access to Next Generation Sequencing (NGS) equipment, as it would significantly expand the positive impact that the genetics research and application has had on the success of the Program.

The panel recommends that the permanent capacity of the program to access and use technological advances in the field of genetics be increased.

5c. x Alternate chemical controls

To date, the SEQ Program has mostly relied on two chemicals to control RIFA nests, namely fipronil for direct nest injection and the IGR pyriproxyfen as part of baits used for more widespread control and to 'mop up' areas surrounding known nests. Both these chemicals have demonstrated high effectiveness, nonetheless it may be prudent for the program to continue to keep a watching brief on alternate chemicals as they become available.

Two recent examples mentioned by the program were 'Siesta' (metaflumizone) which is claimed by its manufacturer to achieve 100% kill of ants in 3–4 days, although published data suggest the kill rate is somewhat lower (87% after one month, and similar to indoxacarb).

Serious consideration should be given to using fast acting baits (colony death within seven days) in place of fipronil injections to improve the efficiency of treating individual nests especially where equipment access is difficult. 'Impede' (fipronil) is another recent entrant into this market and which may hold some promise. In the panel's view, given the demonstrated high efficacy of fipronil (as used in direct nest injections) and pyriproxyfen (used in baits) and well-established methods for their application, these products should remain the focus for the program for the foreseeable future.

Recommendation

> The panel recommends that fipronil (for direct nest injections) and pyriproxyfen (for baits) should remain the focus of the program's treatment practices for the foreseeable future. However, it would be prudent to keep a watching brief on new chemicals as they become available and evaluate the efficiency of using fast-acting baits instead of fipronil injections.

5c. xi Biological control

A focus of long-term management efforts in the United States has been the introduction of parasitic flies (so-called decapitating flies) as well as the dissemination of a microsporidian pathogen of RIFA. Both are common natural enemies of RIFA in its native range, with different species of the flies specialising in parasitising the various sizes of RIFA workers. In the United States, introduction of these flies has yet to show a significant impact on RIFA populations, with relatively low parasitism rates observed (1–3%). However, it has been suggested that these flies may impact on RIFA success more through their effects on foraging efficiency and subsequent lowering of competitive success of colonies than outright losses due to parasitism, since worker ants forage less (at least in the daytime) in the presence of the flies. The microsporidian pathogen, *Kneallhazia solenopsae*, debilitates queens and can eventually kill colonies. Reductions in field populations have been documented (63%); however, infection prevalence and colony densities of infected populations fluctuate.

It would be advisable for the program to monitor developments in the use of biocontrols, but the panel suggests that any serious consideration of their use in Australia would only be necessary should eradication fail and if the program were to then transition to management (or aggressive containment). In addition, Australia has native *Solenopsis* species, which would complicate the feasibility of introducing biocontrol agents, given the potential negative impacts on these endemic species and the need to carry out extensive specificity testing.

There is also current research in the United States into the use of viral diseases (e.g. SINV-1,2 and 3) as biopesticides for RIFA control. SINV-3 appears to be the most promising of these viruses and is capable of causing significant worker mortality and cessation of brood production. Recent work has indicated that this virus is host-specific to South American *Solenopsis* species and so could potentially be deployable in Australia even in the presence of native *Solenopsis* species, although local specificity testing would still be necessary. At present none of these viruses has been commercially produced, however SINV-3 can be deployed in bait formulations, and its efficacy outside the laboratory is being evaluated.

The program should maintain a watching brief on further developments with these potential biopesticides, although again this is a potential control methodology that may need to be more seriously considered only should it prove effective in the field in the United States and eradication fails in Australia. Other innovative biocontrol approaches could involve exploiting cytoplasmic incompatibilities in *Wolbachia* bacterial symbionts, although this work is in the very early stages of characterising which *Wolbachia* strains are present in RIFA populations (Oi and Valles 2009; Oi et al. 2015).

Recommendation

> The panel recommends that the SEQ Program monitor developments in the use of parasitic flies and pathogens to control RIFA, but suggests that any serious consideration of their use in Australia would only be necessary should eradication fail and if the program were to then transition to management (or aggressive containment).
>
> The panel recommends that the SEQ Program maintain a watching brief on further developments with potential biopesticides, although again this is a potential control methodology that may need to be more seriously considered only should it prove effective in the field in the United States and eradications fail in Australia.

5c. xii Publications

The panel noted that the output of peer-reviewed scientific publications from the program has been somewhat less than might have been expected given the volume of research undertaken since the program's inception. This should not be seen as a reflection on the quality of the science that has been undertaken, but more as a consequence of working within a government organisation where the priorities have not traditionally been weighted towards external publications, but more on internal reporting (including to the national funders and the multiple program reviews) and servicing of the operational needs of the program.

Recommendation

> The panel recommends that the program seek wider engagement with Universities and seek to participate in appropriate research programs and projects, for example engaging PhD students to work on specific projects, or providing data and/or advice to collaborators.

5d. Public Relations

5d. i Community engagement

Community engagement has been instrumental in the success of the program since the initial detection of RIFA in 2001. It continues to be an important component of the program which has resulted in increased public reports of RIFA. This is evidenced by the spike in public reports that occurs immediately following a targeted community campaign in particular areas. The 'Beyond the Edge' campaign is a case in point.

Public reporting has accounted for up to 70% of new detections over the last four years (SEQ Program data). Currently, the program's community engagement activities include: information briefings and training of council, industry and landholders in targeted areas to provide a deeper level understanding of identification and control of RIFA; a school education program; public displays; communications to residents in current treatment program; and targeted media promotion. Community engagement responses to new detections are tailored to each situation.

The value of passive surveillance (voluntary searching by the public) is difficult to quantify and as a result, the Monash Model has not attempted to assess the potential increases in public/passive detection probabilities, such as increases arising from information campaigns strategically targeted at locations where new infestations have occurred. However, the modelling study does state that the provision of information to the public to assist them in recognising RIFA and their mounds is an important activity that potentially could have substantial impact on program outcomes (particularly in urban areas where there is more likelihood of detections occurring by the public).

Given the optimal strategy suggested by the Monash Model involves high levels of RSS which currently is not generally used in built up urban areas (based on old RSS technology), the optimal strategy proposed relies on reporting by the public through passive surveillance as the key means of large scale surveillance in SEQ's urban areas. To enhance the optimal strategy suggested by the modelling, the community engagement effort, particularly in urban areas, might need to increase to enhance the overall surveillance effort. The panel has noted that an increase in resourcing for treatment and surveillance will also contribute to greater public awareness due to the visibility of treatment programs and odour detection dog teams.

Due to the costs involved, it is not possible for the SEQ Program to treat and undertake ground surveillance in all areas of SEQ, particularly in built-up residential areas. Therefore the SEQ Program must rely on passive surveillance and public reporting. If the Program's treatment effort increases, it is important that community engagement effort is resourced to support this effort. This will need to be included in the planning processes to support an increased treatment and surveillance budget.

Although approximately 95% of people in Brisbane have an awareness of RIFA, the proportion of people that think RIFA is still a problem in SEQ is significantly lower (56.2% in 2013) (Queensland Treasury and Trade 2013). This reflects the effectiveness of the suppression of RIFA in many of the area where they were highly prevalent, but there is also an opportunity to improve messaging to increase public understanding, community vigilance and participation in eradication efforts (overcoming complacency). The aim of the SEQ Program's community engagement is to change people's behaviour in recognising the significant risk that RIFA present, actively checking their yards and reporting any suspicious ants.

There may be an opportunity for the SEQ Program to investigate and utilise more contemporary methods of communication through the utilisation of technologies, which provide a more efficient and cost-effective means of reaching the public and influencing their behaviour. These could include (but are not limited to) the following:

- Increasing market research opportunities to help inform the SEQ Program's communication strategies and methods of reaching our target audiences. Market research is critical to understanding our target audiences' behaviours and the way they interact with the program i.e. how they absorb information and how they want to be communicated with. All of which would inform the program's messaging and help define the most effective tools to use to influence and encourage target audiences' active participation;
- Investigating improved system functionality to enable use of email and mobile SMS instead of mass postal mail-outs (which are costly and in-efficient);
- Developing a mobile application for use on handheld personal devices to assist the public with the identification of RIFA and assist them with surveillance at their property. This application will be a crucial tool to collect data for those properties that have been surveyed by the occupier to provide the program with confidence of the absence of RIFA. The new application will potentially provide the public with current information about suburbs affected by movement controls and restricted items;
- Upgrading of information/database systems. The maintenance of and extraction of client information from existing databases is inefficient, being both time consuming and resource intensive. The existing databases do not provide accurate recording of communication and engagement effort in order to evaluate the effectiveness of program activities and to make informed decisions about future activities;

- Continuing the use of social media to cater to growing online audiences and enable linkages to reporting functions; and
- Expanding online functions to provide target groups more timely and self-automated information such as hosting of webinars, e-learning for industry, council and residents, resulting in increased efficiencies and time saving.

It should be noted that the upgrading of systems as described above would require a substantial investment, which is difficult to estimate without ascertaining what functions are required. However, the systems (when developed) could also have broader application and benefit for the management of other biosecurity responses.

The current population for the Greater Brisbane region is more than 2 million[36] people and growing each year. To effectively reach this number of people the SEQ Program will need to investigate mass communication channels i.e. television advertising, which comes with significant cost (at least $100,000+).

A key focus of any future campaign will also need to be increased public education about movement controls and the legislated responsibility to report RIFA. This is a part of Queensland's new biosecurity legislation.

The panel has noted the potential efficiency gains that could be achieved if the community engagement activities in the SEQ program could function with a higher degree of autonomy from the established Queensland Government approval processes for communication activities. Given the cost-shared oversight of the SEQ Program, community engagement would be improved by some independent branding to reflect the shared ownership.

Recommendation

> The panel considers community engagement activities should be increased and coordinated with the proposed increased treatment operations, where community engagement is implemented just prior to scheduled treatments in an area to help delineate local infestations for treatment (as is currently done).
>
> The panel recommends that community engagement should be maintained in high risk areas for new incursions and around the edge of the infestation.

[36] ABS 3218.0 Regional Population Growth Australia 2013–14

5d. ii Compliance and movement controls

Compliance and movement controls are a crucial component of the current and future Program. Movement controls are designed to address human-assisted spread of RIFA which is far less predictable than natural spread and therefore more difficult to plan for and potentially harder to control.

New Queensland biosecurity legislation will come into effect on 1 July 2016. The panel has discussed this with the program and found that the new legislation introduces regulatory concepts that could assist the program with compliance and movement controls.

The SEQ Program considers the powers under the legislation to be adequate; however, there will need to be some effort to ensure the public is aware of their responsibilities and obligations under the Act. This provision in the new legislation also strongly underpins the need for increased community engagement activities in the program to elevate public awareness.

With increased awareness of biosecurity obligations generally comes an increase in reporting of suspected breaches of the legislation. The SEQ Program's compliance inspectors will need to assess and investigate all reports of suspected breaches of legislation and the panel has noted the importance of ensuring that this is adequately resourced.

Under the new Act, there is the provision for the establishment of Compliance Agreements with any other party to enable the self-management of biosecurity risks. Whilst this option has not currently been explored for businesses dealing with RIFA, the panel recommends that the program pilots this provision in the new legislation with major players such as local government councils, QRail and Ergon Energy that rely on contractors or subcontractors.

Voluntary compliance is often improved with the presence of regulatory officers in the area and increased public awareness of the need for movement controls. The size of the Restricted Area and the number of industry types that move restricted items makes this task difficult with the current number of compliance inspectors. Currently, each compliance inspector is responsible for approximately 50 suburbs.

An increase in operations could lead to more detections in rural areas (e.g.. Lockyer Valley, Gold Coast, or North Brisbane). If this occurs additional compliance officers would be required to deal with the increased demand for movement approvals.

The panel has noted that further investment in IT capabilities and mobility would significantly improve the productivity of the compliance inspectors, as it would give the inspectors the ability to issue reports and check the compliance history of businesses in the field rather than having to spend time in the office transcribing information.

Currently, there is no nationally harmonised system for specifying movement conditions for hosts of pests and diseases for interstate trade (even hosts for certain pests and diseases differ between states). For an eradication program, this is a risk if states are specifying movement conditions that have no scientific basis for mitigating the risk of spread. It is also very confusing for businesses that move hosts within and out of the state, as there can be different risk mitigation processes involved for both types of movement. Further, if a national program is managing the risks of human assisted spread to beyond the area of infestation (biosecurity zone), these risk mitigation measures should be recognised and adopted by the individual states and territories.

Recommendation

The panel recommends that the SEQ Program has the capacity to increase the number of compliance officers to ensure there is coverage of the whole infested area.

5d. iii Information technology systems

IT systems sit in the background of all the key activities undertaken by the program. The recording, storing and re-accessing of data is integral to the program's business. The IT system should also assist program staff by providing functionality to prioritise areas and report on areas treated. The capacity of the program's IT infrastructure and software needs to be considered as a part of any significant change in focus or increase in size of the program. Additional personnel undertaking more activities, means there will be increased data flow into the program's IT systems. These systems need to be able to handle increased capacity for current tasks, but if they are also able to undertake more tasks – freeing up personnel to deal with exceptional, rather than routine tasks – this will allow the whole system to be more efficient and cost beneficial.

Current examples of areas where upgraded IT systems could add immediate value (in terms of reducing personnel time, and reducing manual entry errors) would be spatial and compliance components for the current system (FAMS), and a better information recording system for community engagement activities.

Recommendation

The panel considers that the SEQ Program's IT systems need to be maintained and improved to enable real-time reporting.

5e. *Future governance arrangements*

5e. i Independent structure/Tramp Ant Commission

The work done by the Queensland Government since the first detections of RIFA in 2001, along with the substantial investment made by cost-shared partners has made a direct contribution to the overall improvement of national capacity to deal with the ongoing threat posed by RIFA and other tramp ants.

There are compelling reasons that support the long-term need to retain a core skill set and a nationally available resource to respond to future tramp ant detections and incursions, beyond the current SEQ Program.

Arguably the most important reasons are the need to preserve:

- Tramp ant eradication management (frameworks, structures and planning for response plans, declaring proof of freedom etc);
- Scientific capability;
- Corporate knowledge;
- Rapid response capacity;
- Treatment technology and tools;
- Industry liaison and collaboration; and
- Public awareness and national coordination.

There are some established precedents that can inform thinking around future options for institutional arrangements to address the threat posed by tramp ants. In response to the threat to Agriculture posed by the Australian plague locust, the Standing Committee of Agriculture agreed in 1974 to create the Australian Plague Locust Commission (APLC). The APLC commenced operations in 1976 and has continued a program of monitoring, forecasting, research and control since that time on Australian plague locusts and, from 2002 onward, two additional species.

The functions of APLC include:

- Implementing preventative control strategies;
- Minimising risks to the natural environment, human health, and markets for Australian produce;
- Employing targeted research;
- Monitoring and forecasting;
- Promoting best practice in locust control;
- Maintaining expertise through participation in international programs; and
- Engaging with industry and the community.

It is acknowledged that the role and functions of APLC relate to the management of locusts, which are endemic pests, however the APLC's mandate reflects the same attributes and skills needed to address exotic pest threats such as tramp ants.

The retention of the current core skill set to address tramp ant threats, for example the creation of a National Tramp Ant Commission, could be readily achieved via a Memorandum of Understanding between the Commonwealth and the States – without the need for separate legislation. This would require a clear commitment from all funding parties for an ongoing basic level of funding to operate, with an additional variable component from importers and the cargo sector that are engaged in pathways of risk creation. This organisation would have a clear mandate to specifically address the tramp ant threat and response, with access and benefits for all portfolios affected by tramp ants, including agriculture, infrastructure, tourism, environment and health.

Other considerations include the development of a charter of operation, agreed between the funding partners, which sets out the scope of activities during an eradication campaign. It will be equally important for the charter to specify the scope of activities when an eradication program is not underway, including research, targeted surveillance, industry extension and community engagement.

5e. ii National Environmental Biosecurity Response Agreement

The NEBRA is a deliverable under the Intergovernmental Agreement on Biosecurity, and sets out emergency response arrangements, including cost-sharing arrangements, for responding to biosecurity incidents that primarily impact the environment and/or social amenity and where the response is for the public good.

Recent incursions of RIFA in Yarwun, Port Botany and the Brisbane Airport – and an incursion of browsing ant in Darwin – have been managed under the NEBRA.

The Review Panel has considered the possible merits of utilising the NEBRA for the future cost-shared program. The SEQ Program meets the policy intent of the NEBRA, which is defined in the agreement "to establish national arrangements for responses to nationally significant biosecurity incidents where there are primarily public benefits". It is important to note that, whilst the NEBRA is not a legally binding agreement, it was introduced whilst the SEQ Program was active.

The Review Panel has considered whether the future SEQ Program could be managed under the NEBRA, noting that Section 1.2 (c) of the NEBRA states "this agreement will not displace or replace the operation of any of the related biosecurity arrangements". The definition of related biosecurity arrangements is "any biosecurity-related agreements, contracts or arrangements already existing at the time this agreement comes into effect". One interpretation of the current SEQ Program would be that due to it commencing in July 2001, it would therefore fall under the definition of a pre-existing biosecurity arrangement and cannot be replaced. On the other hand, if each renegotiation and subsequent funding arrangement is considered to be a new agreement, then a future SEQ Program could be viewed as a new agreement and not in conflict with Section1.2 (c).

Another potential area of conflict is that the NEBRA process is initiated through an 'outbreak' being reported; the definition of an outbreak includes it being a recent detection. The interpretation of 'recently detected' could be taken in the NEBRA context to mean within 24 hours. In Section 6.1 (Step 3), a party is required to notify the Commonwealth reporting point within 24 hours. This is further evidenced by the fact that in making the decision on whether initial containment activities undertaken by the affected party are eligible for reimbursement, the reasons for the party not notifying the reporting point within the 24-hour timeframe must be considered.

It is clear from these examples that if the future SEQ Program was to be managed under the NEBRA, then the potential areas of conflict would require some form of a waiver, or alternatively the NEBRA would require change.

Currently, the SEQ Program is funded through ministerial agreement and, recently, this has been decided on a single financial year basis. In general, decisions on NEBRA responses are made by the NMG and, as such, approval processes should be more streamlined for NEBRA responses. However, under the NEBRA there is an annual cap of $5 million after which decisions are subject to ministerial agreement and budget processes.

If the SEQ Program is brought under the NEBRA (as it currently stands), it will far exceed the cap of $5 million. A process similar to the current one would be required for SEQ funding approval and therefore procedural efficiencies are unlikely to be gained. A further consideration would be the potential to jeopardise the approval process for any subsequent NEBRA responses, as these would also need ministerial approval given the funding cap would have been exceeded.

One immediate advantage for cost-shared partners of managing the future SEQ Program under the NEBRA is that it provides a set of pre-determined rules for many aspects of undertaking a response. For example, there are auditing and reporting requirements for cost-shared expenditure.

It is important to note that the NEBRA may be amended with an exchange of letters between all parties through the Commonwealth, State and Territory Government ministers responsible for biosecurity matters. Also, any party may withdraw from the agreement with six months' notice. Alternatively, changes could be considered as part of the forthcoming NEBRA five-year review.

The Review Panel concluded that unless AGMIN could agree to a suite of waivers from the NEBRA, applicable to the SEQ Program, then it would not be feasible to conduct future arrangements under the NEBRA and the current off- deed response arrangements would continue. Were AGMIN to proceed with a future cost-shared SEQ Program under the NEBRA, a five-year review of that agreement is being undertaken this year and could provide a suitable mechanism for progressing appropriate changes.

Recommendation

> The panel recommends that, subject to acceptance of the Review Panel's report, cost sharing partners sign off on a whole of life response plan.
>
> The panel recommends that AGMIN consider the establishment of a permanent governance body to oversight the program implementation and preserve the capacity of government to respond to tramp ant threats.

5f. A Possible Future Funding Model

Over $320 million has been allocated to eradicate RIFA. A changing budget forces the SEQ Program into reprioritising its strategies and abilities to eradicate RIFA. This process leads to resource waste and increases the time to eradicate RIFA as the funds no longer match the eradication campaign. While funding is limited and has an opportunity cost, if the national goal is to eradicate RIFA, the difference between funds requested and funds provided prevents the SEQ Program from maximising the eradication benefits from past expenditure.

Additional benefits would be gained from a known multi-year budget if the SEQ Program had the ability to introduce flexibility with the way expenditure occurs. By providing the SEQ Program flexibility to forward spend or conserve funds on a given calendar year, it then has the opportunity to take advantage of opportunities when RIFA are climatically vulnerable (i.e. years of low spread), or quickly eradicate new areas of infestation if RIFA are rapidly spread by flood events in the SEQ corner.

While prior review recommendations were helpful in determining if RIFA had been contained, no additional funding was provided to examine the delimiting question. Subsequently, funding earmarked for eradication was reallocated towards the delimiting program. This reallocation of funding has allowed RIFA to re-establish in areas it had been eradicated.

*Table 1: SEQ Program Funding*The Review Panel recommends that from all evidence gathered, a further $380 million is required to achieve eradication. The current funding arrangement is a 50–50 spilt between the Federal Government and the States and Territories. In its purest form, this is a public pays system and there are no direct costs applied to those individuals whose actions reduce the effectiveness of eradication nor are costs applied to those individuals (including other areas of government (local, state and federal) who benefit from the removal of RIFA.

The nature of market failure ensures the need for government expenditure to combat biosecurity breaches to prevent economic inequality, maintain iconic social activities and preserve environmental assets. However, such a system also encourages 'free riding' from those who are risk creators and those beneficiaries who could contribute to the eradication of RIFA. The Review Panel notes that the adoption of a new cost-sharing arrangement between the Federal Government and the states may help encourage the management of all eradication campaigns and that there are benefits from investing in a cost-recovery model. However, it is important to note that risk creators (or 'risk exacerbators' as these organisations do not necessarily create the risk) include a broad range of industries and government entities including farmers, developers, road construction by all levels of government and any other bodies that disturb soil.

A Possible Way Forward
The first step for consideration is locking in the budget, the timeframe and understanding that there are elements of responsibility and accountability.

There must be an acknowledgement by the funders that:

- It will take time to scale up the SEQ Program to meet is goals;
- Deviations, or discontinuity in funding will reduce the probability of eradication;
- The costs for new incursions of RIFA into Australia have not been estimated by the panel;
- On-going demands on these resources for non-project work (i.e. SEQ Program's participation in other eradication events) is an opportunity cost which will delay timeframes and increase costs;
- There is a level of risk that eradication is not possible;
- Where possible, the SEQ Program needs flexibility in its budgets to allocate resources efficiently and as effectively as possible in responding to opportunities; and
- They are responsible for ensuring that the goals are achieved as quickly and efficiently as possible.

Options for Extending the Existing Funding Model
The requested funding would almost double what has so far been allocated to eradicating RIFA. Biosecurity funding is an investment in Australia's economy, its way of life and the preservation of its unique ecosystem.

The question that requires further consideration is: *Should the requested funding come from the current existing sources or should a proportion of costs be passed back to society and if so, who should pay and what percentage?* The percentage is not explored in this document.

Introduction of new funding groups
If the SEQ Program's cost-shared partners decided to pass some of the eradication campaign costs back on to those groups who benefit and those that create risk, then careful explanation of the supporting justification for this will be essential.

The SEQ Program has gathered extensive information over time and significant efforts have been placed into defining the risk creators, the beneficiaries and the financial contributors (DAFF 2013).

This information helps understand the complexity in attempting to charge the risk creators and those that benefit[37] from the eradication of the biosecurity event. The panel noted that in the United States experience, human health and environmental impacts are as significant, if not possibly more significant than the agricultural impacts.

The objective would be to shift part of the cost-burden away from the public purse and back to those benefiting from eradication. There is a risk that this will create some disharmony but the introduction of taxes and levies on biosecurity is neither new nor is biosecurity unique in efforts at expanding the funding base. While most efforts at increasing biosecurity funding have been applied to the producer or consumers to deal with meeting compliance costs[38], or specific industries (e.g. chestnut blight[39]), it might be time to consider a levy to obtain funding from the creators of risks to be placed on the following groups:

- The wider community at a range of alternative scales – National level, a State/Territory level, or directly on those local boundaries who are experiencing the biosecurity outbreak or may be affected by the biosecurity outbreak;
- Large capital owners who benefit from RIFA eradication; and
- Those risk creators who fail to maintain agreed biosecurity protocols to limit the risk they pose to society.

There are multiple ways of applying the levy or transferring the costs to beneficiaries and risk creators:

- Partial or full cost recovery on those risk creators who fail to comply;
- Direct cost to large capital owners whose assets are at risk:
    - For example, RIFA are known to destroy electrical cables and the NBN is likely to be at risk from RIFA; and
    - Councils currently are not charged for having RIFA removed from land under their control.
- A permanent or temporary levy based on gross income (as per the Medicare Levy or the Flood levy); and
- An addition to household bills:
    - Electricity (as per the ambulance levy); and
    - Council rates (as per the green levy).

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[37] While individuals may still experience some costs associated with a biosecurity event, they are still not paying the full costs of eradicating RIFA on their property

[38] http://www.agriculture.gov.au/SiteCollectionDocuments/biosecurity/australia/cost-recovery-arrangements/charging-guidelines-2015-16.pdf

[39] There is a 1% levy/export charge on Chestnuts to help pay for the chestnut blight response http://www.agriculture.gov.au/ag-farm-food/levies/rates/chestnuts

Table 10: Increasing funding from beneficiaries

	Year							
Funder	1	...	...	...	....	...	....	N
Federal Contribution	50%	50%	50%	40%	40%	40%	40%	40%
All States and Territories	50%	50%	50%	40%	40%	40%	40%	40%
Beneficiaries & risk Creators				20%	20%	20%	20%	20%
TOTAL	100%	100%	100%	100%	100%	100%	100%	100%
The final design of the cost sharing arrangement is not the responsibility of the review panel.								

Logically, there are direct costs to implement such a system and these costs would need to be recovered. However, the extensive experience available in the government agencies would be able to deliver current best practice on this approach. This would need to include both the scale (number of years implemented, which areas pay e.g. local, region, state, and nation) and scope (which groups pay).

Refer to Annex E: Biosecurity funding: The User Pays v Public Pays v Cost Sharing Arrangements.

Recommendation

The panel recommends that alternative funding options need to be further considered and scoped to work toward a more appropriate funding balance between risk creators and risk beneficiaries (specific and general) for the SEQ Program.

This should include consideration of general and specific risk beneficiaries (local governments, private landholders) as well as risk creating entities (utility companies, land development interests).

5g. Critical review points

The current Response Plan for the SEQ eradication states that any of the following triggers would necessitate a review by TACC to determine if the risk profile had changed to such an extent that NMG should be notified of a threat to the program objectives:

- The effectiveness of remote sensing is compromised, for example by the rate of false negatives/positives;
- The new area of infestation is more than 600 ha in a given financial year;
- Infestation is detected beyond the 30 km boundary;
- Reproductive areas of infestation are found beyond the area scheduled for remote surveillance; and

- A dramatic and ongoing decline in community support is evident.

Following discussion with the program specialist staff and consideration by the Panel, it is recommended that future program review triggers should be high level, triggering an activation only when the program's eradication objectives are compromised. It is also important that the triggers can be measured and monitored in a meaningful way.

The two recommended review triggers are substantive in nature and reflect the need for measurable triggers that focus on whether the new infestation can or cannot be dealt with by the SEQ Program.

Future Triggers for an immediate significant detection report

The current SEQ Program Response Plan also specifies that the following events will trigger an immediate significant detection report from Queensland to TACC:

- Polygyne colonies or multiple monogyne colonies representing a reproductive infestation beyond the 5 km buffer; and
- Human-assisted spread resulting in infestation outside of the Restricted Area.

TACC will consider information in any significant detection reports to determine if redirection of any activity or resources is required in response. All infestations which are not the subject of significant detection reports will be reported in the quarterly reports provided to TACC.

Future Reporting Requirements

The panel recommends that further efficiencies could be achieved if the SEQ Program were to provide reports to TACC on a six monthly basis, rather than a quarterly basis, as the current practice unnecessarily diverts resources away from core activities that lead to the direct achievement of eradication objectives. This would also be in line with other recent response plans developed under NEBRA.

The panel recommends that reporting on significant detections to TACC in accordance with the triggers above be deleted from any future plan. In recent years, the preparation of Significant Detection Reports for TACC by the SEQ Program has required significant time and effort, but which has not resulted in any redirection of activity or resources as intended (apart from the Brisbane Airport detection which was a new incursion, being proven to be genetically distinct).

The intent of the existing triggers could be met by reporting this information in the SEQ Program reports (currently done each quarter) rather than the preparation of separate reports. This would be an efficiency gain with no material loss to the effectiveness of the program.

Recommendation

The panel recommends that the triggers, which would necessitate a review by TACC to determine if the risk profile had changed to such an extent that NMG should be notified of a threat to the program objectives, should be high level, triggering an activation only when the Program's eradication objectives are compromised.

The panel recommends two review triggers for the future eradication plan:

Trigger 1 – New infestation discovered that is beyond the capacity of the SEQ Program to treat. For example, this might include a large number of multiple infestations detected in a local government area that has not previously been infested.

Trigger 2 – There is a significant reduction in the efficacy of the baits used by the Program, as demonstrated by Science monitoring trials, and there are no alternative effective baits available.

5h. Proof of Freedom – options to declare success and validate declaration

Eradication projects are of two types. One type aims to kill 100% of the target population in a single, short control event, as with aerial baiting for insular rodents (e.g. Cromarty et al. 2002). For this type, everything has to go right on the day, so meticulous planning and 'start rules' are critical as the project has one chance at success and little or no information on success is provided by the control itself.

The second type aims to achieve eradication by a sequence of control events, often changing methods as they proceed, which sequentially reduce the target population to zero (e.g. Parkes et al. 2014). For this type, there is a chance to learn and adapt as data are collected, and so 'start rules' are less critical. However, knowing when to stop and declare success is often difficult. Eradication of the SEQ RIFA incursion is of the second type because even if the whole population could be treated in a single 'event' such as aerial baiting, this would have to be repeated several times over at least two years, and in reality the project will also deploy other control tools across many years before success could be declared and validated.

There are several ways any declaration of success for the RIFA population can be validated, from a simple 'wait and watch' option that provides no estimate of the probability that 'no ants detected equals no ants present' but in time would demonstrate failure, to several models based on repeated surveys without detection or explicitly spatial models using the estimates of detection probabilities of the surveillance tools.

5h. i Wait and Watch

Many eradication projects, particularly of the one-hit type, adopt arbitrary rules for declaring success based simply on the time elapsed since the last known detection. For species with a high rate of increase, any undetected survivors are likely to reproduce and eradication failure becomes obvious as the population recovers and spreads after a few years. Conversely, success is claimed after some period when the lack of evidence allows an assumption that no undetected ants have survived and reproduced. This approach does not provide estimates of the probability of success and so declarations of success by the program staff might be contestable.

The judgement of success needs to be based on rules set before the final stages of the program. For example, after the final round of baiting is completed over areas of known infestation the program might claim success if:

- No validated RIFA nests are reported by the public for two years;
- No RIFA nests are detected by dogs at any of the proposed sentinel sites for two years; and
- No validated RIFA nests are detected by remote sensing for two years.

For most ant eradication projects, a period of two years without detection has been used as a rule of thumb to declare success (Hoffmann & O'Connor 2004). The exponential rate of increase of RIFA is estimated at 1.39 (Keith & Spring 2015), so a nest with reproductive individuals will produce up to 4 new nests per year or 16 over two years. In the case of monogyne colonies, which can spread over several kilometres from the founding nest (Vogt et al. 2000), detection via passive or active surveillance is more likely and therefore failure would be confirmed.

The SEQ Program will have ongoing reports of ants from the public after the initial judgement that none are left and after the two-year rule of thumb period. These will need to be checked – and hopefully all found to be false. The program has the data on the proportion of these false positives from current surveillance data.

5h. ii Validation based on estimates of probabilities that none found equals eradication

There are several modelling methods that allow estimates of the probability that no ants detected means no ants are present. Some models also prescribe how much more surveillance of different types (without detection) and where this should be deployed to increase this probability to some level of comfort based on the costs of the extra surveillance versus the costs of falsely declaring success – and having to redeploy the control effort.

(a) Repeat surveys across the transition from ants present to ants potentially absent

One group of models uses a standard set of surveys to measure across the transition from known presence to putative absence. A string of surveys with zero detection is used to estimate the probability that eradication has been achieved (Regan et al. 2006; Rout et al. 2009). Several sub-models are described in these papers, including the optimal number of surveys without detection, a stochastic dynamic model and a sighting rate Bayesian model where detection rates are assumed to decline as ant colony density declines. This group of models do not require estimates of the detection abilities of the surveillance tools, but do require the surveys are the same (effort and methods) across the transition period.

Therefore, what constitutes a 'standard survey' is clearly a critical issue that will have to be resolved by the program. Coverage of the whole risk area, sampling stratified by site-risk profiles, cost, and the start and end dates across the transition period are some obvious parameters for the program staff to consider. For example, public reporting has the advantage of coverage, albeit with differences between urban, peri-urban and rural zones, while remote sensing and active surveillance by odour detection dogs have higher detection characteristics but can only sample smaller areas.

A 'survey' might be a check using odour detection dogs of the high-risk areas (sentinel sites) being proposed by the program as part of its current operational surveillance, plus using dogs to check a smaller set of randomly located sites during the transition period (surveillance sites) to give some coverage of the whole area during the transition period. A survey might also be a sample of rural areas covered by remote sensing, plus the results of public reports (probably divided between urban, peri-urban and rural zones) around the time taken to complete the active surveys. Such surveys will now produce positive results, which will decline toward the end of the project and begin to give negative results. The models tell us how many successive negative survey results result in increasing confidence that eradication has been achieved, and allow some optimisation of the net costs of continuing the surveys versus stopping and declaring success.

(b) Spatially explicit detection models

Some (smaller) ant eradication projects, where the detection probabilities of the different surveillance tools have been estimated, have developed spatially explicit models to determine the probability that absence of evidence equals eradication (Anderson et al. 2013, Ward et al. unpublished manuscript), and the net costs of more surveillance and stopping as described above.

The SEQ Program has estimates for the detection capacities of dogs, public reports and remote sensing, so the program could make use of these by quantifying them within a spatial model.

5h. iii Conclusions

The SEQ Program has the data and data collection systems to develop the default 'wait and watch' option and the more objective modelling approaches to validate success. If the repeat survey models are used, the program will need to design a standard survey to deploy over the transition period, as well as test and refine it as soon as possible. If the spatially explicit models are used, it would be advisable to improve the estimates of detection probabilities of the surveillance methods.

The SEQ Program, with its surveillance and treatment phases, needs to transition into a validation phase once no new nests are being discovered and treated. Confirmation of eradication must be seen as part of the whole eradication program and not simply something to be added afterwards.

A process for declaring proof of freedom should include:

- A simple 'wait and watch' approach, which will be done by default but does not provide the required probabilities and risk management capacity;
- Repeated standardised surveys that cover the whole risk area (public reports) or sample the whole area with stratification of effort based on predicted risk (detection dogs and/or remote sensing) are the simplest way to obtain these probabilities;
- The standard surveys need to be designed now and conducted over the periods when ants are present (now), ants may not be present but treatment is incomplete (a transition phase), and when it is hoped no more ants remain (a validation phase). Note: these validation survey sampling sites may or may not be the same as 'sentinel' sites set up to monitor chronic infestations for current operational purposes;
- A spatially explicit validation model that requires better estimates of the detection parameters of public reporting across different rural-urban landscapes, and of detection dogs and remote sensing; and
- A robust repeat survey model that should provide confidence for a proof of freedom assessment. Which sub-model within this approach that provides the most robust estimates can be determined by testing them all with the data collected.

Recommendation

The panel recommends a process for declaring successful eradication including repeat surveys and spatially explicit models, noting the SEQ Program has the data collection systems available to validate success.

5i. Other options considered - Containment and transition to management - benefits/consequences

Consistent with the findings in the interim report, the panel maintains the view that the eradication of RIFA is still technically feasible and cost beneficial and it is in the national interest to eradicate. In line with this view, the panel has not proceeded with any extensive consideration of the containment or management options or what the cost might be of pursuing such options. The panel did note that the cost of any containment or management program, should RIFA be declared non-eradicable, would ultimately be contingent on how effective the SEQ Program had been in reducing the area(s) of infestation and the stringency of any future movement controls.

The panel did discuss these options in general terms and concluded that the long-term costs of containment or management outweigh any short-term cost savings that would be achieved through the cessation of the SEQ Program.

The evidence to support this view is derived from the experience in the United States, where there are no centrally coordinated preventative measures for RIFA in place and the estimated annual cost to the United States is US$7 billion in control, damage repair and medical care (Avant 2014). RIFA infest millions of acres in urban, agricultural, wildlife, recreational and industrial areas. It is clear from the history of spread of RIFA in the United States that containment or management is an on-going expense with increasing costs/impacts to the public as RIFA progressively expands its range and the densities increase.

The panel concluded that Australia has made a considerable national investment in the SEQ Progam since 2001, resulting in technical and managerial expertise, improved technologies, operational infrastructure, and a commitment to achieving eradication. In view of this, it is imperative that the SEQ Program be given enough resources and time to succeed.

Annexes

Annex A: Terms of Reference

Background

Since 2001, the National Red Imported Fire Ant Eradication Program in South East Queensland (SEQ Program) has managed three separate incursions of the Red Imported Fire Ant (RIFA) – two of the three incursions have been eradicated. Genetic analysis has shown all incursions were established as the result of separate introductions.

- Port of Brisbane – detected 2001 (present for at least 10 years before detection). Declared eradicated in 2012.
- Richlands – detected 2001 (suspected to be present at least 10 years before detection). Persistent infestation at low levels spread over a large area in SEQ. Showing signs of genetic bottleneck.
- Yarwun – detected 2006. Declared eradicated in 2010 at a cost of $1.531M, using expertise and sharing resources with the SEQ eradication program.

Queensland has managed the program at a total cost of more than $300M, the majority of which is national cost-share funding. The SEQ Program has successfully eradicated the infestation at the Port of Brisbane and the first infestation at Yarwun.

However the infestation originally detected at Richlands has yet to be eradicated and although contained in SEQ, infestations have been found further west, in the Lockyer Valley, and south in the Tamborine areas. Since 2001, research, development and technological advances such as RSS, RIFA spread and habitat modelling, and validation and operational application of odour detection dogs, along with community engagement efforts, have assisted in the identification of infestations in areas in SEQ that weren't previously known.

National decision-making processes have previously noted:

- RIFA is a pest of national significance (as determined through the application of national significance criteria outlined in the National Environmental Biosecurity Response Agreement);
- The outcomes of three benefit-cost analyses found there was significant national benefit from the eradication of RIFA in Australia; and
- Advice from multiple previous reviews and audits suggested eradication of RIFA remains technically feasible, efficient and cost beneficial.

The last major independent review of the program was conducted in 2009. A Scientific Advisory Panel reviewed molecular genetics in 2011 and a Technical Panel (TACC) reviewed recent developments in RIFA detection and eradication in 2012.

Since 2010/11, the focus of the SEQ Program has been on containment and suppression of RIFA and delimiting the extent of RIFA infestation by June 2015, with a long-term view of returning to an eradication focus.

In December 2014, the Agricultural Ministers' Forum (AGMIN) agreed to commission and fund, in accordance with existing cost apportionments, an independent review outlining options for achieving eradication or long-term containment of RIFA in SEQ. The outcomes of this review will inform a national decision on the future of the Program after June 2015.

AGMIN also noted that advice from multiple previous reviews and audits of the Program and three benefit-cost analyses have consistently shown that RIFA is a pest of national significance and eradication remains technically feasible, efficient and cost beneficial. The impacts in Australia have been estimated as between A$5.3 billion and A$45 billion over 20 to 70 years. The Program has effectively prevented these impacts from being realised in Australia.

<u>Terms of Reference</u>

Part 1: Review the current operations of the SEQ Program and provide advice on the success of the Program's efforts to delimit the SEQ RIFA infestation and provide preliminary advice on strategies for the future direction of the program including:

a. Is the program on track to delimit the SEQ RIFA infestation by June 2015?
b. Is remote sensing surveillance contributing to delimitation of the SEQ RIFA infestation?
c. Has the infestation been suppressed and contained during delimitation?
d. Is it still in the national interest to eradicate RIFA?
e. Is there demonstrated technical feasibility of eradication of RIFA?
f. Is there is an acceptable benefit: cost to eradicate RIFA?

Based on the outcomes of Part 1, the Review Panel will advise and oversee the engagement of a suitable consultant/s to model different scenarios/options for Part 2.

Note: As with all incursions, knowledge of the extent of the infestation ('delimitation') is fundamental for eradication success.

Part 2: Undertake scenario modelling to provide advice on options for eradication, containment and/or management of RIFA, including the following:

a. Indicative costs and benefits for each option, recommendations on funding, critical review points, governance arrangements for any future program and implications for the future (economic, environmental and social);

b. The nature of any future eradication program including the balance between surveillance and treatment strategies, as well as public relations/community engagement, movement controls and research and development;
c. Whole-of-life response plan, indicative budgets and timeframes; and
d. Advice on any new science, research or development that needs to be considered in the future program.

In making recommendations, the review is to:

- Examine previous reviews, reports, plans, modelling and benefit-cost analyses of the program, including modelling to be commissioned by the program, to assess the confidence remote sensing surveillance and other tools used by the Program have successfully delimited the infestation. (Previous modelling by Monash University found that remote sensing surveillance has the potential to significantly increase the success of eradication);
- Consider relevant technical knowledge and management experience, both overseas and domestically;
- Assess progress to achieve the current operational objectives of the Response Plan;
- Consider the nature of future community engagement campaigns to boost public involvement in the program; and
- Consider the National Biosecurity Committee Funding Model Project and alternative options for financial contributions from private beneficiaries and risk creators.

<u>Review Panel</u>

The Review Panel would be a panel of independent experts and jurisdiction representatives.
Membership options for the Review Panel could include any combination of the following:

- **1 x Independent Chair**
- **1 or 2 International RIFA experts**
- **1 or 2 experts in eradication and/or agriculture resource economics**
- **3 or 4 representatives nominated by jurisdictions**

The SEQ Program will provide administrative and secretariat support and if requested any information and data on policy, science and operational issues with regard to the program, noting that this has the potential to be time and resource intensive for the program.

The Independent Review Panel will report directly to AGMIN.

<u>Cost</u>

Final cost is dependent on membership of the Review Panel, but is expected to be approximately $200K (including the cost of engaging a consultant/s to model different scenarios/options and any further research required). Funding for the review will be additional to the current program budget and be funded through the cost-sharing apportionments that apply to the program.

It is anticipated that an independent chair and experts in eradication and/or agriculture resource economics will charge fees to undertake the review. While fees are usually not charged by RIFA experts, all their expenses must be covered. Expenses will also be covered for accommodation, travel and meals for all expert members of the Review Panel.

If jurisdictions nominate a representative to be part of the Review Panel, then that jurisdiction will be expected to meet all costs and expenses of their nominee (other than accommodation and meals during the conduct of the review, which will be met from the national cost-shared budget for the review).

Annex B: Table: Budget, key statistics and genetic fitness breakdown by year

Year	*Budget*	*Key statistics (as reported)*			*Genetic Fitness*[40]			*Explanatory Notes*
	TOTAL	**Infestation area, colonies,**[41] **sites, Infested parcels/ properties**	**Area treated (ha)**	**Area surveyed (ha)**	**Sterility**[42] (measured by calendar year not financial year)	**Inbreeding**[43] (Note this is clearer when shown graphically – refer below (Att 4))	**Fragmentation**[44]	
2001–02	$31M	Initial treatment area (TA)-27 807 ha[7]	105 748[45]	Surveillance area 37 582 ha[7]	N/A	East -0.06 Main -0.022 West -0.029	2 populations (Richlands and Port of Brisbane pop.)	Treatment phase July 2001–June 2004 included 4 applications of IGR per year to entire treatment area (TA); 100% surveillance of 5km buffer around TA; 20% 5–10 km buffer and 10–15 km buffer around TA each year. Infested property (IP) used as measure, may be 100 mounds on IP but may be only one sample & coordinate recorded. Not 100% surveillance of property, find one mound and move on. IP survey found 72% success (July 2002).
2002–03	$42.59M	TA-47 336 ha (40 202 ha minus rivers, roads etc)[7]; Record of treatments- (paperwork only) 401 988[46]; total	137 756[7]	34 796[7] + 14 239 ha[*] Surveillance area 44 230 ha[7]	N/A	East -0.054 Main 0.02 West -0.051	2 populations	IP survey found 97.5% (July 2003). "Millennium drought"[48].

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[40] *The expectation for a Red Imported Fire Ant (RIFA) incursion after 10 years is that there would be no decrease in genetic variation and limited sub-structuring of the population due to genetic mixing via natural mating, migration and human-assisted transport. The opposite of this is observed in Queensland which strongly suggests the eradication program is being effective.*

[41] *Actual area of infestation (AOI) year by year is not a good measure of progress unless we have the capacity to do 100% surveillance, which is not currently possible. AOI is affected by temperature (affects mound construction and detection); rainfall (more mounds visible, easier to find); drought (no mound building); policy (balance between surveillance and treatment; no imperative to clear areas until recently); community engagement (CE) campaigns; evolving nature of program.*

[42] *Measured by % of males collected and tested that are sterile. Males have been collected only when easily available (only since 2009). Diploidy in monogyne males is used as indicator of sterility. Rate of diploidy has been seen to increase. By comparison, in the US diploid sterile males in a normal monogyne population is only approximately 1% (Tschinkel (2006) The Fire Ants) NB: no split into clusters, listed by calendar year, not FY. Numbers are low but trend seems consistently increasing.*

[43] *Measured by a co-efficient of level of inbreeding for each subpopulation (temporal divisions by FY). Using F_{IS} as coefficient to measure inbreeding (where F_{IS} -1.0 is totally random breeding and F_{IS} 1.0 is "total inbreeding"). The level of inbreeding is following an increasing trend over time (since 08/09) in the remaining population (Brisbane), and is occurring in all three recognised sub-clusters of this population. This evidence of inbreeding is not observed elsewhere. This suggests that the Program is disrupting the mating system and causing loss of genetic diversity.*

[44] *Measured by number of sub-populations in SEQ. (Australian National Red Imported Fire Ant Eradication Program, Science Advisory Panel for Molecular Genetics, Introduction, Data, Collection Methodology and Workflow). This is not observed elsewhere. Also using F_{st} as a coefficient to indicate diversity/distance between clusters. If F_{st} trends towards reducing it suggests the clusters are slowly "merging", whereas a constant F_{st} suggests a maintained fragmentation and increasing F_{st} suggests there is adaptation and diversification between the clusters. Within and between the remaining population and its sub-clusters, F_{st} suggests a maintained fragmentation (no adaptation or genetic establishment, not loss of diversity to merge with main which would indicate continued influx.)*

[45] *Progress Report SEQ Program June 2001–Sept 2003*

[46] *Progress Report SEQ Program 17 December 2002–3 January 2003*

[*] *Progress Report SEQ Program June 2001 – July 2004*

Year	*Budget*	*Key statistics (as reported)*			*Genetic Fitness*[40]			*Explanatory Notes*
	TOTAL	**Infestation area, colonies,**[41] **sites, Infested parcels/ properties**	**Area treated (ha)**	**Area surveyed (ha)**	**Sterility**[42] (measured by calendar year not financial year)	**Inbreed-ing**[43] (Note this is clearer when shown graphically – refer below (Att 4))	**Fragment-ation**[44]	
		parcels treated to date-95 997[47];						
2003–04	$41.09M	Initial TA-67 890 ha (start of treatment season 3)[11].	217 981[49] (This paper also reports 222 491 ha treated)	8 095 (season 3)[11]	N/A	East 0.054 Main -0.004 West -0.063	2 populations	South West Extension Treatment Area (SWETA) added. "Millennium drought". IP areas not standard (0.04 ha IP with one nest classed the same as 100 ha property with one nest) so SEQ Program changed to a different system.
2004–05	$30.972M		45 924 (until 11 Feb 2005)[50] Target 103 000 ha	100% surveillance of treatment area 31 309 (to Feb 2005) (area defined as the surveillance area was 59 034)[12]	N/A	East -0.048 Main 0.011 West N/A	2 populations (Richlands pop., Eastern sub-pop.)	"Millennium drought." Validation surveillance of core area commenced[12]
2005–06	$24.566M	N/A – changed reporting format	N/A – changed reporting format	100% surveillance of treatment area	N/A	East 0 Main -0.049 West -0.042	2 populations	2005. Only 113 mounds found for the year (Rochedale market gardens). "Millennium drought". 3 treatment passes on infested areas°
2006–07	$10.274M	N/A – changed reporting format	N/A – changed reporting format		N/A	East -0.024 Main 0.014 West-0.019	2 populations	SEQ Program downsized including staff and budgets halved. However, Jeebropilly, Amberley and Yarwun infestations detected. "Millennium drought."
2007–08	$14.173M	132 sites[14]	12 967 (to Nov 2007)[51] Target- 33 489	6 566 (to Nov 2007); Planned 7078.	N/A	East -0.017 Main 0.046 West -0.027	3 populations (Richlands pop., Western and Eastern sub-pop.)	Significant detections in Amberley, Willowbank, Ti Trees (90 000 mounds, 200 CPs), No increase in budget but 7500 ha added to the Restricted Area. "Millennium drought"
2008–09	$10.91M	Approx. 22 000 ha (see explanatory notes)	40 562[52]	7 114 + 485 dog surveillance (not sure if this is	N/A	East 0.01 Main 0.018 West -0.002	3 populations	The initial treatment task in 2008–09 was 66 000 ha (equivalent to 22 000 ha being treated 3 times). However under budget this was

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[48] The 2002-2007 drought was two separate droughts, each of about 12 months duration 2002-03 and 2006-07, with no significant wet period in between. Water storages remained below pre-drought levels until late 2010.
[47] Progress Report SEQ Program 5 – 22 April 2015
[49] Progress Report SEQ Program June 2001 – July 2004
[50] Progress Report SEQ Program June 2001 – February 2005
[51] SEQ Program Progress Report July 2007 – November 2008 (included data appears to only be until November 2007)
[52] SEQ Program Progress Report July 2009
° Fire Ant Eradication: Program Performance — Year to date 30 June 2006

Year	*Budget*	*Key statistics (as reported)*			*Genetic Fitness*[40]			*Explanatory Notes*
	TOTAL	**Infestation area, colonies,**[41] **sites, Infested parcels/ properties**	**Area treated (ha)**	**Area surveyed (ha)**	**Sterility**[42] (measured by calendar year not financial year)	**Inbreed-ing**[43] (Note this is clearer when shown graphically - refer below (Att 4))	**Fragment-ation**[44]	
		149 sites; 732 CPs[13]		already included)[13]				cut to 37 000 ha with some areas getting no, one or two treatments, but no areas getting 3 passes). Outlier at Lower Mount Walker 6.9 km from RA[13] Predominately low infestation levels except Amberley and Richlands[13]
2009-10	$15M	Area subject to infestation-479 (retrospective calculation)[14]; New colonies-4800; at 411 sites across 90 suburbs[53]	37 220	8 200	1/82 1.2%	East 0.019 Main 0.021 West 0.014	3 populations	Initial remote sensing trials commenced July-September 2009.
2010-11	$21M	Area subject to infestation-561; colonies-2480; infested sites-448[7]	82 606[54]	17 614	1.6% (7/428)	East 0.011 Main -0.007 West 0.025	3 populations	Large infestations found in Purga, Rosewood, Marburg, Larapinta, Yamanto, Rochedale[15] Area subject to infestation was introduced (point of infestation plus 50 m buffer)
2011-12	$21M	Area of new Infestation[55]- 426; infested sites- 443; colonies detected- 879; AOI retrospectively calculated 1401 ha [8]	73 525[56]	16 117 field & 9025 RSS (area flown only - not surveyed)[19]	1.8% (6/333)	East 0.017 Main 0.027 West 0.025	3 populations	Unusually wet treatment season[18] Imperative to remove cleared areas
2012-13	$17.9M	Total Area of New Infestation-784; Infested sites-751; colonies detected 1548; AOI retrospectively	20 073[57]	49 047 field & 85 716 RSS	1.7% (7/412)	East 0 Main 0.016 West 0.027	3 populations	New methodology for reporting AOI introduced that excluded overlap of AOI.

[53] *SEQ Program Annual Report 2009-10*
[54] *SEQ Program Annual Report 2010-11*
[55] *Point of infestation plus 50m buffer, excluding overlap from previous infestation.*
[56] *SEQ Program Annual Report 2011-2012*
[57] *SEQ Program Annual Report 2012-13*

Year	*Budget*	*Key statistics (as reported)*			*Genetic Fitness*[40]			*Explanatory Notes*
	TOTAL	**Infestation area, colonies,**[41] **sites, Infested parcels/ properties**	**Area treated (ha)**	**Area surveyed (ha)**	**Sterility**[42] (measured by calendar year not financial year)	**Inbreed-ing**[43] (Note this is clearer when shown graphically – refer below (Att 4))	**Fragment-ation**[44]	
		calculated 1959 ha 144 ha removed[19]						
2013–14	$18M	Total AOI-2334; New infestation-558; cleared-204	34 100[58] (32 214 preventative & 596 new infestation)	6 233 targeted field; 93 625 RSS Treatment target 32 000	2.1% (8/373)	East 0.018 Main 0.029 West 0.037	3 populations	Change in AOI reporting methodology. 36% increase in public reporting (from 2013–14) 3 major CE campaigns.
2014–15	$18.567M[59]	AOI-3072; new infestation-1133; cleared 395	55 192[60] (53 300 preventative & 1890 new infestation)	12 436 targeted field & 84 986 RSS Treatment target 32 000	3.3% (12/365)		3 populations	SEQ experienced a marked increase in the number of detections. The wet weather including the one-in-2000 year rain event experienced in early May 2015 teamed with cooler conditions has given rise to highly visible mounds. The Beyond the Edge campaign may also have been a contributing factor. Publicity surrounding high profile detections such as QUT, Gardens Point campus and New Farm park may also have contributed to the increased number of detections.

[58] *SEQ Program Annual Report 2013-14*
[59] *In 2014-15 RSS is estimated to have cost approximately $5M.*
[60] *SEQ Program Annual Report 2014-15*

Annex C: Queensland production of vegetables

Commodity	Australian Average	Queensland Average	Comparative Advantage			% of Australia's production in Queensland
Asian vegetables - Yield (kg/ha)	10,246.49	16,051.96	1.57		Beans (including French and runner) - Production (kg) (j)	46%
Broccolini - Yield (kg/ha)	8,540.27	9,893.94	1.16		Broccoli - Production	26%
Celery	31,429.61	57,966.46	1.84		Celery - Production	21%
Chillies - Yield (kg/ha)	11,586.45	17,195.22	1.48		Cucumbers	28%
Mushrooms - Yield (kg/m²)	27.79	48.38	1.74		Eggplants	49%
Parsnips - Yield (t/ha)	19.19	25.00	1.30		Lettuce (outdoor)	29%
Peas - fresh market - Yield (kg/ha)	1,950.55	3,183.19	1.63		Melons	43%
Spring onions (including shallots) - Yield (kg/ha)	14,388.62	21,819.43	1.52		Peas - fresh market	41%
					Pumpkins	39%
					Tomatoes - fresh market	47%
					Zucchini and button squash	47%

Data derived from ABS (2015a). One comparative advantage here is multiplier based on the national average in the case of Asian Vegetables, a Queensland producer produces 57% more per ha than the Australian average.

Annex D: Other eradication activities necessary for the future SEQ Program

		Current National Cost-Sharing Budget for 2015-16 as at June 2015					2015-16 TOTAL BUDGET $'000	Note: This is not a forward budget estimate. This is a summary of SEQ Program areas that would need to increase if there were an increase in treatment and surveillance by 232.77% based on modelling)		
Work Units	**Project Description**	**FTEs**	**Labour $'000**	**Non-Labour $'000**	**Total**	**Cost-Sharing Budget $'000**		**Approximate Scale up budget required (2017-18 to 2027-28)**	**Estimated additional budget required (2017-18 to 2018-19)**	**Notes**
Management	Management	1.86	203,694	57,964	261,658			0		Management costs are constant and are not expected to increase.
	Total Management	**1.86**	**203,694**	**57,964**		**261,658**		**261,658**		
Business Support	Administration	7.70	637,292	453,988	1,091,280			2,540,173		Business support is currently at capacity, with only 1 dedicated human resources and one financial officer. A treatment and surveillance scale up would see a corresponding increase in all administrative areas every year (HR, Finance and Administration) (232.77% increase as per treatment and surveillance cost increase). A document management person, to manage paperwork for vehicle fleet, and a WHS officer, would be required to assist with the increased workload.
	Site Lease Charges			296,740	296,740			800,000		Site lease costs will go up significantly with satellite sites and if the SEQ Program were to co-locate in commercial premises. Currently the Program has access to Qld Government building in Moggill which is much cheaper than commercial rates. A new science lab would also add to accommodation costs. Exact cost is unknown. However estimated budget is based on commercial properties which currently cost around $215m² for office space (need 1250) and $110m² for warehouse (need 1500) (not including fitout) to meet current workforce needs.
	Departmental support costs				0			300,000		When SEQ Program has had a larger budget in the past, it has been expected to provide contributions to corporate costs (eg shared services, central media, workers compensation has a higher premium). Exact cost is unknown.
	Total Business Support	**7.70**	**637,292**	**750,728**		**1,388,020**		**3,640,173**		
Policy, Leg & Compliance	Policy & Planning	3.95	469,553	13,158	482,711			482,711		Policy and Planning is not expected to increase.
	Compliance	11.00	907,965	52,551	960,516			1,397,114		If ramp up led to more detections in rural areas (i.e. Lockyer Valley, Gold Coast, North Brisbane), more compliance officers would be required. Also if SEQ Program wishes to prosecute breaches of movement restrictions, more case management officers would need to be employed. Realistically this could require an additional 5 compliance officers particularly given that compliance officers are currently at full capacity.

										(Each compliance officer currently manages approximately 50 suburbs each).
Total Policy & Governance		**14.95**	**1,377,518**	**65,709**		**1,443,227**		**1,879,825**		
Community Engagement	**Community Engagement**	5.77	703,983	356,538		1,060,521		2,468,574		Increased treatment would mean that more public notifications, training and stakeholder/industry engagement would be required. Panel also recognised the need to improve and modernise notifications to the public through social media and bulk SMS messaging services. Exact costs difficult to assess over 10 year period. Note: Currently Program has 8 CE staff which is not reflected in the 2015-16 budget. This estimate has been calculated by increasing by 232.77%.
Program Support	Science	8.95	902,610	79,551	982,161			1,800,000		Increased treatment / surveillance area in conjunction with campaigns for passive surveillance asking the public to report will increase the number of diagnostic samples received. More samples coming in = at least one more scientist (dedicated operational scientist) and possibly more lab technicians to confirm ants, better equipment, better facilitated labs and colony rooms. Also CE campaigns involving development of an app/social media would require increased levels of photo diagnosis. New diagnostic technologies could be utilised/developed. Bait trials, seasonality trials could be done more efficiently with better facilities (new lab/colony room) and more staff. Exact cost is difficult to assess however it is believed this is a conservative estimate. It is not a proportionate increase but would remain constant at least until the final years of eradication. (However tail end for Science Activities might offset the costs to declare proof of freedom in final years).
	Remote Sensing Development	0.00	0	508,916	508,916			0		RSS Research and Development (R&D) costs are unknown however R&D in the past cost over $2M. This initial outlay for RSS R&D will need to factored into ramp up budget ($750k) for one year only. This might be split over 2 years however that would delay RSS commencement. Note there would also be an RSS monitoring and maintenance role, particularly for the first two years and then again possibly to review after 5 years if necessary. (However, maintenance role budget is factored into the Science budget).
	Genetics	1.50	170,515	144,459	314,974			400,000		This area is currently at capacity. Ongoing annual cost for next generation sequencer technology will increase budget slightly. However exact cost to Program unknown. Also Genetics team is currently partly funded through the EA Program. EA program is due to cease in 2016, therefore SEQ program may need to provide for increased cost of positions (.4 FTE).

	Information Services	1.00	85,336	819,174	904,510			1,154,510		Additional IT support and hardware will be required to increase treatment and surveillance by 232.77%. This is not directly proportionate but would be a constant cost over 10 years, including 1 extra IT position. The costs of reviewing and addressing deficiencies of the current IT system also need to be factored in to any ramp up budget. Panel recommends improvements including spatial, CE/CRM and compliance upgrades, in-field mobility and reporting functionality. This is included in the ramp up budget. Cost is indicative only as budget is unknown until issues are assessed and prioritised and proposal is costed. Expect a budget surge in initial years and then a drop off once these improvements have been implemented, which will need to be incorporated in any ramp up budget
	Spatial Services	1.85	174,387	73,656	248,043			248,043		Spatial services would not be expected to increase.
	Total Program Support	**13.30**	**1,332,848**	**1,625,756**		**2,958,604**		**3,602,553**		
Operations	Field Operations	55.00	3,340,010	1,873,094	5,213,104					This is the optimal treatment and surveillance budget (as per the Monash modelling). Currently budget for this component is $10,310,714 so modelling suggests a budget increase of 232.77%. Costs vary depending on strategies used for implementation (particularly increased travel, i.e. returning to access properties where occupiers were not home can increase overall treatment and surveillance).
	Chemical Treatments			3,646,000	3,646,000			24,000,000		Declaration of proof of freedom was not included in the scenario modelling. The modelling allocates resources to reduce infestation through treatment and surveillance of estimated infestations. It doesn't model what needs to be done in order to declare these areas free from RIFA. This needs to be costed separately.
	Aerial Applications			1,451,600	1,451,600					Odour detection dogs used for validation surveillance also not factored in.
	Remote Sensing Operations			0	0					Modelling assumes RSS can occur for $72/ha.
	Planning & Reporting	11.70	854,169	46,384	900,553			2,096,217		An increase in treatment and surveillance would mean a corresponding increase in operational planning, job reporting, data entry and customer service (ie increase of 232.77%).
	Odour Detection Dogs	3.00	221,489	283,541	505,030			1,111,066		The odour detection dog unit could be increased over 3 years. Ramp up year 2016-17 will require $707,042 (increase capacity by 4 dogs from a total of 10 to 14 dogs). This will go up to $909,054 in year 1 2017-18 (+4 = 18 dogs) and year 2 (2018-19) $1,111,066 (+4 = 22 dogs) a total increase of 232.77%. Costs of odour detection dogs used primarily for validation surveillance were not included in the modelling. On-costs for approximately 10 (Varied throughout year) dogs = $50,503 per dog. The Program has capacity to increase to 40 dogs. This does not include training costs (below). Proposed that 4 additional dogs be trained in ramp up year so they are ready for operation 2017-18; and a further 8 be trained

										progressively over following two years (2017-18 and 2018-19). Dog replacement costs also need to be considered as life expectancy is 6-8 years.
	Surveillance / traps to declare proof of freedom									The cost of proof of freedom declaration was not included in modelling however the dog component might be covered by additional dogs proposed below. Considerations including cost of traps have not been costed.
	Odour Detection Dogs (training new dogs) - for surveillance and proof of freedom declaration			150,000	150,000				200,000	This is the cost of buying and training 4 extra dogs in 2017-18 and 2018-19 only. Proposed 4 additional dogs be purchased and trained in ramp up year (2016-17). (This is budgeted in separate ramp up budget). Cost of training and buying dogs= $50k ($5K to buy + $45K to train). Dogs have a 99% sensitivity so are the best means of ensuring a site is clear of ants (validation surveillance), declaring proof of freedom, and checking high risk areas (such as schools, parks etc.). Like ground surveillance it can be used year round (in the warmer months) whereas in the past RSS cannot be used in summer.
	Total Operations	**69.70**	**4,415,668**	**7,450,619**		**11,866,287**		**27,207,283**	**200,000**	
	Unallocated portion used for treatment			230,683						
TOTAL Budget for Fire Ant Program - SEQ		**113.28**	**8,671,003**	**10,307,314**		**18,978,317**	**19,209,000**	**39,060,066**		**Estimated total budget $38.1M (63/37 split with a $24M treatment and surveillance budget).**

Calculations used to determine 63/37 split

Note: CPI (including salaries and operating) increase adjustments will need to be factored in also.

Note: RSS R&D and IT system budgets will need to be considered as a part of the ramp up or first year budget.

The SEQ Program has estimated that the future budget should be split as follows: 63% of total current budget for treatment and surveillance; and 37% for other program elements, and believes this is a conservative estimate. This is a linear split regardless of how much treatment and surveillance increases. For explanations on estimated future budgets required by different areas, refer to Notes column above.

63/37 split calculation based on existing budget	**0.63**	Operations (Operations + Unallocated treatment budgets)
	0.37	Other (all the other areas)
	1.00	

Annex E: Biosecurity funding: the User Pays v Public Pays v Cost Sharing Arrangements

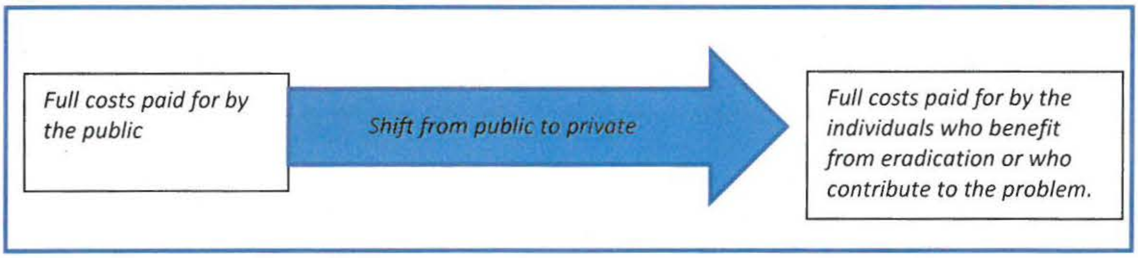
Biosecurity funding falls into three distinct categories and objectives:

- Pre-border – funding spent overseas designed to reduce the risk of biosecurity issues arriving in Australia either naturally or from human intervention;
- Border – funding designed to prevent biosecurity events from establishing in Australia. This funding has two components:
    - funding allocated to prevent biosecurity issues from entering Australia, i.e. surveillance and detection activities; and
    - funding aimed at eradicating any exotic species before it can become established in Australia; and
- Post-border – funding which is allocated to either contain or reduce the density and distribution of a biosecurity event. Funding in this category is generally not designed to eradicate the biosecurity issue.

The line between border and post-border biosecurity funding becomes blurred the longer the event takes to eradicate. As Section 3 argued, it is still in the national interest to eradicate RIFA, consequently RIFA can still be considered a border biosecurity issue.

Alternative funding models can be used to provide clear signals to private individuals and public bodies about their social responsibility to national biosecurity expectations. Biosecurity is a shared responsibility between public agencies and individuals and the cost-recovery procedures adopted by governments highlight this from the fees charged for monitoring import, export controls[61]. This shared responsibility then overcomes the limitations that occur in the extreme funding models where the full costs for biosecurity services are paid for by the public (i.e. government) or by the beneficiaries or risk creators, see *Figure 13: Cost Recovery and Funding*.

Figure 13: Cost Recovery and Funding



[62] BQCC Communications and Engagement 2014–15 Section Plan.

Full Cost-Recovery Model

A purely private beneficiary or risk creator model will inevitably introduce inequality and create market failure. The economic benefit of eradicating a biosecurity event is derived from preventing the event reaching its potential: scale (temporal and spatial aspects), scope (the number of groups affected) and impact (combined functions of density to damage and density to cost). It is impossible to definitively state the true economic burden on the first and second round due to cost, difficulty, risk and uncertainty in trying to parametrise the future. Without definite numbers it becomes difficult to justify fees and charges. In some situations, there are groups/individuals who benefit from a biosecurity program but who cannot pay. For example:

- Who pays for savings to the health system if an exotic zoonotic disease is prevented from entering Australia or part of Australia?
- Who pays for the preservation of pubic goods, including but not limited to ecosystems services and the environment?

It can be difficult to definitely prove the source of a biosecurity event, preventing funds being sourced from the risk creators. Even when it is possible to track where a biosecurity event originated from, does the importer or exporter pay?

In given situations individuals can benefit from biosecurity events by providing goods and services that can be used to combat the scope, scale and impact of the biosecurity event. Obtaining funding from these individuals may be both counter intuitive and counter-productive, as the goods and services they provide are:

- Providing that individual with an additional income stream that was not available until the biosecurity event occurred;
- Combating the biosecurity event and these efforts have both a private and public benefit; and
- Providing potential multiple benefits. For example, a contract weed sprayer may not just target one weed to be eradicated but all weeds.

In this case any form of levy or tax on this individual may prevent additional private expenditure contributing to the eradication program.

This inability to clearly identify all beneficiaries and risk creators inevitably leads to the free rider problem and this can become complicated by a standard fixed levy as:

- Not all beneficiaries (industry or individual) receive the same benefit so a uniform payment will discriminate;
- The beneficiaries and risk creators change over time;
- There are parts of society that either cannot pay or will not contribute; and
- Individuals adapt and find ways to avoid paying.

Significant care is needed in the design, communication and enforcement of any system designed to encourage individual participation. Any failure to clearly define the need for and articulate why these incentives are required can create perverse outcomes, for example individuals may:

- Refuse to pay and/or delay payment;

- Gain satisfaction by:
    - Deliberately flaunting rules and regulations designed to prevent the distribution of the biosecurity agent;
    - Being deliberately confrontational with staff involved in the eradication campaign leading to situation where a police presence is required; and
    - Sabotaging equipment and/or treatment efforts.

While incentives must be designed so that they discourage individuals to either:

- Take financial advantage of the less informed in an effort to gain funds from individuals or from government subsidies; and
- Eradicate outbreaks on their property and fail to pass on the information to the agency responsible for the eradication of the outbreak. This then provides a loss of knowledge about the true distribution and density of the biosecurity event.

Where individual(s), community(ies) and business(s) engage in actions counter to the goals of eradication then additional costs are incurred for monitoring, compliance and enforcing rules and regulations. These additional transaction costs in a purely user pays model would then have to be factored into the cost structure.

Purely Public Funded Model

Alternatively if all the costs are borne by the public purse then:

- There can be a welfare transfer from society to those few individuals who directly and indirectly benefit from the eradication of the biosecurity issue. In extreme cases this can create perverse outcomes where it encourages risk taking behaviour as there is no individual responsibility for creating a biosecurity event;
- The exclusion of private contributions to biosecurity events then decrease the funding available to deal with biosecurity events. This reduction in the total budget prevents the social optimal funding being available to deal with biosecurity in the national interest. For example this may:
    - Limit the number of biosecurity incursions that can be deal with;
    - Lead to the wrong biosecurity incursions being funded. For example, if the first three incursions use all the available funding, then the 4th event with the greatest impact on society could miss out on being funded;
    - Introduce time delays in eradication campaigns there by reducing the possibility of eradication and/or increasing the total budget cost required to achieve eradication;
    - Halt funding prematurely; and
    - Prevent society from understanding the risks and consequences (economic, ecological and health) of a biosecurity event. In this situation, information asymmetry could encourage society to believe that a sub-optimal level of public funding should be spent on combating biosecurity and ultimately lead to welfare loss. This outcome then compounds the negative impacts of the above point.

The Cost-Sharing Model

The current policy biosecurity and quarantine settings, are a mixture of public and private cost sharing, that defines a level of biosecurity risk that the country is willing to accept from being engaged with the world. The enforcement and charges applied to these rules and regulations are designed to maintain this level of risk. In simple terms, the government is acting as the insurance agent who assesses the biosecurity event and decides if funding will be spent to eradicate the problem.

Annex F: Glossary

Active Colony Point	A colony that has been treated but that has not undergone validation surveillance to confirm that the colony has been destroyed.
Approved Risk Management Plan	Plan approved under the *Plant Protection Act 1989* for the management of risks associated with a commercial activity in order to prevent the spreading of RIFA.
Area of Infestation	50 metre buffer surrounding a colony point. This is based on known maximum foraging distance.
Biosecurity Queensland	The business group within the Queensland Department of Agriculture and Fisheries that administers the National Red Imported Fire Ant Eradication Program.
Colony	A group of ants that are living together and dependent on each other for reproduction and survival.[54] The colony can consist of one or more mounds.
Colony point	Reference point denoting a single RIFA colony.
Community Engagement	Program's primary activities of communication and stakeholder engagement. Underpinning the Program's engagement is the use of commercial principles, tools and techniques in media, marketing and communications[62].
Containment	Refers to the application of agreed protocols and strategies to contain RIFA through movement controls, community engagement, risk management strategies focussed on the high-risk Restricted Area, audits of Approved Risk Management Plans, and inspector's approval for movement of risk materials. Community engagement is essential for successful containment as it ensures awareness of the requirements. The review triggers in the current Response Plan include: 1/ infestation is detected beyond the 30km boundary; and 2/ reproductive areas of infestation are found beyond the area scheduled for RSS[63].
Delimitating survey	Survey conducted to establish the boundaries of an area considered to be infested by, or free of, a pest. Typically surveys are conducted in a 50-metre, 100-metre or 500-metre radius around a colony point, depending on the location of the infestation.

[62] BQCC Communications and Engagement 2014–15 Section Plan.

[63] Response Plan for the Eradication of Red Imported Fire Ant in Queensland 2009.

Delimitation boundary	The maximum extent of infestation as determined by surveillance.
Direct Nest Injection	The procedure of inserting an insecticidal solution directly into known fire ant mounds to destroy them.
Disturbance model	Software applied to land satellite imagery (landsat) to identify changes in land use (soil disturbance) over time. Newly mated RIFA queens prefer disturbed land to establish their nests.
Fire ant	For the purposes of this document means red imported fire ant.[44]
Habitat model	Software applied to landsat to define likely areas of suitable habitat for RIFA.
Inactive Colony Point	A colony that has been treated and has undergone validation surveillance to confirm that the colony has been destroyed.
Infested site/property	A location where RIFA have been confirmed. It is defined by a property boundary.
Insect Growth Regulator	A substance that inhibits the lifecycle of an insect by mimicking the juvenile hormone, one of the two major hormones in insect mating, thereby sterilising the queen.
Monogyne	A social form of fire ant where each colony consists of a single queen and her offspring.
Mound	An above-ground structure that ants use for survival that is associated with one colony of ants.[44]
Nest	A structure which ants form and use for reproduction and survival[44]. A nest may not always take the form of an above ground mound but usually includes sub-terrain tunnels and chambers.
Point of Interest (POI)	A suspected RIFA mound that has been identified through a process of Remote Sensing Surveillance image capture, algorithm recognition and manual analysis. GPS coordinates are plotted on a map and the coordinates of the POI issued to field staff for ground truthing.
Polygyne	Social form of RIFA where a colony may contain multiple queens and their offspring.
Red imported fire ant	*Solenopsis invicta* Buren, 1972 (RIFA).

Remote Sensing Surveillance	The process of detection of RIFA infestations through the use of high resolution imagery and analyses to produce points of interest verified by field surveillance.
Remote Sensing Zone	An area where remote sensing surveillance activity has been undertaken.
Restricted Area	A defined area within a pest quarantine area where specific obligations are placed on persons to contain, control and eradicate red imported fire ant. For RIFA, the whole of Queensland has been declared as a pest quarantine area (section 11, *Plant Protection Act 1989*).
RIFA population	A genetically distinct RIFA incursion. There have been several RIFA incursions into Australia, each with its own genetic signature.
Spread	The spatial expansion of a known fire ant population. Spread may occur through natural flight of newly-mated fire ant queens or by human assisted movement.
Surveillance	The process undertaken to determine whether a pest is present or absent in an area. Surveillance may be conducted by means of remote sensing, visual by ground teams, odour detection dogs or members of the public (passive surveillance).
Tramp ant	A general term referring to various ant species that are readily moved across the world through a variety of transport pathways.
Treatment	The application of chemical solutions or substance impregnated with a chemical solution for the purposes of destroying an infestation of RIFA.

Annex G: Acronym list

ABARES	Australian Bureau of Agricultural and Resource Economics and Sciences
AGMIN	Agricultural Ministers' Forum
ANU	Australian National University
AOI	Area of Infestation
BQ	Biosecurity Queensland
BQCC	Biosecurity Queensland Control Centre (operational area for the SEQ Program, Yarwun Program and National Electric Ant Eradication Program)
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DAF	Department of Agriculture and Fisheries
IGR	Insect Growth Regulator (bait)
MRL	maximum residue levels
NEBRA	National Environmental Biosecurity Response Agreement
NRIFAEP	National Red Imported Fire Ant Eradication Program (SEQ Program)
NICTA	National Information and Communications Technology Australia. National Information and Communications Technology Research Centre of Excellence
NMG	National Management Group. The NMG is the peak national decision making forum, through which parties will seek decisions on, but not limited to, policy and financial issues associated with the national response to RIFA. The NMG, established for an outbreak of a pest or disease, is made up of members representing all parties to the agreement.
POI	Point of Interest (located by remote sensing)
QUT	Queensland University of Technology
RIFA	red imported fire ant (*Solenopsis invicta* Buren 1972)
RSS	remote sensing surveillance
RSZ	remote sensing zone
TACC	Tramp Ant Consultative Committee
UNE	University of New England
UQ	The University of Queensland
USDA	United States Department of Agriculture

Annex H: References

ABARES, 2015. Agriculture, Fisheries and Forestry in the Greater Brisbane region of Queensland, 2015: About my region 15.24. Department of Agriculture, Canberra.

Alston, C. (2014) Habitat and associated modeling. Report for Biosecurity Queensland Control Centre. Queensland University of Technology, Brisbane.

Anderson D.P., Ramsey D.S.L., Nugent G., Bosson M., Livingstone P., Martin P.A.J., Sergeant E., Gormley A.M., Warburton B. 2013. A novel approach to assess the probability of disease eradication from a wild-animal reservoir host. Epidemiology and Infection 141: 1509–1521.

Antony, G., Scanlan, J.C., Francis, A., Kloessing, K. and Nguyen, Y. 2009. Revised benefits and costs of eradicating the red imported fire ant. 53rd Annual Conference of the Australian Agricultural and Resource Economics Society, 11–13 February, 2009, Cairns, Australia.

Ascunce, M.S., Yang, C.-C., Oakey, J., Calcaterra, L., Wu, W.-J., Shih, C.-J., Goudet, J., Ross, K.G. and Shoemaker, D. 2011. Global invasion history of the fire ant *Solenopsis invicta*. Science 331: 1066–1068.

Australian Bureau of Statistics, 2015. Agricultural Commodities, Australia, 2013–14 (cat. no. 7121.0), viewed 10 August 2015, <http://www.abs.gov.au/AUSSTATS/abs@.nsf/Lookup/7121.0Main+Features12013-14?OpenDocument>.

Avant, S. 2014. On the trail of fire ant pheromones, United States Department of Agriculture, Agricultural Research Service, Washington, viewed 11 April 2014, <http://www.ars.usda.gov/is/pr/2014/140411.htm>.

Barr, C.L. (2002) Yield loss due to fire ant mounds in hay harvesting. Texas Imported Fire Ant Research and Management Project, Texas A&M University, <https://fireant.tamu.edu/research/research-documents-by-document-type/results-demonstrations/>.

Barr C.L., Davis T., Flanders K., Smith W., Hooper-Bui L., Koehler P., Vail K., Gardner W., Drees B.M., and Fuchs T.W. 2005. Broadcast baits for fire ant control. Texas Agricultural Extension Service, Texas A&M University, <http://oaktrust.library.tamu.edu/handle/1969.1/86883>.

Boser C.L., Hanna C., Faulkner K.R., Cory C., Randall J.M., and Morrison S.A. 2014. Argentine ant management in conservation areas: results of a pilot study. Monographs of the Western North American Naturalist 7: 518–530.

Buczkowski G., Roper E., and Chin D. 2014a. Polyacrylamide hydrogels: an effective tool for delivering liquid baits to pest ants (Hymenoptera: Formicidae). Journal of Economic Entomology 107: 748–757.

Buczkowski G., Roper E., Chin D., Mothapo N., and Wossler T. 2014b. Hydrogel baits with low-dose thiamethoxam for sustainable Argentine ant management in commercial orchards. Entomologia Experimentalis et Applicata 153: 183–190.

Chen, Y.F., Chang, H.C., and Chao, C.M. 2005. Fire ant, a new hazard to military camps in Taiwan. Journal of Medical Sciences 25: 161–166.

Commonwealth of Australia, 2015a. Senate Inquiry on Environmental Biosecurity. Report by the Environment and Communications References Committee, Canberra.

Commonwealth of Australia, 2015b. Agricultural Competitiveness White Paper, Canberra.

Cromarty P.L., Broome, K.G., Cox, A., Empson, R.A., Hutchinson, W.M., McFadden, I. 2002. Eradication planning for invasive alien animal species on islands – the approach developed by the New Zealand Department of Conservation. In: C.R. Veitch, M.N. Clout (eds.) *Turning the tide: the eradication of invasive species*. World Conservation Union, SCC Invasive Species Specialist Group, Gland, Switzerland.

Department of Agriculture, Fisheries and Forestry, 2013. Financial contributions from private beneficiaries and risk creators for the National Red Imported Fire Ant Eradication Program, a discussion paper. Biosecurity Queensland Control Centre internal document, Brisbane.

deShazo, R.D., Butcher, B.T., Banks, W.A., 1990. Reactions to the stings of the imported fire ant. The New England Journal of Medicine 323: 462–466.

deShazo, R.D., Kemp, S.F., deShazo, M.D. and Goddard, J. 2004. Fire ant attacks on patients in nursing homes: an increasing problem. The American Journal of Medicine 116: 843–846.

deShazo, R.D., Williams, D.F., Goddard, J., Rockhold, R., and Kemp, S.F. 2014. Stings of imported fire ants: clinical manifestations, diagnosis, and treatment, viewed 10 August 2015. <http://www.uptodate.com/contents/stings-of-imported-fire-ants-clinical-manifestations-diagnosis-and-treatment>.

deShazo, R.D., Williams, D.F. and Moak, E.S. 1999. Fire ant attacks on residents in health care facilities: a report of two cases. Annals of Internal Medicine 131: 424–429.

Fernández-Meléndez, S., Miranda, A., García-González, J.J., Barber, D., and Lombardero M. 2007. Anaphylaxis caused by imported red fire ant stings in Málaga, Spain. Journal of Investigational Allergology and Clinical Immunology. 17: 48–49.

George, R. 2004. Modelling areas of suitable habitat for colonisation by *Solenopsis invicta* in south east Queensland. Report for Biosecurity Queensland Control Centre. The University of Queensland, Brisbane.

Goddard, J., Jarratt, J., and deShazo, R.D. 2002. Recommendations for prevention and management of fire ant infestation of health care facilities. Southern Medical Journal. 95: 627–633.

Gotelli, N.J. and Arnett, A.E. 2000. Biogeographic effects of red fire ant invasion. Ecology Letters 3: 257–261.

Hafi, A., Addai, D., Zhang, K., and Gray, E.M., 2015. The value of Australia's biosecurity system at the farm gate: an analysis of avoided trade and on-farm impacts. ABARES research report 15.2. Department of Agriculture, Canberra.

Hafi, A., Spring, D., Croft, L., Kompas, T. and Morey, K. 2014. Cost-effectiveness of biosecurity response options to red imported fire ants in South East Queensland. ABARES report for the National Biosecurity Committee. Department of Agriculture, Canberra.

Hall, K.D., Holloway, R.L., Carey, J.B. and Hoelscher, C.E. 1999. Texas poultry pest control practices. Texas Agricultural Extension Service, Texas A&M University, <http://agrilifecdn.tamu.edu/victoriacountyagnr/files/2010/07/TX-Poultry-Pest-Control-Practices.pdf>.

Hara A.H., Aoki K.L., Cabral S.K., and Niino-DuPonte R.Y. 2014. Attractiveness of gel, granular, paste, and solid formulations of ant bait insecticides to the little fire ant, Wasmannia auropunctata (Roger) (Hymenoptera: Formicidae). Proceedings of the Hawaiian Entomological Society 46: 45–54.

Hoffmann B.D., and O'Connor S. 2004. Eradication of two exotic ants from Kakadu National Park. Ecological Management and Restoration 5: 98–105.

Hung W.-F., Lin H.-M., Chen Y.-Y, and Lin C.-C. 2015. Unmanned aerial vehicle applications for red imported fire ants (*Solenopsis invicta*) control in Taiwan. In: T. Schowalter (ed) Proceedings of the 2015 Imported Fire Ant Conference, New Orleans, Louisiana, USA, April 6–8, 2015.

Jennings, C. 2004. A brief history of the red imported fire ant program. The Australian Journal of Emergency Management 19: 97–100.

Jetter, K.M., Hamilton, J. and Klotz, J.H. 2002. Eradication costs calculated: red imported fire ants threaten agriculture, wildlife and homes. California Agriculture 56: 26–34.

Kafle L., Wu W. J., and Shih C. J. 2010. A new fire ant (Hymenoptera: Formicidae) bait base carrier for moist conditions. Pest Management Science 66: 1082–1088.

Keith, J.M., and Spring, D. 2015. Has the Brisbane fire ant infestation been delimited? Consultancy report for Queensland Department of Agriculture and Fisheries. Monash University, Melbourne.

Klotz J.H., Vail K.M., and Williams D.F. 1997. Toxicity of a boric acid-sucrose water bait to *Solenopsis invicta* (Hymenoptera: Formicidae). Journal of Economic Entomology. 90: 488–491.

Kompas, T. and Che, N. 2001. An economic assessment of the potential costs of red imported fire ants in Australia. ABARES report for the Department of Primary Industries. Department of Agriculture, Canberra.

Lard, C.F., Hall, C.R. and Salin, V. 2001. The economic impact of the red imported fire ant on the homescape, landscape, and the urbanscape of selected metroplexes of Texas: a part of the Texas fire ant initiative 1997–1999. Texas A&M University, Department of Agricultural Economics Faculty Paper Series FP 01-3.

Lard, C.F., Salin, V., Willis, D.B., Robison S., Hadley, J. and Schroeder, K. 2001. The statewide economic impact of red imported fire ants in Texas: a part of the Texas fire ant initiative 1999–2001. Texas A&M University, Fire Ant Economic Research Report #01-08.

Lee, Y.C., Wang, J.S., Shiang, J.C., Tsai, M.K., Deng, K.T., Chang, M.Y., Wang, H.H., Ho, L.C., Chen, Y.T., and Hung, S.Y. 2014. Haemolytic uremic syndrome following fire ant bites. BMC Nephrology. 15:5.

Lofgren, C. S. 1986. History of imported fire ants in the United States. In: C. S. Lofgren and R. K. Vander Meer (eds.), *Fire ants and leaf cutting ants: biology and management.* Westview Press, Boulder.

Lofgren C.S., Banks W.A., and Glancey, B. M. 1975. Biology and control of imported fire ants. Annual Review of Entomology 20: 1–30.

Ma, L., Danoff, T.M., Borish, L., 2014. Case fatality and population mortality associated with anaphylaxis in the United States. Journal of Allergy and Clinical Immunology 133: 1075–1083.

McCubbin, K.I., Weiner, J.M., 2002. Fire ants in Australia: a new medical and ecological hazard. Medical Journal of Australia 176: 518–519.

McLeod, R. 2004. Counting the cost: impact of invasive animals in Australia. Cooperative Research Centre for Pest Animal Control, Canberra.

McNaught, M.K, Wylie, F.R., Harris, E.J., Alston, C., Burwell, C.J. and Jennings, C. 2014. Effect of broadcast baiting on abundance patterns of red imported fire ants (Hymenoptera: Formicidae) and key local ant genera at long-term monitoring sites in Brisbane, Australia. Journal of Economic Entomology 107: 1307–1315.

Nester, P.R. 2013. The latest broadcast on fire ant control products. Texas Agricultural Extension Service, Texas A&M University <http://fireant.tamu.edu/files/2013/05/2013-Fire-Ant-Bait-Misc-Control-Products-5-30-13.pdf>.

Nester, P.R., Hurley, J.A., Bostian, B., and Terry, W. 2015. Tackling fire ants, after a student death, a case study for school IPM in Texas. pp. 21-24. In: Schowalter, T. (ed.) Proceedings of the 2015 Imported Fire Ant and Invasive Ant Conference, New Orleans, Louisiana April 6–8.

Oi, D.H., 2008. Pharaoh ants and fire ants, in: Bonnefoy, X., Kampen, H., Sweeney, K. (eds.), *Public health significance of urban pests.* World Health Organization, Regional Office for Europe, Copenhagen, pp. 175–208.

Oi, D.H. and Drees, B.M. 2009. Fire ant IPM, pp. 390–401. In: E.B. Radcliffe, W.D. Hutchison and R. E. Cancelado (eds.), *Integrated pest management: concepts, tactics, strategies and case studies.* Cambridge, USA.

Oi, D.H., Porter, S.D., Valles, S.M. 2015. A review of the biological control of fire ants (Hymenoptera: Formicidae). Myrmecological News 21: 101–116.

Oi, D.H., and Valles, S.M. 2009. Fire ant control with entomopathogens in the USA. In: A. E. Hajek, T.R. Glare, and M. O'Callaghan (eds.) *Use of microbes for control and eradication of invasive arthropods.* Springer, Netherlands.

Parkes, J.P, Fisher, P, Robinson, S, Aguirre-Munoz, A. 2014. Eradication of feral cats from large islands: an assessment of the effort required for success. New Zealand Journal of Ecology 38: 307–314.

Parkes, J.P. and Panetta, F.D. 2009. Eradication of invasive species: progress and emerging issues in the 21st century, pp. 45–60. In: M.N. Clout, and P.A. Williams (eds.), *Invasive species management: a handbook of principles and techniques.* Oxford University Press, Oxford, United Kingdom.

Porter, S.D., Savignano, D.A. 1990. Invasion of polygyne fire ants decimates native ants and disrupts arthropod community. Ecology 71: 2095–2106.

Queensland Treasury and Trade, 2013. Queensland Regional Population Survey 2013. Queensland Government, Brisbane.

Rasmussen, R. and Hamilton, G. 2012. Towards effective surveillance and treatment programs for RIFA in Brisbane. Consultancy report for Biosecurity Queensland Control Centre. Queensland University of Technology, Brisbane.

Regan TJ, McCarthy MA, Baxter PWJ, Panetta FD, Possingham HP 2006. Optimal eradication: when to stop looking for an invasive plant. Ecology Letters 9: 759–766.

Rhoades, R.B., Stafford, C.T. and James, F.K. Jnr. 1989. Survey of fatal anaphylactic reactions to imported fire ant stings. Journal of Allergy and Clinical Immunology 84: 159–162.

Rout TM, Salomon Y, McCarthy MA 2009. Using sighting records to declare eradication of an invasive species. Journal of Applied Ecology 46: 110–117.

Rust M.K., Soeprono A., Wright S., Greenberg L., Choe D-H, Boser C.L., Cory C., and Hanna C. 2015. Laboratory and field evaluations of polyacrylamide hydrogel baits against Argentine ants (Hymenoptera: Formicidae). Journal of Economic Entomology 108: 1228-1236.

Salin, V., Lard, C.F., and Hall, C., 2000. The economic impact of the red imported fire ant on the metroplexes of Texas. Texas A&M University Faculty Paper 00-6, <http://ageconsearch.umn.edu/bitstream/24000/1/fp00-06.pdf>.

Solley, G.O., Vanderwoude, C., and Knight, G.K. 2002. Anaphylaxis due to red imported fire ant sting. Medical Journal of Australia. 176: 521–523.

Souza E., Follett P.A., Price D.K., and Stacy E.A. 2008. Field suppression of the invasive ant *Wasmannia auropunctata* (Hymenoptera: Formicidae) in a tropical fruit orchard in Hawaii. Journal of Economic Entomology 101: 1068–1074.

Spring, D. 2010. Red imported fire ant simulation model: analysis of remote sensing and search and treatment options. Consultancy report for Biosecurity Queensland Control Centre. Monash University, Melbourne.

Spring, D., Keith, J.M. and Croft, L. 2011. Statistical modelling of fire ant spread. Consultancy report for Biosecurity Queensland Control Centre. Monash University, Melbourne.

Stephenson, J., Bauman, A., Armstrong, T., Smith, B. and Bellow, B. 2000. The costs of illness attributable to physical inactivity in Australia – a preliminary study. A discussion paper for the Department of Health and Aged Care and the Australian Sports Commission, Canberra.

Sutherst, R.W. and Maywald, G. 2005. A climate model of the red imported fire ant *Solenopsis invicta* Buren (Hymenoptera: Formicidae): implications for invasion of new regions, particularly Oceania. Population Ecology 34: 317–335.

Tschinkel, W.R. 2006. *The fire ants.* The Belknap Press of Harvard University Press, Cambridge, USA.

Valle, H., 2014. Australian vegetable growing farms: an economic survey, 2012–13 and 2013–14, ABARES research report for Horticulture Australia Limited. Department of Agriculture, Canberra.

Vinson, S.B. 2013. Impact of the invasion of the imported fire ant. Insect Science 20: 439–455.

Vinson, S.B. and Sorensen, A.A. 1986. Imported fire ants: life history and impact. Texas Department of Agriculture, Austin.

Vogt, J.T., Appel, A.G., and West, M.S. 2000. Flight energetics and dispersal capability of the fire ant, *Solenopsis invicta* Buren. Journal of Insect Physiology 46: 697–707.

Ward, D.F., Anderson, D.P., and Barron, M.C. Using spatially explicit surveillance models to provide confidence in the eradication of an invasive ant. Unpublished manuscript, Landcare Research, Auckland.

Williams, D. F., Collins, H.L. and Oi, D.H. 2001. The red imported fire ant (Hymenoptera: Formicidae): an historical perspective of treatment programs and the development of chemical baits for control. American Entomology 47: 146–159.

Wojcik, D. P., Allen, C.R., Brenner, R.J., Forys, E.A,. Jouvenaz, D.P., and Lutz, R.S. 2001. Red imported fire ants: impact on biodiversity. American Entomologist 47: 16–23.

Wylie, R., Jennings, C., McNaught, M.K., Oakey, J. and Harris, E.J. 2016 Eradication of two incursions of the red imported fire ant in Queensland, Australia. Ecological Management and Restoration 17: 22–32.

Xu, Y., Huang, J. Zhou, A., and Zeng, L. 2012. Prevalence of *Solenopsis invicta* (Hymenoptera: Formicidae) venom allergic reactions in mainland China. Florida Entomologist 95: 961–965.

Zhang, R., Li, Y., Liu, N., and Porter, S.D. 2007. An overview of the red imported fire ant (Hymenoptera: Formicidae) in mainland China. Florida Entomologist 90: 723–731.

Senator the Hon Matthew Canavan

Minister for Resources and Northern Australia

Senator the Hon. Stephen Parry
President of the Senate
PO Box 6100
Senate
Parliament House
Canberra ACT 2600

Dear ~~Senator Parry~~ Stephen,

I am writing regarding motion 137 agreed in the Australian Senate on 29 November 2016 to table the 'Independent Review of the National Red Imported Fire Ant Eradication Program: Report of the Independent Review Panel'.

In November 2014, the Agricultural Ministers' Forum commissioned an independent review of the eradication programme for the red imported fire ant incursion in South East Queensland. The final report outlining the review's findings and recommendations was provided to the Agricultural Minister's Forum in May 2016.

Please find enclosed, the 'Independent Review of the National Red Imported Fire Ant Eradication Program: Report of the Independent Review Panel'.

Yours sincerely

Matthew Canavan

30 NOV 2016