NSW invasive species management review

Submission by the
Invasive Species Council

November 2023

Endorsed by:

Australian Association of Bush Regenerators
National Parks Association of NSW
Nature Conservation Council of NSW

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About the Invasive Species Council

The Invasive Species Council was formed in 2002 to advocate for stronger laws, policies and programs to keep Australian biodiversity safe from weeds, feral animals, exotic pathogens and other invaders. It is a not-for-profit charitable organisation, funded predominantly by donations from supporters and philanthropic organisations.

Endorsements

This submission is endorsed by the Australian Association of Bush Regenerators, National Parks Association of NSW and Nature Conservation Council of NSW.

Intellectual property rights

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Recommendations

Priority recommendations have been marked with an asterisk and are in blue font.

Recommendations to strengthen understanding of the current impacts of invasive species

1.1 Update the assessments of invasive species impacts on threatened species and ecological communities (undertaken about 20 years ago).

1.2 Compile and publish baseline data and publicly report each year on the status of naturalised and invasive species (of all taxa types). In the state of biosecurity reports (published every 4 years) include data on naturalisation and invasion trends, new and emerging risks, and the effectiveness of management interventions to reduce the distribution and impacts of priority invasive species.

1.3 Map the distributions of all priority invasive species (as has been done for several invasive vertebrate species) and regularly update these maps to track trends.

1.4 Identify priorities for research on the environmental impacts of invasive species in New South Wales. The priorities should include (a) the risks of flammable invasive grasses and their contribution to altered fire regimes and fire hazards and (b) the biodiversity consequences of varroa mite establishment – on native bees and the pollination of native, exotic and weedy plant species.

Recommendations to identify and respond to future risks

2.1 Prepare a report within 12 months on future invasive risks for New South Wales. This should include analysis of invasion debts and the potential consequences of interactions with climate change and other environmental pressures. Based on predicted trends, identify the likely state of biological invasions in 20, 50 and 100 years' time.

2.2 Conduct regular foresighting (involving experts from a wide range of disciplines) to identify emerging and future biosecurity risks for New South Wales. Risks would include new and emerging industries, trends in consumer demand for exotic plants and pets, cultural influences and political trends. This is consistent with a proposed activity in the NSW Biosecurity and Food Safety Strategy to 'Assess and forecast impacts, such as those caused by climate change, market trends, and trade policy'. Foresighting should trigger the development of policies to prevent the realisation of emerging risks.

2.3 Based on invasion debt analysis, focus prevention efforts on the categories of species likely to be significant sources of future invasions. This should include the large pool of unregulated species in private keeping or cultivation already present in the state.

2.4 Evaluate the risks of permitting the introduction of new genotypes of existing naturalised and invasive species in New South Wales. Develop a policy to prevent 'genetic boosting'.

2.5 In all biosecurity plans and strategies consider climate change impacts and how they are likely to interact with biological invasions. Ensure that climate change is taken into account in risk assessments over an ecologically relevant timeframe.

2.6 Include management of invasive species as a standard and important element in drought, flood and bushfire preparation and recovery strategies. Address both the invasive risks (e.g. weed spread, predator impacts) and opportunities (e.g. the potential for significant population suppression).

2.7 Develop a NSW resilience strategy for biodiversity that includes a strong focus on (a) preventing and mitigating invasive species impacts and (b) protecting and restoring climate refuges.

2.8 Prior to supporting or establishing biodiversity or carbon markets, develop clear principles to ensure landscape-scale effectiveness and durability and avoid perverse invasive outcomes. See Attachment 5 for proposed principles.

Recommendations to strengthen planning and prioritisation for prevention

*3.1 Identify the priority pathways that represent the highest risks for future environmental invasions in New South Wales. Develop strategies (pathway action plans) to mitigate these risks.

*3.2 Develop a NSW priority list of species for prevention focused on species already present in Australia and develop strategies to mitigate their risks. The process should involve experts for all taxonomic groups.

Recommendations to reduce the risks of new plant invasions

*3.3 Adopt a permitted list approach for plants – by prohibiting the trade and new cultivation of all species other than those explicitly permitted. The permitted list should only contain species that are low risk or whose invasive risks will not be limited by prohibition (e.g. they are widely cultivated). Ideally, this would be coordinated with other states, with permitted and prohibited lists based on an agreed best-practice risk assessment method and taking into account the risks for neighbouring states or territories of permitting particular species. See Attachment 6 for detailed recommendations.

*3.4 Develop a strategy (a pathway action plan) to identify and mitigate the risks of potential invasive plant species present (but not established) in New South Wales. This could include programs to encourage or require people to remove high-risk species from their gardens (e.g. by providing free safe replacement plants), support for industries to develop safe alternatives to favoured high-risk species. Prepare a community education and compliance strategy with approaches tailored for different communities, including for people from different cultural backgrounds.

3.5 Permit the introduction of new variants of invasive or potentially invasive pasture or crop species only if they are assessed as low risk. This is in recognition that commercial uses often impose high propagule pressure, and that new varieties are often selected and bred for persistence, vigour and other qualities that increase their invasive potential.

Recommendations to reduce the risks of pet animals escaping and becoming invasive

*3.6 Adopt a permitted list approach for vertebrate animals kept as pets – by prohibiting the trade and keeping of species other than those explicitly permitted. The permitted list should only contain species that are low risk or whose invasive risks will not be limited by prohibition (e.g. they are widely kept). For some species prohibitions could be facilitated by grandfathering (permitting the keeping of animals until the end of their life). When prohibition is not feasible, a permit system, with categories and restrictions based on the assessed risk and feasibility, may reduce risks. See attachment 7 for more detailed recommendations.

*3.7 Develop a strategy (a pathway action plan) to identify and mitigate the risks of potential invasive animal species kept as pets in New South Wales. The strategy should include the identification of priority risk species, research to better understand the risks of the pet trade, monitoring of online trading, and evaluation of the risks of disease spillover to native wildlife. Prepare a community education and compliance strategy with approaches tailored for different communities, including for people from different cultural backgrounds. Implement an ongoing amnesty for anyone who voluntarily forfeits prohibited or high-risk species coupled with rigorous enforcement.

3.8 Remove exotic bird species from Schedule 3 of the NSW Game and Feral Animal Control Act 2002 (7 of the 8 have been assessed nationally as an extreme or serious invasion risk).

Recommendations to reduce the risks of aquarium fish being released into the wild

*3.9 Adopt a permitted list approach for aquarium fish – by prohibiting the trade and keeping of species other than those explicitly permitted. The permitted list should only contain species that are low risk or whose invasive risks cannot be limited by prohibition. Ideally, this should be a nationally consistent approach, but New South Wales should take preventative action in the absence of a national consensus. See Attachment 8 for detailed recommendations.

*3.10 Develop an aquarium fish strategy (a pathway action plan) to significantly reduce the risks of aquarium fish-keeping. This should set out a transparent process for determining the appropriate biosecurity status of fish species consistent with their invasive risks and applying the precautionary principle (in recognition of the limited introduction history for many species). Prepare a community education and compliance strategy with approaches tailored for different communities. It should include online monitoring and enforcement, amnesties for voluntary forfeiture of illegal species, and surrender and rehoming options for people wanting to discard fish.

Recommendations to improve detection of new incursions

3.11 Expand New South Wales's list of notifiable diseases to include diseases of environmental significance. All diseases listed on Australia's National Priority List of Exotic Environmental Pests, Weeds and Diseases should be notifiable.

3.12 As a high priority, develop a surveillance program for online trading in prohibited plant and animal species, including through the use of web-scraping technology.

3.13 Trial citizen science biosecurity surveillance, adopting the lessons learned from trials in other jurisdictions and the federally funded Bug Hunt project.

3.14 As an immediate urgent priority, promote a citizen science focus on surveillance for red imported fire ants and other high-risk alert species such as yellow crazy ants. Concentrate engagement particularly around major sea ports (Newcastle, Port Botany, Wollongong/Port Kembla).

Recommendations to facilitate the eradication of high priority risk species

3.15 Establish a High Risk Environmental Incursions Response Fund (as recommended by the Natural Resources Commission in 2014). This will enable agencies to rapidly respond in the early stages of an incursion, avoiding delays that escalate costs and reduce the prospects of eradication. It should be a reserve fund, with unused funding rolling over year to year, to be used only when national or industry cost-sharing arrangements do not apply. The NSW Government should contribute at least $1.5 million a year. This could be supplemented by an annual flat rate contribution of $10 by all Local Land Services rate payers (estimated in 2014 to raise $1.3 million a year).

3.16 Review the process and criteria applied by the NSW Government for determining whether to eradicate new incursions. The process should be transparent and all assessments underpinning a decision (whether to proceed or not) should be published. The precautionary principle should apply. Maintain a public database of all detected incursions and the outcomes of biosecurity responses.

3.17 For locally naturalised and sleeper species, develop a transparent process for identifying and prioritising potential candidates for state-wide eradication. Apply this systematically across all taxa to develop a priority eradication list. Maintain a public database of attempted eradications and the outcomes.

3.18 Encourage and support regional eradications of locally naturalised and sleeper invasive species. Establish a service similar to that provided by the Victorian Weeds at an Early Stage of Invasion (WESI) program to support local governments, and natural resource and environmental groups to undertake eradications.

Recommendations for strengthening threat abatement

4.1 Comprehensively identify and list key threatening processes through an independent scientific process, supplemented by a public nomination process. Regularly review the list of threats to ensure it remains up to date.

4.2 List threats in a hierarchical scheme of key threatening processes and environmental threats of state significance. Establish an additional threat category – emerging threatening processes.

4.3 Set ambitious and inspiring goals for abating the major threats to nature in New South Wales. Design a fit-for-purpose abatement response for all listed threats, including threat abatement plans or action plans (e.g. for cross-sectoral threats), regional plans, and policy and regulatory responses.

4.4 Establish an implementation taskforce for each major threat response, with a coordinator to drive implementation of plans for the priority threats. Facilitate collaborations by governments, Traditional Owners and community and cross-sectoral stakeholders on abating major threats.

4.5 Collaborate with other jurisdictions on implementing threat abatement plans for nationally listed key threatening processes. Advocate for the development of an intergovernmental agreement that commits the Australian, state and territory governments to collaboratively abate major threats to nature.

4.6 Systematically monitor and report on threat abatement progress. Introduce independent oversight of the threat abatement system.

4.7 Investigate the economics of threat abatement – the annual costs of effective abatement and the economic consequences of abatement failures and successes.

4.8 Substantially increase public spending on threat abatement and threatened species recovery, and allocate funds based on a transparent prioritisation process.

Recommendations to strengthen the capacity for invasive animal management

*4.9 Identify state environmental priorities for invasive animal management and develop state action plans or threat abatement plans with clear targets for threat reduction. Priority species for state plans include foxes and feral cats, deer, goats and pigs. Ensure that regional plans are aligned with state plans or, if there is no relevant state plan, with a national plan (e.g. the action plans for feral deer and pigs and threat abatement plans for feral cats, goats and foxes).

*4.10 Establish dedicated coordinator roles for priority invasive animals to facilitate cross-tenure and cross-regional collaborations, and motivate and support landholder participation.

4.11 As recommended in the 2016 NRC review, 'Provide adequate resources to deliver effective pest animal management'. Work is needed to evaluate what can be achieved for particular levels of public funding (recommendation 32) and the budgets needed to achieve defined outcomes.

4.12 Build the rapid response capacity of regional groups to manage invasive species after major disturbances such as droughts, floods and fire. When there are significant risks or opportunities, funding should be provided from a Rapid Response Trust Fund. The establishment of such a fund in each Local Land Services region was recommended in the 2016 NRC review of pest animal management.

4.13 In regional plans clearly specify the management activities and outcomes expected of land managers to discharge their general biosecurity duty. Develop GBD guidelines about what should be considered when specifying these expectations – e.g. the potential for environmental harm, location in or near sensitive environmental sites, feasibility of control. Widely communicate these expectations in messaging appropriate for key audiences. Also see recommendations 5.18.

4.14 Develop performance measures for regional plans that reflect environmental outcomes (rather than effort). Report regularly against these measures. Require independent evaluations of regional plan outcomes to inform revisions of the plan. Publish all evaluations.

Recommendations to improve the management of invasive ungulates

4.15 Clearly communicate what New South Wales's general biosecurity duty requires of landholders with populations of feral ungulates on their property and use powers under the Biosecurity Act as needed to achieve compliance. This may require imposed control operations and cost recovery.

4.16 Develop a NSW feral deer plan that implements the zones specified in the national action plan. Appoint a state feral deer coordinator. Revise regional plans to align with the state plan and develop local plans to achieve area-specific objectives, including a containment plan for the Greater Blue Mountains and an eradication plan for the Northern Rivers exclusion zone. Strengthen deer farm controls to limit and track escapes, modelled on South Australia's scheme.

4.17 Develop a NSW feral goat plan with a goal to reduce feral populations to less than 0.5 million within a decade. Appoint a state coordinator and provide funding sufficient to achieve the target.

4.18 Repeal the Kosciuszko Wild Horse Heritage Act 2018 and develop eradication plans for feral horse populations in other protected areas including Barrington, Oxley Wild Rivers, Guy Fawkes, Yuraygir and Torrington national parks.

4.19 Revise aerial shooting protocols in New South Wales to optimise their effectiveness, including to enable the use of thermal imaging shooters.

Recommendations to improve management of foxes and feral and pet cats

4.20 Develop a statewide feral cat and fox strategy (threat abatement plan) aligned with the national threat abatement plans.

4.21 Amend the Companion Animals Act or use other mechanisms to require 24/7 pet cat containment. Mandate desexing for all cats by 4 months of age. Support these measures with funding for education, enforcement and assistance for low income households.

4.22 To help resolve important questions about dingoes, support a large-scale experiment to realign the dingo fence bordering Sturt National Park to allow the reintroduction of dingoes and comprehensively and robustly test the effects over several years.

Recommendations to improve management of invasive plants

4.23 Accord continued high priority to research into biocontrol options for the most invasive environmental weeds.

4.24 Commission research to examine the costs, benefits and feasibility of different models of integrated land management models and trial new approaches.

4.25 Increase funding for the Weeds Action Program to $20 million a year and provide long-term multi-year funding certainty for regional weed programs.

4.26 Evaluate the adequacy of funding for the coordination of regional weed programs, enforcement and education. Increase funding where needed to optimise these important functions.

4.27 Add a 'weed' category for all local government and Snap, Send, Solve incident reporting tools.

4.28 On the sale of a property, require the vendor to declare the presence and extent of any priority weeds identified in the regional weeds strategy.

Recommendation to support island eradications

4.29 Continue to support Lord Howe Island's exemplary weed eradication program.

Recommendations to improve management of invasive species on public lands

4.30 Undertake an audit of invasive species and the effectiveness of management programs on public lands other than protected areas. Identify the priority properties where invasive species threaten biodiversity values and require the development of management plans for these properties, with performance targets and measures. There should be independent oversight and regular public reporting on the effectiveness of public land management. This can be a role for the proposed GBD auditor (recommendation 5.19) or, otherwise, for the Biosecurity Commissioner.

4.31 Allocate sufficient resources for public land managers to discharge their general biosecurity duty. Disclose publicly how much funding is spent on invasive species management by each agency with public land management responsibilities.

4.32 Undertake aerial shooting of invasive animals in state forests where needed to protect biodiversity values.

4.33 Establish processes to foster collaboration with neighbouring land holders across tenures in public land management programs.

4.34 Include invasive species management as a core focus in any transition strategy away from forestry in public native forests.

Recommendations to strengthen institutional arrangements for environmental biosecurity

*5.1 Restructure the biosecurity portfolio to optimise the biosecurity focus on all values important to people in New South Wales – environmental, social, cultural and economic. This can be achieved by (a) creating a standalone title (Biosecurity Minister) for the minister administering the Biosecurity Act and (b) integrating the agency into a department with a broader remit or creating a standalone agency. To avoid perceived conflicts of interest, it would be best if the biosecurity minister was not also an agriculture or trade-focused minister.

*5.2 In the absence of a standalone biosecurity agency, establish a role for a Chief Environmental Biosecurity Officer in the Department of Primary Industries – as the equivalent of the Chief Plant Protection Officer and Chief Veterinary Officer – to focus on environmental priorities and ensure a strong voice for the environment in all biosecurity decision-making.

Recommendations to strengthen transparency and accountability

5.3 Develop meaningful performance measures in the state biosecurity strategy and invasive species plan and require independent evaluation of the progress on implementation. Publish all evaluations.

5.4 Require the Biosecurity Commissioner to publish a state of biosecurity report every 4 years. Further develop the report indicators to better reflect the status of invasive species and their environmental impacts.

5.5 Publish all risk assessments, prioritisation assessments and other documents underpinning biosecurity decisions and funding allocations.

5.6 Reconstitute the NSW Biosecurity Advisory Committee with representatives from the NSW Farmers Association, Nature Conservation Council of NSW, NSW Aboriginal Land Council, Local Land Services, National Parks and Wildlife Service, Landcare NSW, Department of Primary Industries, and NSW Local Government Association, with an independent chair.

Recommendations to establish and strengthen biosecurity partnerships

*5.7 Appoint a NSW Indigenous Commissioner for Country to facilitate First Australians' leadership and engagement in natural resource issues. An important focus would be biosecurity, including to advise the government on managing invasive species to better protect indigenous culture and country. This could be a co-commissioner role in the Natural Resources Commission or a standalone position.

5.8 Establish dedicated positions or set a target for indigenous employment when recruiting and contracting for invasive species management.

5.9 Include Indigenous cultural heritage protection as a focus area for invasive species management.

5.10 Establish an environmental and community advisory body to advise on and facilitate the more meaningful involvement of the community sector in biosecurity. This body should oversee work to identify the variety of community interests in biosecurity and their capacities to contribute (in all facets, including policy development), leading to the development of a strategy to establish genuine partnerships with communities.

5.11 Implement the recommendation of the NSW Audit Office for the Department of Primary Industries to 'implement formal agreements with partner agencies that it relies on to deliver effective biosecurity compliance activities and emergency responses'. One high priority should be a detailed MOU between the Department of Primary Industries and the Department of Planning and Environment to clarify roles and responsibilities and ensure that environmental priorities are incorporated into all biosecurity decision-making.

Recommendations to increase funding and optimise the returns on investment

*5.12 Commission a review of biosecurity investment in NSW and new options for sustainable funding. The review should analyse current sources of funding, including private and public, and how the funding is allocated across different biosecurity functions – prevention, eradication, containment/control, research – and for different purposes, including for environmental, social and production benefits. It should analyse trends in funding and staffing levels compared to trends in biosecurity risks and impacts. The assessment of options for new funding sources should include cost recovery, contributions from risk creators and beneficiaries and insurance options.

5.13 Invest in new frontline jobs in invasive species management to secure additional capacity of 180 FTE, comprising:

- 110 new pest and weed officers (10 in each Local Land Services region)
- 50 new local government weed control positions
- 20 new DPI biosecurity officers

*5.14 Develop a statewide investment strategy to optimise the returns (durable public benefits) on investment. The strategy should include clear criteria and a prioritisation algorithm (including cost, public benefit and feasibility) to guide decision-making. Funding allocations should be guided by advice from an independent expert body on where the best outcomes, including for biodiversity, can be achieved. Funding decisions should be transparent and justified.

Recommendations to improve methods for estimating and comparing returns on biosecurity investments

5.15 Develop, publish and regularly update a set of standard costings for the range of biosecurity interventions, including for the abatement of major threats to biodiversity.

5.16 Commission research (by the Centre of Excellence for Biosecurity Risk Analysis) to assess the relative environmental returns on investments in interventions across the invasion curve.

5.17 Commission research (by the Centre of Excellence for Biosecurity Risk Analysis) to evaluate and recommend methods to compare and rank economic, social and environmental impacts and returns on investment. These should appropriately weigh the irreversible nature of some environmental impacts (extinction, ecosystem transformation).

Recommendations to improve implementation of the general biosecurity duty

5.18 As a high priority, develop more effective strategies to improve public understanding of the general biosecurity duty and the measures it requires.

*5.19 Appoint an independent GBD auditor within the Biosecurity Commission to undertake audits of different sectors to assess compliance with the general biosecurity duty. This should include a particularly strong focus on government agencies and local governments.

5.20 Require each government agency and local government to publicly identify their obligations under the general biosecurity duty. This would apply to activities with biosecurity risk (e.g. land management) and functions that influence the risk behaviours of industries or community members (e.g. the approval of developments or regulation of industries). Each entity should prepare a plan specifying how they propose to discharge their GBD with respect to these risks and report annually against performance measures. Some GBD responsibilities will require the development of guidelines – for example, on measures to mitigate biosecurity risks for new development approvals.

5.21 Specify the measures needed to comply with the general biosecurity duty for all people active on high-risk invasion pathways. This should be a focus in the development of the proposed pathway action plans. Develop strategies to foster compliance in the risk-creating groups, including messaging specific to different cultural groups. Each pathway strategy needs the advice of social scientists about how to optimise compliance. This should also be a priority research focus.

5.22 Evaluate whether the management expectations specified in regional weed and pest animal management plans reflect a defensible interpretation of the general biosecurity duty. Assess the extent to which landholders are implementing these expectations. Explore ways (e.g. by levy or rates concessions) to incentivise landholders to develop and implement biosecurity plans to identify and manage priority risks on their property.

Recommendations to strengthen enforcement

5.23 Shift jurisdiction for offences under the Biosecurity Act to the Land and Environment Court.

5.24 Implement the recommendation of the NSW Audit Office for the Department of Primary Industries to ‘establish a data collection and reporting system that enables data sharing with LLSs and LCAs that allows them to better target their biosecurity compliance activities’.

5.25 Implement the recommendation of the NSW Audit Office for the Department of Primary Industries to ‘publish annual data on performance targets and outcomes for its biosecurity compliance and emergency response activities’.

5.26 Implement the recommendation of the NSW Audit Office for the Department of Primary Industries to better meet its obligations to protect the environment by revising its compliance procedures and emergency response practices to address risks to the environment and the community.

Recommendations to improve control methods for invasive species

*5.27 Retain the use of existing control methods, including 1080 and glyphosate, while investing in the development of new technologies. These methods are essential tools for conservation with no viable alternatives in most circumstances.

5.28 Develop a biosecurity research plan to comprehensively assess and identify research priorities. It should include a strong focus on developing more effective control and ecological management options.

5.29 Substantially increase the investment in research on long-term solutions. Given the lack of effective methods for effective large-scale control of most invasive species, it may be justified to prioritise research over non-critical short-term management priorities.

Recommendations to improve monitoring and reporting

5.30 Review the current extent of and methods used for monitoring the outcomes of invasive species management in New South Wales.

5.31 Publish the reports of publicly funded control activities and undertake regular evaluations of the overall program outcomes achieved. Periodically review these programs to document the lessons learned and make recommendations to improve their effectiveness.

Recommendations to maintain a social licence for controlling invasive animals

5.32 Prioritise research on the development and trialing of more-humane and more-effective ways of controlling invasive animals, with alternatives to 1080 being a high priority.

5.33 In the absence of more-humane and effective alternatives, maintain and defend the use of important methods for conservation and the welfare of at-risk native animals. Make decisions about welfare on the basis of evidence, not public opinion.

5.34 Design long-term control programs that minimise the overall extent of killing of introduced animals – for example, by eradicating or rapidly suppressing their populations, and by intervening ecologically to help native animals withstand invasive pressures. Improve monitoring to ascertain whether programs achieve predefined conservation goals and are cost effective (it is unethical to kill animals if no conservation benefit is achieved and wrong to waste scarce conservation funds).

Recommendations to manage social conflict

5.35 To more effectively manage the social dimensions of invasive species issues, invest more in social science research. Integrate best-practice conflict prevention and management into biosecurity programs.

5.36 For some conflicts, particularly those where there are conflicts of interest within governments, appoint an independent arbiter to manage deliberative processes for resolution.

Recommendation for participation in the Decade of Biosecurity

6.1 Support the Decade of Biosecurity initiative by providing 3-year partnership funding and nominating as a lead or supportive partner for one of the 6 priority projects.

Introduction

The Invasive Species Council welcomes this review – it is very much needed.

In the already heavily invaded and degraded state of New South Wales, new invasive species keep arriving and establishing, emerging invaders are proliferating and spreading, and the worst extirpators and degraders haven't let up. Climate change, habitat destruction and degradation and intensifying fire regimes are creating new opportunities for invasions.

We encourage a search for transformative solutions. Cautious incremental reforms will only reduce the rate at which decline occurs rather than suffice to stop extinctions, declines and degradation due to invasive species.

We are keen to collaborate with the Natural Resources Commission, the government and other stakeholders to explore new ways of thinking about and responding to New South Wales's invasive species challenges.

1. Current impacts

Consultation question: To what extent are the NSW environment, industries and communities currently impacted by invasive species?

1.1 The state of information

'We are seeing one of the great historical convulsions in the world's fauna and flora,' said the pioneering invasion biologist Charles Elton in 1958.[1] The convulsions in New South Wales due to invasive species have been particularly severe with numerous species extinctions and large-scale degradation. But the publicly available information about invasive species and their environmental impacts in New South Wales is surprisingly scant.

The 2021 state of the environment report lacks up-to-date information – mostly citing analyses from 2006 and 2007 on impacts – and fails to provide any meaningful analysis of the effectiveness of responses. For example, the section on 'Management of invasive species by the National Parks and Wildlife Service' reports a 5-fold increase in average effort and removal of more than 55,102 feral animals from the national park estate since 1 January 2020, which reveals nothing about the current ecological health of national parks and management effectiveness. Tellingly, the 'impact of widespread invasive species' – one of 3 indicators – is rated as poor and the reliability of information is given the lowest rating.

A 2019 pilot study assessed the environmental impacts of 7 invasive animals and 15 weeds on 97 listed threatened species and ecological communities, but there is no indication that it was applied more broadly.[2]

The NSW Government also publishes a state of biosecurity report every 4 years – the only Australian jurisdiction to do so. While it includes important data about the status of invasive species, it makes only general statements about environmental impacts and mostly recounts activities rather than evaluates biosecurity effectiveness.

As the basis for developing effective biosecurity programs, New South Wales needs detailed, up-to-date information about the current distribution and impacts of invasive species, their trends and the effectiveness of management. The distribution of all priority species should be mapped. There is great potential to use the observations of 'citizen scientists' to inform mapping, which can be facilitated by the use of phone apps. In the ACT, public land managers all use the same phone app (ArcGIS Field Maps) to add records of priority weeds to a single, shared, editable map.[3]

[1] Charles Elton, *The Ecology of Invasions by Animals and Plants* (Methuen, 1958).

[2] https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Animals-and-plants/Biodiversity/Biodiversity-Indicator-Program/report-card-invasive-species-supplement-to-biodiversity-outlook-report-210486.pdf

[3] https://esriaustralia.com.au/blog/act-parks-smart-mapping-control-system-invasive-species

1.2 Naturalised and invasive plants

New South Wales is rated as one of the weediest mainland regions in the world.[4] The 1,700–1,800 plant species reported as naturalised in the state now make up more than 1 in every 5 species in the state (>22% of the total flora; Attachment 1, Attachment 2). The state has more naturalised plant species than any other Australian jurisdiction, and about half the total recorded for Australia. Most have been deliberately introduced from other countries for gardening and farming, while about 5% are native to Australia.

Based on various state and territory weed assessments (using different methods), about half the naturalised plant species in NSW are rated as having an adverse environmental impact somewhere in Australia (they are 'invasive') and another 10% are rated as potentially invasive (Attachment 2).

A 2018 assessment rated 225 plant species and species groups (of 266 assessed) naturalised in NSW as a high environmental threat.[5] In a national assessment 149 species naturalised in NSW have been rated as a threat somewhere in Australia to nationally listed threatened species,[6] although this is a considerable underestimate as threat descriptions for listed species often refer generically to weed threats without naming the species. The only published assessment of weed impacts on threatened biodiversity in NSW is now almost 20 years old – it found that weeds threaten 45% of threatened species, populations and communities.[7] We recommend this assessment be updated and expanded to focus on all threats using the methodology of a recent national assessment by the National Environmental Science Program.[8]

Given the rising environmental, economic and human hazards of intensifying fire regimes in New South Wales, one important topic for research should be the impacts of and management options for flammable invasive grasses. A Victorian study found that native grasslands invaded by canary grass (*Phalaris aquatica*) had 3–5 times more fuel mass than native kangaroo grass grasslands, and fire intensity was 3 times higher.[9] Exotic pasture grasses have been widely planted in New South Wales, with 14% of the state (11.5 million hectares) classified as 'improved pastures'.[10] Invasion of native plant communities by exotic perennial grasses was listed as a key threatening process in 2003 but no threat abatement plan has been prepared.

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[4] P Pysek et al., "Naturalized Alien Flora of the World: Species Diversity, Taxonomic and Phylogenetic Patterns, Geographic Distribution and Global Hotspots of Plant Invasion. Preslia89: 203-274," 2017; Mark Van Kleunen et al., "Global Exchange and Accumulation of Non-Native Plants," *Nature* 525, no. 7567 (2015): 100–103.

[5] Josh Dorrough, Ian Oliver, and Julian Wall, "Consensus When Experts Disagree: A Priority List of Invasive Alien Plant Species That Reduce Ecological Restoration Success.," *Management of Biological Invasions* 9, no. 3 (2018).

[6] Michelle Ward et al., "A National-scale Dataset for Threats Impacting Australia's Imperiled Flora and Fauna," *Ecology and Evolution* 11, no. 17 (2021): 11749–61.

[7] AJ Coutts-Smith and PO Downey, "The Impact of Weeds on Threatened Biodiversity in New South Wales" (CRC for Australian Weed Management, 2006), https://www.researchgate.net/publication/264240230_The_Impact_of_Weeds_on_Threatened_Biodiversity_in_New_South_Wales.

[8] Ward et al., "A National-scale Dataset for Threats Impacting Australia's Imperiled Flora and Fauna."

[9] Zac C Walker and John W Morgan, "Perennial Pasture Grass Invasion Changes Fire Behaviour and Recruitment Potential of a Native Forb in a Temperate Australian Grassland," *Biological Invasions* 24, no. 6 (2022): 1755–65.

[10] https://www.abs.gov.au/statistics/environment/environmental-management/national-land-account-experimental-estimates/latest-release#land-use

The NSW Government has funded some research on invasive grass management – a program facilitated by the Centre for Invasive Species Solutions to establish large-scale experimental sites 'to develop and demonstrate the best management practices for major invasive grasses'[11] – and biocontrol for African lovegrass (section 4.3).

Attachment 1 provides a list of naturalised plant species and Attachment 2 has more information about the status of introduced plant species.

1.3 Naturalised and invasive animals

At least 69 vertebrate species have naturalised in New South Wales (excluding fish translocated for conservation reasons) – the second highest number in Australia (after Queensland). Fish species make up 33% of naturalised vertebrates, mammals 29% and birds 25% (Attachment 1, Attachment 2).

Most naturalised vertebrates have been introduced from other countries – mostly for hunting or fishing or as livestock – but more than a third of the naturalised fishes are native to Australia, translocated for recreational fishing. Apart from fish, most naturalised vertebrates have been established for several decades. About 40% of the fishes, mostly aquarium fish, have naturalised in Australia only since the 1970s.

The majority of naturalised vertebrates in New South Wales, 63%, have had adverse environmental impacts somewhere in Australia and the potential for adverse impacts has been noted for another 29% (Attachment 2). At least 5 species naturalised in New South Wales are known to have contributed to national extinctions and 30 have been rated as a medium- or high-impact threat to nationally listed threatened species (Attachment 3).

The only published assessment of invasive animal impacts on threatened biodiversity in NSW is now almost 20 years old – it found that invasive animals (29 different species) threaten 40% of threatened species, populations and communities.[12] We recommend this assessment be updated and expanded to all threats using the methodology of a recent national assessment by the National Environmental Science Program.[13]

A recent global assessment found that invasive species have played a role in 60% of plant and animal extinctions worldwide, particularly on islands.[14] In Australia invasive animals have caused more extinctions than any other threat, particularly of mammals and island birds.[15] The extinction rate appears to be accelerating, with 6 of 9 national extinctions since 2000 caused by invasive species.[16]

Reflecting the situation nationally, invasive species are likely to have been the dominant cause of animal extinctions in NSW – the main cause or a major (≥30%) contributor to at least 20 (of 31) extinctions (65%) – mainly due to predation by cats (n=12), foxes (n=12) and black rats (n=4) (Attachment 3).

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[11] https://invasives.com.au/wp-content/uploads/2022/09/Weeds-grasses-factsheet-Sep-22-final.pdf

[12] Coutts-Smith et al., "The Threat Posed by Pest Animals to Biodiversity in New South Wales" (Invasive Animals Co-operative Research Centre, Canberra, 2007).

[13] Ward et al., "A National-scale Dataset for Threats Impacting Australia's Imperiled Flora and Fauna."

[14] IPBES, "IPBES Invasive Alien Species Assessment: Summary for Policymakers," 2023, https://doi.org/10.5281/zenodo.10004329.

[15] J.C.Z. Woinarski et al., "Reading the Black Book: The Number, Timing, Distribution and Causes of Listed Extinctions in Australia," *Biological Conservation* 239 (November 2019): 108261, https://doi.org/10.1016/j.biocon.2019.108261.

[16] Tim Low and Carol Booth, "GONE: Australian Animals Extinct since the 1960s" (Invasive Species Council, 2023).

Offering the potential for restoration in future, 18 extinctions have been at a state level only – for example numbats, bilbies, greater stick-nest rats, western quolls, Tasmanian bettongs (Attachment 3). Some have recently been reintroduced to predator-free havens or there are plans to do so. To restore them more widely will require much more effective control of cats and foxes, which is not feasible with current control techniques.

Invasive vertebrates have also caused extensive degradation in New South Wales – particularly rabbits and ungulates on land and carp in rivers.

It is not feasible to comprehensively compile information on naturalised invertebrates, for too little is known about these species and their impacts. The most impactful group have been the ants, bees and wasps – at least 33 alien Hymenopteran species have naturalised in New South Wales, of which at least 6 ant, 1 wasp and 2 bee species are considered invasive or potentially invasive somewhere in Australia (Attachment 1, Attachment 2). At last one mite species causes severe disease (sarcoptic mange) and others are potentially invasive. The environmental consequences of the recent naturalisation of varroa mite are as yet unknown but likely to be beneficial for native pollinators and for reducing the impacts of some weeds heavily reliant on pollination by feral honey bees. These consequences should be monitored.

Attachment 1 provides a list of naturalised animal species, Attachment 2 has more information about the status of introduced animal species and Attachment 3 provides more information about extinctions and biodiversity impacts.

Recommendations to strengthen understanding of the current impacts of invasive species

1.1 Update the assessments of invasive species impacts on threatened species and ecological communities (undertaken about 20 years ago). The most useful approach may be to apply the method used by Ward et al. 2021 (National Environmental Science Program).

1.2 Compile and publish baseline data and publicly report each year on the status of naturalised and invasive species (of all taxa types). In the state of biosecurity reports (published every 4 years) include data on naturalisation and invasion trends, new and emerging risks, and the effectiveness of management interventions to reduce the distribution and impacts of priority invasive species.

1.3 Map the distributions of all priority invasive species (as has been done for several invasive vertebrate species) and regularly update these maps to track trends.

1.4 Identify priorities for research on the environmental impacts of invasive species in New South Wales. The priorities should include (a) the risks of flammable invasive grasses and their contribution to altered fire regimes and fire hazards and (b) the biodiversity consequences of varroa mite establishment – on native bees and the pollination of native, exotic and weedy plant species.

2. Future risks

Consultation question: What are the future risks posed by invasive species to the NSW environment, industries and communities?

2.1 Increasing invasion risks

There is high potential in New South Wales for an already critical situation to worsen, for the state faces a very large 'invasion debt' due to the large numbers of:

- serious invasive species yet to achieve their full potential range or population densities and likely to benefit under changing environmental conditions
- locally naturalised species with the potential to spread and become invasive or more invasive
- potential invasive species (based on an invasion history elsewhere) present but not (yet) naturalised (cultivated or kept species)
- non-native species present in Australia that are permitted for trade into the state.

To assess future risks, we need a better accounting of the current status of introduced, naturalised and invasive species and their potential to progress along the invasion curve (and exact their debt). Based on recent trends, what is the likely state of invasive species in New South Wales in 20, 50 and 100 years time? Peering into the future (foresighting) should be a prime function of biosecurity agencies.

Globally, the number of invasive species is rising rapidly – expected to increase by 36% by 2050, with costs expected to quadruple every decade.[17] There has been a regular flow into Australia of new potential invasive species – both permitted and accidental. The recent NSW state of biosecurity report notes 'outbreaks from exotic incursions are rising in number, complexity, and severity'.[18]

The majority of future invaders in New South Wales are probably already present in Australia – in gardens, paddocks, aquariums and houses or naturalised in another region. Because most introductions occurred prior to any requirement for import risk assessments, the vast majority of species present have never been assessed for their risk. Most are permitted entry into New South Wales.

The majority of naturalised species have not had time to spread far. Even if all new introductions ceased, the potential for increasing impacts as species spread and proliferate is extremely high. One very clear pattern in invasion biology is that the longer the residence time, the more species that will become invasive. Invasional meltdown will become increasingly common. Another concern that receives too little attention in biosecurity is the potential for exacerbation of invasion impacts by the continued introduction of new genotypes of naturalised and already invasive species.

Also likely to exacerbate invasions are the multiplying and intensifying environmental stresses that often favour invasive species over native species – extreme weather events, severe fires, land clearing and degradation.

[17] IPBES, "IPBES Invasive Alien Species Assessment."
[18] NSW Department of Primary Industries, "State of Biosecurity Report 2018-2021" (NSW Government, 2022).

2.2 Interactions with climate change

A 2009 assessment of the vulnerability of Australia's biodiversity to climate change noted that in many cases the impacts of invasive species benefiting from climate change are likely to exceed the direct impacts of climate change.[19]

Under climate change, some species will decline and others will thrive (see Attachment 4). Winners and losers will include invasive species. The cane toad, for example, is expected to expand its range further south but rising temperatures will constrain rabbit breeding. This does not mean there will be an overall balancing out: for a variety of reasons invasive species are overall likely to cause more harm under climate change. One reason is that many invasive species are generalists and highly adaptable, able to tolerate or take advantage of change and disturbance. Many weeds are weedy because they thrive over a wide range of climatic conditions.

An increase in extreme events in particular will offer new opportunities for invasive species to proliferate and spread – weeds colonise bare patches after droughts, fires and cyclones; and foxes and cats prey on animals whose shelter is destroyed by those events. Extreme events promote invasions: floods in the 1970s spread carp throughout the Murray-Darling system and athel pine along hundreds of kilometres of the Finke River in central Australia. The bushfires of 2019–20 are likely to have provided opportunities for invasive species to have colonised new places.

Native species and ecosystems stressed by climate change will become less competitive and more vulnerable to threats by invasive species. Stressed plants, for example, would be more vulnerable to diseases like phytophthora dieback or displacement by weeds.

Human responses to climate change are likely to provide new invasive opportunities – with the introduction of weedy biofuel crops or the spread of weeds in fodder after droughts and other extreme events – and less control of existing invaders. If farmers are under economic stress due to extreme weather events and governments have other climate-related budgetary demands, we can expect less focus on invasive species control. A NSW survey found that feral animal numbers did not decline during one drought, attributed to fewer control efforts by farmers under economic stress.[20] In addition, some herbicides and biological control agents may be rendered less effective under climate change.

The NSW Government should take climate change impacts and interactions with invasive species into account across all biosecurity planning and risk assessment. Climate change adaptation and mitigation measures should include the following:

- Reduce existing invasive species threats to increase the capacity of native species and ecosystems to adapt to climate change – for example, protect fire refuges from invasion by flammable weeds and drought refuges from cats and foxes.
- Control invaders or potential invaders likely to benefit and become more invasive under climate change – for example, implement programs to eradicate potential invaders that could invade warming alpine areas.
- Prevent harmful new introductions and ensure that responses to climate change (such as biofuel cropping and more drought-tolerant pastures) do not create new invasive species problems.

[19] Will Steffen, *Australia's Biodiversity and Climate Change* (Csiro Publishing, 2009).
[20] Peter West and G Saunders, "Pest Animal Survey: 2004-2006. A Review of the Distribution, Impacts and Control of Invasive Animals throughout NSW and the ACT" (NSW Department of Primary Industries, 2007).

- Control invasive species that contribute to greenhouse gas emissions or impede sequestration – for example, limit the spread of flammable weeds that increase fuel loads well beyond natural levels and increase emissions due to more fires, and reduce populations of feral herbivores.

For references and more detailed information about the interaction of climate change and invasive species, see Attachments 4A, 4B and 4C. These documents provide examples of the potential for exacerbated invasions due to climate change impacts.

2.3 Interactions with other environmental changes

Invasions often occur in association with and are facilitated by other environmental changes. Given the severity of the biodiversity crisis facing New South Wales, there needs to be a concerted focus to avoid and mitigate the avoidable or reversible impacts – particularly habitat destruction and fragmentation, adverse fire regimes and invasive species threats. This is core to fostering resilience to the unavoidable impacts. Also essential for fostering resilience is to protect and restore climate, fire and drought refuges.

New South Wales needs to focus intensively on restoration – for much of the state's ecological carrying capacity has been lost.[21] By 2018, only 15% of remnant native vegetation in the state was in 'close-to-natural condition'. A 2013 assessment found that only a third of the state's original habitat effectiveness remained to support native species. The fires of 2019–20 reduced the ecological carrying capacity in the burned areas by 39% (an assessment in the immediate aftermath). Some of this is recoverable. But such disturbances often create opportunities for invasions, which can then impede or stymie recovery.[22]

Recommendations to identify and respond to future risks

2.1 Prepare a report within 12 months on future invasive risks for New South Wales. This should include analysis of invasion debts and the potential consequences of interactions with climate change and other environmental pressures. Based on predicted trends, identify the likely state of biological invasions in 20, 50 and 100 years' time.

2.2 Conduct regular foresighting (involving experts from a wide range of disciplines) to identify emerging and future biosecurity risks for New South Wales. Risks would include new and emerging industries, trends in consumer demand for exotic plants and pets, cultural influences and political trends. This is consistent with a proposed activity in the NSW Biosecurity and Food Safety Strategy to 'Assess and forecast impacts, such as those caused by climate change, market trends, and trade policy'. Foresighting should trigger the development of policies to prevent the realisation of emerging risks.

2.3 Based on invasion debt analysis, focus prevention efforts on the categories of species likely to be significant sources of future invasions. This should include the large pool of unregulated species in private keeping or cultivation already present in the state.

[21] K Williams et al., "Australia State of the Environment 2021: Land, Independent Report to the Australian Government Minister for the Environment" (Commonwealth of Australia, 2021).
[22] Suzanne M Kercher and Joy B Zedler, "Multiple Disturbances Accelerate Invasion of Reed Canary Grass (Phalaris Arundinacea L.) in a Mesocosm Study," *Oecologia* 138 (2004): 455–64.

2.4 Evaluate the risks of permitting the introduction of new genotypes of existing naturalised and invasive species in New South Wales. Develop a policy to prevent 'genetic boosting'.

2.5 In all biosecurity plans and strategies consider climate change impacts and how they are likely to interact with biological invasions. Ensure that climate change is taken into account in risk assessments over an ecologically relevant timeframe.

2.6 Include management of invasive species as a standard and important element in drought, flood and bushfire preparation and recovery strategies. Address both the invasive risks (e.g. weed spread, predator impacts) and opportunities (e.g. the potential for significant population suppression).

2.7 Develop a NSW resilience strategy for biodiversity that includes a strong focus on (a) preventing and mitigating invasive species impacts and (b) protecting and restoring climate, fire and drought refuges.

2.8 Prior to supporting or establishing biodiversity or carbon markets, develop clear principles to ensure landscape-scale effectiveness and durability and avoid perverse invasive species outcomes. See Attachment 5 for proposed principles.

3. Effectiveness of existing programs – prevention

Consultation question: To what extent do you think existing programs in NSW are effectively managing invasive species?

3.1 Prioritising and planning

The NSW Government recognises that prevention should be a high priority. The Biosecurity and Food Safety Strategy 2022–2030 notes that the return on investment in prevention is greater than the return on other biosecurity activities along the invasion curve: 1:100–1000 compared to 1:25 for eradications, according to the featured invasion curve diagram. The government's first strategic objective is to 'effectively manage future and emerging threats through improved prediction, early detection, and better understanding of risk pathways'.

However, there do not appear to be any public documents comprehensively identifying, analysing and prioritising the current risk pathways for New South Wales or predicting future pathway risks. Of the 23 activities listed under the prevention objective in the biosecurity strategy, none appear to be focused on pathway-specific analysis or planning, and the activities focused on risk reduction include only some elements of prevention (Table 1). The proposed activities are focused mainly on improving surveillance and response preparedness for unintentional introductions. There appears to be little or no focus on preventing unsafe intentional introductions and managing the risks of species present but not naturalised.

Table 1. NSW prevention priorities as indicated in the biosecurity strategy

Essential elements of prevention	Proposed prevention activities in the NSW biosecurity strategy
Prevent the introduction to NSW of potentially invasive taxa	• Enhance analytic techniques to support prediction, including climate change risk assessment and response decisions • Manage biosecurity risks at borders including ports and receival sites • Assess and forecast impacts, such as those caused by climate change, market trends, and trade policy
Minimise the risks of escape or release of potentially invasive taxa present in NSW	
Conduct surveillance to detect new incursions and outbreaks	• Adoption of sensor technologies to boost surveillance such as at borders • Partnerships to support surveillance and early detection practices, such as e-commerce surveillance • Cultivate community-based action such as in surveillance and reporting
Eradicate incursions and outbreaks of potentially invasive taxa (where feasible)	• Improve response plans for key emergency pests, weeds, and diseases • Multisectoral response preparedness exercises

Notes: The activities in column 2 come from the NSW Biosecurity and Food Safety Strategy 2022–2030, page

16 (prepare and prevent activities). It's not clear to us what is meant by 'Ongoing research and development to identify new responsible pest and disease management innovations'.

Based on a modified classification of pathways adopted under the Convention on Biological Diversity[23] and on recent patterns of incursions and naturalisations in Australia, Table 2 lists some of the obvious risk pathways into and within New South Wales (focused on post-border pathways within Australia) with examples of recent incursions and naturalisations. These indicate high risks associated with plant, aquarium fish and other pet pathways as well as accidental pathways by which the likes of red imported fire ants and yellow crazy ants arrive in the state.

One of the patterns evident with plant invasions is that the more non-native species present in a jurisdiction and the longer they have been present, the more that are likely to naturalise and the more that are likely to then become invasive.[24] Given the patterns of naturalisation over the past 20 years, it is safe to predict that the huge pool of species already present in New South Wales – as garden or agricultural plants or pets (including aquarium fish) – are likely to be a major source of future invasive species. There is no apparent focus on these pathways in the biosecurity strategy (Table 1). However, prior to the 2023 NSW election, the Labor Party committed to the development of a permitted list for the sale of plants,[25] which indicates a focus on this pathway should be imminent.

As the basis for strategies to reduce future invasions, the NSW Government should comprehensively identify and assess the risks of pathways and develop strategies to reduce the priority pathway risks. In one precedent worth considering, the British Government has identified 6 priority pathways and is in the process of developing pathway action plans.[26]

In the following sections, we summarise 3 known high-risk or emerging pathways in New South Wales, each of which warrant a risk reduction strategy:

- the trade and cultivation of plants in gardens and on farms (Attachment 6)
- the trade and keeping of pets (excluding aquarium fish) (Attachment 7)
- the trade and keeping of aquarium fish (Attachment 8).

Table 2. Some risk pathways for New South Wales

CBD pathway category	Risk description	Examples of incursions and naturalisations detected since 2000
Release / Other intentional release	Release of aquarium fish into waterways	Naturalised: Jack Dempsey, southern platyfish, pearl cichlid, white cloud mountain minnow, Mozambique tilapia, speckled livebearer

[23] CA Harrower et al., "Guidance for Interpretation of CBD Categories on Introduction Pathways. Technical Note Prepared by IUCN for the European Commission" (IUCN, 2018).
[24] Angela C Bartlett et al., "Characteristics of Australia's Alien Flora Vary with Invasion Stage," *Global Ecology and Biogeography*, 2023.
[25] Letter to the Invasive Species Council (1 March 2023).
[26] "Pathway Action Plans » NNSS," GB Non-native Species Secretariat, 2020, https://www.nonnativespecies.org/biosecurity/pathway-action-plans/.

Escape / Ornamental, Agriculture	Escape of garden plants, pasture plants or crop species	Naturalised (~10–20/year): powdery thalia, skunk vine, mouse ear hawkweed, frogbit, Sicilian sea lavender, paper mulberry, sweet vibernum, zig-zag plant, water star-grass
Escape / Pet	Escape of pet animals from captivity	Detected at large: corn snake (many), racoon, African pygmy hedgehog, Mexican red knee tarantula, panther chameleon, Hermann's tortoise, golden flying snake
Contaminant / Parasites on plants	Introduction of pathogens with imported plants	Myrtle rust, *Lasiodiplodia pseudotheobromae*, *Phytophthora niederhauserii*, wheat streak mosaic virus
Contaminant / Parasites on animals	Introduction of pathogens with escaped pets	*Nannizziopsis barbatae*, *Ophionyssus natricis*, Bellinger River turtle virus (origins unknown)
Stowaway / Airplanes, Ships, Land vehicles	Introduction and dispersal of species with vehicles	Cane toad, yellow crazy ants, red imported fire ants, Asian black spined toad, Indo-Pacific gecko

Some species have been identified as prevention priorities for New South Wales – those that are prohibited or restricted, some of which are specified as alert species in regional pest animal strategies. One of the proposed activities in the NSW Biosecurity and Food Safety Strategy is to improve response plans for key emergency pests, weeds, and diseases, presumably to be focused on a subset of the prohibited species.

But there is no public evidence that priority risk species for New South Wales – those that could arrive and become highly invasive – have been comprehensively identified and prioritised. One of the recent advancements at the federal level, since the appointment of a Chief Environmental Biosecurity Officer, has been the development of a National Priority List of Exotic Environmental Pests, Weeds and Diseases (known as EEPL) – species assessed as priorities to keep out of Australia or that represent groups of species (e.g. invasive ants) to keep out.

We need a similar list for species already present in Australia that could cause significant environmental harm if they were to establish. We recommend that the NSW Government institute a process involving experts from all taxonomic groups to identify, assess and prioritise the candidate species for a priority prevention list. This should inform the proposed pathway action plans and precipitate policies and strategies to mitigate the risks of priority species.

Recommendations to strengthen planning and prioritisation for prevention

*3.1 Identify the priority pathways that represent the highest risks for future environmental invasions in New South Wales. Develop strategies (pathway action plans) to mitigate these risks.

*3.2 Develop a NSW priority list of species for prevention focused on species already present in Australia and develop strategies to mitigate their risks. The process should involve experts for all taxonomic groups.

3.2 Plant pathways

A recent compilation of plant introductions since 1770 recorded 34,650 alien species in Australia – about 1.5 times the number of Australian native species, and almost 9% of the world's known flora.[27] Because New South Wales permits the trading and cultivation of any plant species other than <100 prohibited or restricted species, the vast majority of future invaders are likely to already be in the state (cultivated in gardens or on farms) or in Australia, with no legal impediments to being introduced to New South Wales.

Several thousand species with a weed history overseas have not (yet) naturalised (an estimated 5,900 in 2007[28]), indicating that the weeds-in-waiting could exceed the high number of weeds we already have. Plants with a history of invasion do not fully constitute the pool of risk species, given that many other species do not have an extensive history of introduction elsewhere to draw from, that changing conditions in Australia may facilitate future invasions, and that what is benign elsewhere may find conducive conditions for invasion among the highly diverse ecosystems in Australia. Native plants shifted out of their range also constitute a growing risk – a 2007 estimate was that more than 11,000 had been introduced to regions beyond their native range.[29]

The rate of new plant naturalisations being detected in New South Wales – 10–20 a year – appears to be escalating, but that could be due to more diligent searching. Searches from 2000 to 2005 yielded more than 100 records of new taxa, 10 of which were assessed as having major or moderate-to-major weed potential,[30] while the most recent state of biosecurity report reported a tally of 84 new species over 4 years.[31]

For several reasons, the current regulation of plant pathways in New South Wales and most other states and territories is guaranteed to exacerbate already severe weed problems, due to:

- the ongoing naturalisation of the thousands of plant species being traded and cultivated, mostly legally
- the importation of new genotypes of species already present or naturalised, boosting their invasive risks
- smuggling – likely to be a 'significant problem,'[32] facilitated by online trading.[33]

In 2006, weed officers from 6 state/territory governments (including New South Wales) published a paper, 'Turn the tap off before you mop up the spill', recommending that the state and territory governments consider implementing a nation-wide permitted-list approach.[34] The prohibited-list

[27] Bartlett et al., "Characteristics of Australia's Alien Flora Vary with Invasion Stage."
[28] Rod P Randall, *The Introduced Flora of Australia and Its Weed Status.* (Cooperative Research Centre for Australian Weed Management, 2007).
[29] Randall.
[30] John R Hosking et al., "Plant Species First Recognised as Naturalised or Naturalising for New South Wales in 2004 and 2005," *Cunninghamia* 12, no. 1 (2011): 85–114.
[31] NSW Department of Primary Industries, "State of Biosecurity Report 2018-2021."
[32] Steve Csurhes et al., "'Turn the Tap off before You Mop up the Spill': Exploring a Permitted-List Approach to Regulations over the Sale and Interstate Movement of Potentially Invasive Plants in the States and Territories of Australia," 2006, 95–98.
[33] Jacob Maher et al., "Weed Wide Web: Characterising Illegal Online Trade of Invasive Plants in Australia," *NeoBiota* 87 (2023): 45–72.
[34] Csurhes et al., "'Turn the Tap off before You Mop up the Spill': Exploring a Permitted-List Approach to Regulations over the Sale and Interstate Movement of Potentially Invasive Plants in the States and Territories of Australia."

approach, they said, 'struggles to keep pace with the tens of thousands of potentially invasive plant species' offered for sale.

To significantly reduce the rate of naturalisation of new potential invaders, the NSW Government needs to greatly strengthen regulation of plant pathways. The most feasible way of doing so is to ban the trade of introduced species unless they pass a weed risk assessment. Prior to the March 2023 election, the Labor Party committed to the development of a permitted list for the sale of plants.[35]

Since 2017 the NSW and ACT governments have been working with the Nursery and Garden Industry to develop a voluntary certification scheme. Funded by a $1 million grant from the NSW Environmental Trust, it was launched in 2022 with a website (gardeningresponsibly.org.au/) containing information on low risk 'certified' plants and suppliers committed to the scheme (currently 9 retail nurseries and 14 wholesale nurseries). It has not yet been adopted by any large retailers. A similar scheme operating in California since 2005, PlantRight, has achieved some positive outcomes, with annual surveys (by volunteers) finding that nurseries selling one or more of a subset of 7 locally invasive plants dropped from 44% in 2014 to 20% in 2021[36] (but 20% is equivalent to >300 nurseries). Despite some success, voluntary certification seems a laborious, slow and uncertain way of reducing the risks of this pathway. The pivotal question is whether people should be given the choice of selling and growing plants likely to become invasive. Applying a statutory permitted list approach would surely be a much more effective, efficient and fair approach.

For more detailed information and recommendations see Attachment 6.

Recommendations to reduce the risks of new plant invasions

*3.3 Adopt a permitted list approach for plants – by prohibiting the trade and new cultivation of all species other than those explicitly permitted. The permitted list should only contain species that are low risk or whose invasive risks will not be limited by prohibition (e.g. they are widely cultivated). Ideally, this would be coordinated with other states, with permitted and prohibited lists based on an agreed best-practice risk assessment method and taking into account the risks for neighbouring states or territories of permitting particular species. See Attachment 6 for detailed recommendations.

*3.4 Develop a strategy (a pathway action plan) to identify and mitigate the risks of potential invasive plant species present (but not established) in New South Wales. This could include programs to encourage or require people to remove high-risk species from their gardens (e.g. by providing free safe replacement plants), support for industries to develop safe alternatives to favoured high-risk species. Prepare a community education and compliance strategy with approaches tailored for different communities, including for people from different cultural backgrounds.

3.5 Permit the introduction of new variants of invasive or potentially invasive pasture or crop species only if they are assessed as low risk. This is in recognition that commercial uses often impose high propagule pressure, and that new varieties are often selected and bred for persistence, vigour and other qualities that increase their invasive potential.

[35] Letter to the Invasive Species Council (1 March 2023).
[36] GJ Lee, "Results of PlantRight 2021 Spring Retail Nursery Survey" (Plant California Alliance, 2021).

3.3 Pet pathways (excluding fish)

The trade and keeping of pets is emerging as a potential significant invasion pathway.[37] The diversity of alien vertebrate species detected in Australia for the first time is increasing, with no saturation evident in the rate of new interceptions from 1999 to 2016 at the Australian border and post-border.[38] This has been facilitated by the ease of online trading and the difficulty of regulating it.

Reptiles are a particularly high-risk group, often kept illegally. Once established, they are difficult to eradicate; no snake has been eradicated from more than a few hectares anywhere in the world.[39] Although the Australian Government does not permit their importation for pet-keeping, reptiles are the vertebrates most commonly intercepted at the national border and by state and territory biosecurity agencies.[40] From 1999 to 2012, the Victorian Government detected 33 alien reptile species being illegally traded in the state, including 28 not previously recorded in Australia.[41] This was due to a concerted enforcement effort, which included an amnesty for those who voluntarily forfeited illegally kept wildlife. About 12 of those 28 new species were assessed as likely to naturalise if released into the wild a 'modest' number of times (3 times, in the absence of incursion management), including common snapping turtle, Burmese python, yellow anaconda, puff adder, Gaboon adder, monocled cobra and Russel's viper.[42] All 28 species were assessed as likely to establish if released at least 7 times. One species likely to establish in New South Wales is the corn snake – 79 were captured in the Greater Sydney region by just 3 wildlife organisations at an increasing rate between 2004 and 2012.[43]

Even worse than a new reptile in the wild could be a new pet-borne disease that spreads to native wildlife. This is a risk associated with any escapes, whether or not the species is native or alien and whether or not it naturalises. Diseases suffered by captive snakes and lizards in Australia that are not known to be in the wild include inclusion body disease and snake fungal disease. Since 2000, at least 2 potentially significant disease agents believed to have spilled from captive animals into native reptiles have been detected – *Nannizziopsis barbatae* and *Ophionyssus natricis* (Attachment 2).

Pet birds are another group at high risk of adding to Australia's naturalised fauna and introducing diseases to native birds. The Australian List of Threat Categories of Non-Indigenous Vertebrates lists 262 introduced alien bird species, many in private keeping as pets, most of which have been assessed as an 'extreme' threat. That list also includes 7 'game birds' listed under the Game and Feral Animal Control Act 2002, all assessed as a serious or extreme threat. Two serious pet-borne parrot pathogens may have recently spilled over into native birds in Australia – psittacid herpesvirus-1 and parrot bornavirus (uncertain) (Attachment 2).

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[37] Adam Toomes et al., "New Aliens in Australia: 18 Years of Vertebrate Interceptions," *Wildlife Research* 47, no. 1 (2020): 55–67; Pablo García-Díaz et al., "The Illegal Wildlife Trade Is a Likely Source of Alien Species," *Conservation Letters* 10, no. 6 (2017): 690–98.

[38] Toomes et al., "New Aliens in Australia: 18 Years of Vertebrate Interceptions."

[39] Robert N Reed and Gordon H Rodda, "Giant Constrictors: Biological and Management Profiles and an Establishment Risk Assessment for Nine Large Species of Pythons, Anacondas, and the Boa Constrictor" (US Department of the Interior, US Geological Survey, 2009).

[40] García-Díaz et al., "The Illegal Wildlife Trade Is a Likely Source of Alien Species"; Wendy Henderson, Mary Bomford, and Phillip Cassey, "Managing the Risk of Exotic Vertebrate Incursions in Australia," *Wildlife Research* 38, no. 6 (2011): 501–8.

[41] García-Díaz et al., "The Illegal Wildlife Trade Is a Likely Source of Alien Species."

[42] García-Díaz et al.

[43] Michael S McFadden, Philip Topham, and Peter S Harlow, "A Ticking Time Bomb: Is the Illegal Pet Trade a Pathway for the Establishment of Corn Snake (Elaphe Guttata) Populations in Australia?," *Australian Zoologist* 38, no. 4 (2017): 499–504.

The risks of pets as an emerging invasion pathway – highlighted in a series of recent research papers[44] – have not yet been comprehensively assessed and addressed by Australia's governments as the trade moves from 'traditional brick-and-mortar marketplaces' to online platforms.[45] The ease-of-access, anonymity and large consumer base afforded by e-commerce has increased both the scale and diversity of pet trade. There is a lack of consistent surveillance of alien pet species held, legally or otherwise, within Australia.[46] It is encouraging to see that the NSW Biosecurity and Food Safety Strategy includes an intention to form 'partnerships to support surveillance and early detection practices, such as e-commerce surveillance'.

Recommendations to reduce the risks of pet animals escaping and becoming invasive

*3.6 Adopt a permitted list approach for vertebrate animals kept as pets – by prohibiting the trade and keeping of species other than those explicitly permitted. The permitted list should only contain species that are low risk or whose invasive risks will not be limited by prohibition (e.g. they are widely kept). For some species prohibitions could be facilitated by grandfathering (permitting the keeping of animals until the end of their life). When prohibition is not feasible, a permit system, with categories and restrictions based on the assessed risk and feasibility, may reduce risks. See attachment 7 for more detailed recommendations.

*3.7 Develop a strategy (a pathway action plan) to identify and mitigate the risks of potential invasive animal species kept as pets in New South Wales. The strategy should include the identification of priority risk species, research to better understand the risks of the pet trade, monitoring of online trading, and evaluation of the risks of disease spillover to native wildlife. Prepare a community education and compliance strategy with approaches tailored for different communities, including for people from different cultural backgrounds. Implement an ongoing amnesty for anyone who voluntarily forfeits prohibited or high-risk species coupled with rigorous enforcement.

3.8 Remove exotic bird species from Schedule 3 of the NSW Game and Feral Animal Control Act 2002 (7 of the 8 have been assessed nationally as an extreme or serious invasion risk).

3.4 Aquarium fish pathway

The aquarium trade is an extremely high-risk pathway – for introducing invasive fish and their pathogens, as well as other aquatic organisms such as plants and snails. It has been responsible for the establishment of more vertebrate animals than any other pathway into Australia, as well as for

[44] Adam Toomes et al., "Drivers of the Australian Native Pet Trade: The Role of Species Traits, Socioeconomic Attributes and Regulatory Systems," *Journal of Applied Ecology* 59, no. 5 (2022): 1268–78; Adam Toomes et al., "Australia's Wish List of Exotic Pets: Biosecurity and Conservation Implications of Desired Alien and Illegal Pet Species," *NeoBiota* 60 (2020): 43; Adam Toomes et al., "A Snapshot of Online Wildlife Trade: Australian e-Commerce Trade of Native and Non-Native Pets," *Biological Conservation* 282 (2023): 110040; García-Díaz et al., "The Illegal Wildlife Trade Is a Likely Source of Alien Species"; Pablo García-Díaz and Phillip Cassey, "Patterns of Transport and Introduction of Exotic Amphibians in Australia," *Diversity and Distributions* 20, no. 4 (2014): 455–66; Toomes et al., "Drivers of the Australian Native Pet Trade: The Role of Species Traits, Socioeconomic Attributes and Regulatory Systems."

[45] Toomes et al., "A Snapshot of Online Wildlife Trade: Australian e-Commerce Trade of Native and Non-Native Pets."

[46] Toomes et al., "Australia's Wish List of Exotic Pets: Biosecurity and Conservation Implications of Desired Alien and Illegal Pet Species."

severe pathogens that infect native fish, one of which may have been responsible for the likely extinction of the Kangaroo River Macquarie perch, endemic to New South Wales.[47] Despite this, the ornamental fish pathway has received limited biosecurity attention – probably because it is one of the most complex, difficult and contentious pathways to regulate.

There has been a recent escalation of fish naturalisations in New South Wales, with at least 6 new species detected in waterways since 2000 – Jack Dempsey (subject to a failed eradication attempt), southern platyfish (failed eradication attempt), pearl cichlid (eradication not feasible), white cloud mountain minnow (failed eradication attempt), Mozambique tilapia (eradication not feasible) and speckled livebearer (eradicated). Several of these are significant environmental threats, particularly tilapia and other cichlids.

Invasive fish and fish disease threats are set to steadily worsen – inevitable due to the large number of alien species kept in Australia (many assessed as high risk [48]), the highly deficient regulation of fish-keeping, and the propensity of people to dump unwanted fish into waterways.

The number of alien aquarium fish species present in Australia is highly uncertain – an indication in itself that management of this pathway is deficient.[49] In 2010, the estimate was 2,000 species[50] but a recent 14-week analysis of online trade (by website scraping) suggests a lower number, with advertisements for 509 species, as well as others identified only by genus or family.[51] Other species may circulate within hobbyist groups and not be publicly advertised, particularly if they are prohibited or not permitted.

While the importation of fish into Australia is prohibited except for species on a permitted list (assessed under the EPBC Act), the opposite approach is taken by New South Wales and most states and territories – any species is permitted unless expressly prohibited.

Australia's governments have recognised that this permissive approach is deficient and have long sought to rectify it. Almost 20 years ago, after various efforts to better regulate the trade foundered in the face of strong opposition by the aquarium industry, the federal, state and territory governments set up a national working group with industry and hobby representatives to jointly negotiate and implement a better approach. A 2006 strategic plan included actions to review grey-list species, develop a national list of high-risk noxious species to be adopted by each state and territory, and develop a list of low-risk permitted species. In a rapid risk screening process about two-thirds of a grey list of 806 species were scored as high risk. The national working group agreed that high-risk species of no interest to the industry or hobby representatives should be listed by each jurisdiction

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[47] Simon Kaminskas, "Alien Pathogens and Parasites Impacting Native Freshwater Fish of Southern Australia: A Scientific and Historical Review," *Australian Zoologist* 41, no. 4 (2021): 696–730.

[48] Joshua Fredberg and Dale G McNeil, "Review of Non-Native Ornamental Fish Species Grey Listed in Australia" (SARDI Aquatic Sciences, 2010); Kathleen Beyer and Joshua Fredberg, "Review of Grey Listed Non-Native Ornamental Fish Species: Report to the Ornamental Fish Management Implementation Group (OFMIG)" (SARDI Aquatic Sciences, 2010); Andy Moore, Nicholas Marton, and Alex McNee, "A Strategic Approach to the Management of Ornamental Fish in Australia: Communication Strategy and Grey List Review, a Report to OFMIG" (Bureau of Rural Sciences, 2010); Mariah Doreen Millington, Bonnie Jane Holmes, and Stephen Richard Balcombe, "Systematic Review of the Australian Freshwater Ornamental Fish Industry: The Need for Direct Industry Monitoring," *Management of Biological Invasions* 13, no. 2 (2022): 406.

[49] Millington, Holmes, and Balcombe, "Systematic Review of the Australian Freshwater Ornamental Fish Industry: The Need for Direct Industry Monitoring."

[50] Moore, Marton, and McNee, "A Strategic Approach to the Management of Ornamental Fish in Australia: Communication Strategy and Grey List Review, a Report to OFMIG."

[51] Toomes et al., "A Snapshot of Online Wildlife Trade: Australian e-Commerce Trade of Native and Non-Native Pets."

and that valued species should be reviewed in more detail to determine which to prohibit. But the process of further review stalled.

It appears that a new attempt at pathway regulation is now underway, with the recent compilation and assessment of a new grey list with 447 species nominated by industry representatives as currently traded. But the assessors of these species have criticised the assessment methodology for underestimating risks and being incongruent with known risks.[52]

To reduce the risks of this pathway requires significantly reducing the number of high-risk fish kept and traded in Australia. **For more detailed information and recommendations, see Attachment 8.**

Recommendations to reduce the risks of aquarium fish being released into the wild

*3.9 Adopt a permitted list approach for aquarium fish – by prohibiting the trade and keeping of species other than those explicitly permitted. The permitted list should only contain species that are low risk or whose invasive risks cannot be limited by prohibition. Ideally, this should be a nationally consistent approach, but New South Wales should take preventative action in the absence of a national consensus. See Attachment 8 for detailed recommendations.

*3.10 Develop an aquarium fish strategy (a pathway action plan) to significantly reduce the risks of aquarium fish-keeping. This should set out a transparent process for determining the appropriate biosecurity status of fish species consistent with their invasive risks and applying the precautionary principle (in recognition of the limited introduction history for many species). Prepare a community education and compliance strategy with approaches tailored for different communities. It should include online monitoring and enforcement, amnesties for voluntary forfeiture of illegal species, and surrender and rehoming options for people wanting to discard fish.

3.5 Surveillance

From 2000 to 2005, more than 100 naturalised plant taxa were recorded for the first time in New South Wales – an extraordinary number of detections achieved not because there was a sudden upsurge in naturalisations but because there was an active search for them.[53] Without active searching, it can often take many years, sometimes decades, for naturalised species to be detected, particularly those in the natural environment and particularly small or obscure species such as insects.

Active surveillance programs of environmental relevance in New South Wales include surveillance of plantations, amenity trees and native forests – insect trapping and examination of trees for symptoms of insect and disease attack – particularly focused around high-risk areas such as seaports and airports.[54] Other than that, there is no information about surveillance programs for other species of potential environmental concern.

[52] Millington, Holmes, and Balcombe, "Systematic Review of the Australian Freshwater Ornamental Fish Industry: The Need for Direct Industry Monitoring."
[53] Hosking et al., "Plant Species First Recognised as Naturalised or Naturalising for New South Wales in 2004 and 2005."
[54] https://www.dpi.nsw.gov.au/forestry/science/forest-health

New South Wales's biosecurity policy for 'Surveillance for diseases of animals and aquatic pests' says that 'Risk assessment is a tool used to determine which diseases of animals and aquatic pests are classified as notifiable and surveillance priorities are targeted accordingly'.[55] But the only diseases of environmental concern on the NSW list of notifiable animal diseases[56] are white nose syndrome (bats), devil facial tumour disease (not exotic) and a few diseases that also infect either livestock or humans (e.g. high pathogenicity avian influenza and avian tuberculosis). Not on the list are most of the diseases identified as nationally significant for the environment (on the National Priority List of Exotic Environmental Pests, Weeds and Diseases) such as crayfish plague, bonamiosis, proventricular dilatation disease, Pacheco's disease and internal papillomatosis disease and yellowhead disease.[57]

One clear urgent priority for surveillance should be online trade in prohibited plants and animals.[58] The Biosecurity and Food Safety Strategy includes an activity to form 'partnerships to support surveillance and early detection practices, such as e-commerce surveillance'.

Many new invasive species are initially detected and reported by members of the public. The potential to more systematically harness 'citizen scientists' for surveillance is an increasing focus in biosecurity. The Invasive Species Council runs a project called Bug Hunt[59] (funded by the Environmental Biosecurity Project Fund) whose objectives include:

- identify opportunities to improve procedures for flagging species of biosecurity concern within select existing citizen science projects/platforms
- increase and maintain active survey effort for invasive insects of biosecurity concern through existing projects/platforms
- assess the scale (volume) and reliability of community detection and identification of insects by existing citizen science projects/platforms, feeding data into the Atlas of Living Australia
- develop recommendations to improve the ability of citizen science programs to assist long-term reporting of insect species of biosecurity concern.

Similar citizen science trials have been conducted by the Queensland, Victorian and Western Australian governments. Lessons and challenges have been shared between the agencies to improve the usability and reliability of survey data. The Department of Primary Industries should trial similar projects to harness the community's surveillance capacity. A relevant activity specified in the Biosecurity and Food Safety Strategy is 'Cultivate community-based action such as in surveillance and reporting'. The discovery of red imported fire ants in Murwillumbah (by a member of the public) highlights an urgent need to proceed with this.

Recommendations to improve detection of new incursions

[55] https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0003/722838/Surveillance-for-diseases-of-animals-and-aquatic-pests.pdf

[56] https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0015/114414/notifiable-pests-and-diseases-of-animals-in-nsw.pdf

[57] https://www.agriculture.gov.au/biosecurity-trade/policy/environmental/priority-list

[58] Maher et al., "Weed Wide Web: Characterising Illegal Online Trade of Invasive Plants in Australia"; Toomes et al., "A Snapshot of Online Wildlife Trade: Australian e-Commerce Trade of Native and Non-Native Pets."

[59] https://invasives.org.au/blog/introducing-the-bug-hunt/

3.11 Expand New South Wales's list of notifiable diseases to include diseases of environmental significance. All diseases listed on Australia's National Priority List of Exotic Environmental Pests, Weeds and Diseases should be notifiable.

3.12 As a high priority, develop a surveillance program for online trading in prohibited plant and animal species, including through the use of web-scraping technology.

3.13 Trial citizen science biosecurity surveillance, adopting the lessons learned from trials in other jurisdictions and the federally funded Bug Hunt project.

3.14 As an immediate urgent priority, promote a citizen science focus on surveillance for red imported fire ants and other high-risk alert species such as yellow crazy ants. Concentrate engagement particularly around major sea ports (Newcastle, Port Botany, Wollongong/Port Kembla).

3.6 Eradicating potential invasive species

The NSW Government has responded to incursions of several species discovered at large, including escaped illegal pets such as raccoons, African pygmy hedgehogs and corn snakes (as documented in the state of biosecurity reports). We presume there is a systematic process for rapidly assessing the risks of all new incursions detected and determining whether eradication is feasible and warranted (including potentially under national cost-sharing arrangements), but the process and criteria for determining a response do not appear to be publicly documented.

New South Wales has not attempted many eradications of established species – we have records of only 26 state-wide attempts since 2000 (Attachment 9). Of these, 6 were successful, 6 were unsuccessful and 13 (12 plant species, 1 ant) are ongoing (not counting the red imported fire ants just detected in Murwillumbah). Two eradications of particular note for which the NSW Government should be commended are those of yellow crazy ants and red imported fire ants. The eradication of yellow crazy ants is ongoing at another site.

There does not appear to have been any systematic attempt in New South Wales to identify opportunities to eradicate sleeper species – an undoubtedly large pool of potential invaders with localised populations that are not yet rapidly (exponentially) increasing or spreading, because they are constrained by biotic or abiotic conditions (for example, lack of a pollinator or conducive climate).[60] The lag phase can last many decades, sometimes centuries – a 50-year lag is often taken as the mark of a sleeper weed.[61] Sleepers represent 'a latent threat' to biodiversity, an invasion debt that can potentially be voided by eradication.[62]

[60] RH Groves, "Sleeper Weeds" (Proceedings of the 12th Australian weeds conference, Tasmanian Weed Society, 1999), 632–36; Bethany A Bradley et al., "Regional Invasive Species & Climate Change Management Challenge: Preparing for Sleeper Species," 2018.
[61] Olusegun O Osunkoya et al., "Lag Times and Invasion Dynamics of Established and Emerging Weeds: Insights from Herbarium Records of Queensland, Australia," *Biological Invasions* 23, no. 11 (2021): 3383–3408.
[62] Daisy Englert Duursma et al., "Next-Generation Invaders? Hotspots for Naturalised Sleeper Weeds in Australia under Future Climates," *PLOS ONE* 8, no. 12 (December 26, 2013): e84222, https://doi.org/10.1371/journal.pone.0084222.

Recommendations to facilitate the eradication of high priority risk species

3.15 Establish a High Risk Environmental Incursions Response Fund (as recommended by the Natural Resources Commission in 2014). This will enable agencies to rapidly respond in the early stages of an incursion, avoiding delays that escalate costs and reduce the prospects of eradication. It should be a reserve fund, with unused funding rolling over year to year, to be used only when national or industry cost-sharing arrangements do not apply. The NSW Government should contribute at least $1.5 million a year. This could be supplemented by an annual flat rate contribution of $10 by all Local Land Services rate payers (estimated in 2014 to raise $1.3 million a year).

3.16 Review the process and criteria applied by the NSW Government for determining whether to eradicate new incursions. The process should be transparent and all assessments underpinning a decision (whether to proceed or not) should be published. The precautionary principle should apply. Maintain a public database of all detected incursions and the outcomes of biosecurity responses.

3.17 For locally naturalised and sleeper species, develop a transparent process for identifying and prioritising potential candidates for state-wide eradication. Apply this systematically across all taxa to develop a priority eradication list. Maintain a public database of attempted eradications and the outcomes.

3.18 Encourage and support regional eradications of locally naturalised and sleeper invasive species. Establish a service similar to that provided by the Victorian Weeds at an Early Stage of Invasion (WESI) program to support local governments, and natural resource and environmental groups to undertake eradications.

4. Effectiveness of existing programs – managing species and places

Consultation question: To what extent do you think existing programs in NSW are effectively managing invasive species?

4.1 Managing key threatening processes

A few major threatening processes – particularly invasive species, habitat destruction and adverse fire regimes – have caused the majority of extinctions and declines in Australia, including in New South Wales. Unless we abate these mega-threats, many more unique species and ecological communities will be doomed to perpetual rarity or extinction. It is not feasible to save the thousands of threatened species and ecological communities – species-by-species, community-by-community – while the major threats remain potent.

It was for this reason that Australia and a few states and territories, New South Wales included, have formally adopted a 2-pronged approach to threatened species conservation – one prong focused on species-specific recovery and the other on broad-scale threat abatement. Both approaches are essential – but both have been failing. Since Australian governments started officially listing threatened species, only a handful are known to have recovered. Recovery has often been stymied by a lack of effective methods for abating threats and deficient implementation of threat abatement and recovery plans.

A concerted focus on threat abatement is needed to enable recovery not only of listed species, but also of the many unlisted species in decline – some on the edge of extinction. It is also essential for fostering resilience, to optimise species' capacity to adapt under climate change. The development of enduring abatement solutions will also be far less expensive over the long term than ongoing recovery efforts in the face of unrelenting threats.

About two-thirds of the listed key threatening processes (KTPs) in NSW are invasive species: 25 of 39 (64%). Some are focused on individual species – e.g. foxes, rabbits, myrtle rust – while others encompass multiple invasive species – exotic perennial grasses, escaped garden plants and exotic vines and scramblers. The listings are not comprehensive of major threats. For example, there is no listing for invasive freshwater fish, one of the major threats to aquatic biodiversity.

Much more concerning is that there are no current threat abatement plans for KTPs, rendering the listings unhelpful except for information purposes. The lack of state threat abatement or management plans for priority threats means that New South Wales lacks clear strategies for abating the major threats to biodiversity, including the most harmful invasive species threats such as feral cats and foxes. The only state-based program is for dingoes/wild dogs (primarily an agricultural threat), and a program for feral pigs is under development. There is also no systematic monitoring of, regular reporting on or independent reviewing of the status of key threats and threat abatement progress.

For more detail on the importance of a strong focus on threat abatement and the proposed reforms, see Attachment 10.

Recommendations for strengthening threat abatement

4.1 Comprehensively identify and list key threatening processes through an independent scientific process, supplemented by a public nomination process. Regularly review the list of threats to ensure it remains up to date.

4.2 List threats in a hierarchical scheme of key threatening processes and environmental threats of state significance. Establish an additional threat category – emerging threatening processes.

4.3 Set ambitious and inspiring goals for abating the major threats to nature in New South Wales. Design a fit-for-purpose abatement response for all listed threats, including threat abatement plans or action plans (e.g. for cross-sectoral threats), regional plans, and policy and regulatory responses.

4.4 Establish an implementation taskforce for each major threat response, with a coordinator to drive implementation of plans for the priority threats. Facilitate collaborations by governments, Traditional Owners and community and cross-sectoral stakeholders on abating major threats.

4.5 Collaborate with other jurisdictions on implementing threat abatement plans for nationally listed key threatening processes. Advocate for the development of an intergovernmental agreement that commits the Australian, state and territory governments to collaboratively abate major threats to nature.

4.6 Systematically monitor and report on threat abatement progress. Introduce independent oversight of the threat abatement system.

4.7 Investigate the economics of threat abatement – the annual costs of effective abatement and the economic consequences of abatement failures and successes.

4.8 Substantially increase public spending on threat abatement and threatened species recovery, and allocate funds based on a transparent prioritisation process.

4.2 Managing priority invasive animals

4.2.1 Planning and targets

One of the outcomes of the 2016 Natural Resource Commission's review of pest animal management was the establishment of 11 regional pest animal committees and the development of 11 regional pest animal management plans. The 6-year plans identify priority species for prevention (alert species) and management (pest species). They define the management objectives for each priority species under 4 categories – eradication, containment, asset based protection, limited action (for species for which there are limited control options). The first plans were developed in 2018 and new plans have been under development since 2022.

The regional plans underpin a more systematic approach to invasive animal management and provide guidance about how landholders can meet their general biosecurity duty. Whether they are being effectively implemented and achieving their defined objectives is not clear. Although the plans mandate annual reporting against the KPIs and mid-term and final reviews, there are no published reports by which progress can be ascertained. We understand that the reviews were conducted

internally and informally. This is a concerning lack of transparency, including for those in each region who contribute to managing the priority invasive species.

Implementation of the plans has been hampered by limited resources – with the exception of funding for managing dingoes and wild dogs – and a failure to develop local action plans, again except for wild dog management.[63] Their effectiveness is also limited by a lack of state planning to inform regional priorities and coordinate programs across the regions – except for wild dogs.

There is a heavy reliance in the regional plans on landholders accepting and implementing the specified expectations for managing priority species on the basis that this will enable them to discharge their general biosecurity duty. There is no information about whether this is being enforced and the extent of compliance.

We question whether the expectations of landholders as specified in the regional plans consistently reflect a valid interpretation of the general biosecurity duty. There is, for example, a very low expectation of landholders in the Western region to manage feral goats despite the serious damage they cause and the feasibility of control (see section 4.2.2). In contrast, the expectations of landholders to manage dingoes are much higher – active control wherever found, keeping numbers to minimal levels, active participation in coordinated control programs, monitoring and reporting.

It is well recognised that major disturbances such as droughts, floods and fires can either exacerbate the threats of invasive species (e.g. cats and foxes targeting recently burned areas for hunting) or offer major opportunities for suppressing invasive populations (e.g. pig populations declining during drought). This was recognised by the Australian Government after the 2019–20 bushfires, with grants provided for controlling invasive animals and plants.[64] The Natural Resources Commission recommended in its 2016 review the establishment of a Rapid Response Trust Fund in each Local Land Services region to enable the regions to respond effectively and rapidly to such risks and opportunities, and also to tackle new invasive threats. Although the NSW Government agreed to this recommendation, the fund has not been established.

Recommendations to strengthen the capacity for invasive animal management

Recommendations for particular species are in sections 4.2.2 and 4.2.3 and for measuring progress in section 5.4.2.

*4.9 Identify state environmental priorities for invasive animal management and develop state threat abatement or action plans with clear targets for threat reduction. Priority species for state plans include foxes and feral cats, deer, goats and pigs. Ensure that regional plans are aligned with state plans or, if there is no relevant state plan, with a national plan (e.g. the action plans for feral deer and pigs and threat abatement plans for feral cats, goats and foxes).

*4.10 Establish dedicated coordinator roles for priority invasive animals to facilitate cross-tenure and cross-regional collaborations, and motivate and support landholder participation.

63 https://mcusercontent.com/09401bc2ed23ae622ec6d1588/files/5e573d49-b987-6071-8de0-2d6c56cf3a38/NWDAP_Over_2500_NSW_landholders_committed_to_wild_dog_management.pdf

64 https://www.dcceew.gov.au/environment/biodiversity/bushfire-recovery/funding-support

4.11 As recommended in the 2016 NRC review, 'Provide adequate resources to deliver effective pest animal management'. Work is needed to evaluate what can be achieved for particular levels of public funding (recommendation 5.15) and the budgets needed to achieve defined outcomes.

4.12 Build the rapid response capacity of regional groups to manage invasive species after major disturbances such as droughts, floods and fire. When there are significant risks or opportunities, funding should be provided from a Rapid Response Trust Fund. The establishment of such a fund in each Local Land Services region was recommended in the 2016 NRC review of pest animal management.

4.13 In regional plans clearly specify the management activities and outcomes expected of land managers to discharge their general biosecurity duty. Develop GBD guidelines about what should be considered when specifying these expectations – e.g. the potential for environmental harm, location in or near sensitive environmental sites, feasibility of control. Widely communicate these expectations in messaging appropriate for key audiences. (Also see recommendations 5.18–22).

4.14 Develop performance measures for regional plans that reflect environmental outcomes (rather than effort). Report regularly against these measures. Require independent evaluations of regional plan outcomes to inform revisions of the plan. Publish all evaluations.

4.2.2 Invasive ungulates

The spread and population densities of most invasive ungulate species in New South Wales have been escalating in the past decade – particularly feral pigs, deer and goats, as indicated by recent distribution mapping,[65] and horses in national parks, due to political impediments to effective control. The cumulative long-term damage being caused is likely severe but mostly undocumented. The failures to effectively contain and manage invasive ungulates in New South Wales highlight the need for more effective approaches in response to conflicts of interest (goats, deer) and social conflict (horses, deer) about management of invasive species (section 5.5).

Since the 2016 review into pest animal management by the Natural Resources Commission, feral deer have been better recognised as pest animals by (a) a change in status under the Game and Feral Animal Control Act to remove impediments to controlling deer on private land and (b) their listing as priority pests in all 11 regional pest management plans. The limited effectiveness of recreational hunting for control is now generally accepted.[66]

The National Feral Deer Action Plan 2023–28 proposes the establishment of 'no-deer' and 'containment buffer' zones that in New South Wales would prevent feral deer from spreading to the western third of the state and the Far North Coast and suppress populations in the central buffer zone. For the rest of the state, zoned as 'asset protection', reducing impacts and protecting priority assets is the proposed goal. Some parts of the asset protection zone, such as the Greater Blue Mountains World Heritage Area, are still largely free of deer and should be the focus of local containment strategies. Prior to their election in March 2023, the NSW Labor Party committed to implementing the 3 zones. This will require the alignment of regional management plans to the zoning approach and the allocation of sufficient resources to achieve the zones' objectives. The

[65] Department of Primary Industries, "Distribution Maps for Vertebrate Pests," NSW Government, 2023, https://www.dpi.nsw.gov.au/biosecurity/vertebrate-pests/publications/distribution-maps-for-vertebrate-pests.
[66] The National Feral Deer Action Plan, for example, says that recreational hunting is not preventing the spread or impacts of deer and 'has been shown to have little impact on population growth'.

development of new control tools such as targeted bait stations and the increasing use of thermal-image assisted aerial shooting will also be essential. The NSW Government has embarked on much-needed research to 'develop innovative, cost-effective and humane control techniques for managing feral deer' (Cross Tenure Feral Deer Management Project).[67]

Feral pigs now occupy about three-quarters of the state and are also identified as a priority in all regional pest management plans. The risk of African swine fever arriving in Australia has precipitated a much stronger focus on feral pig control and the development of the National Feral Pig Action Plan 2021–2023. In October 2023 the NSW government announced the appointment of a NSW feral pig coordinator and the allocation of $13 million over 8 months for control programs focused on the Riverina, northwest and western NSW. While this is welcomed, the resources will be wasted unless there is consistent follow-up population suppression. When conditions are optimal for pigs, some 60%–70% of a population needs to be removed annually to keep it stable.[68] Population monitoring before and after control is essential to ascertain whether control efforts achieve population reduction.

Feral goats have been a neglected environmental threat in western New South Wales that will exacerbate desertification in a region already much damaged by sheep and rabbit overgrazing. Figures released by the NSW Government in 2020 show a precipitous rise in feral goat numbers over the past 20 years (Figure 1)[69] – due to the emergence of a lucrative industry in harvesting feral goats, mostly for export to the Middle East, which has turned them from 'pest' to 'resource' for many graziers. The problem is exacerbated by intensive control of the only predator of feral goats – dingoes (a tension not mentioned in the regional pest management plan). Although feral goats are identified as a priority pest in the Western Regional Strategic Pest Animal Management Plan, the objectives are to reduce impacts only in areas of high biodiversity or cultural values – not to prevent large-scale degradation.

The foremost consideration should be long-term landscape health. As a foundation for more effective management of this growing problem, the NSW Government should make clear that the general biosecurity duty requires landholders to reduce feral goat populations on their property to densities that do not cause degradation. To achieve this will require a coordinated regional program to significantly reduce goat numbers.

67

https://www.environment.nsw.gov.au/topics/animals-and-plants/pest-animals-and-weeds/pest-animals/feral-deer/cross-tenure-feral-deer-management-project

68 M Gentle, Cameron Wilson, and John Cuskelly, "Feral Pig Management in Australia: Implications for Disease Control," *Australian Veterinary Journal* 100, no. 10 (2022): 492; Jim Hone, Richard P Duncan, and David M Forsyth, "Estimates of Maximum Annual Population Growth Rates (Rm) of Mammals and Their Application in Wildlife Management," *Journal of Applied Ecology* 47, no. 3 (2010): 507–14.

69 Legislative Council, "2203 - Energy and Environment - Feral Goats. Questions and Answers September 2020.," Parliament of NSW, 2020, https://www.parliament.nsw.gov.au/lc/papers/pages/qanda-tracking-details.aspx?pk=82215.

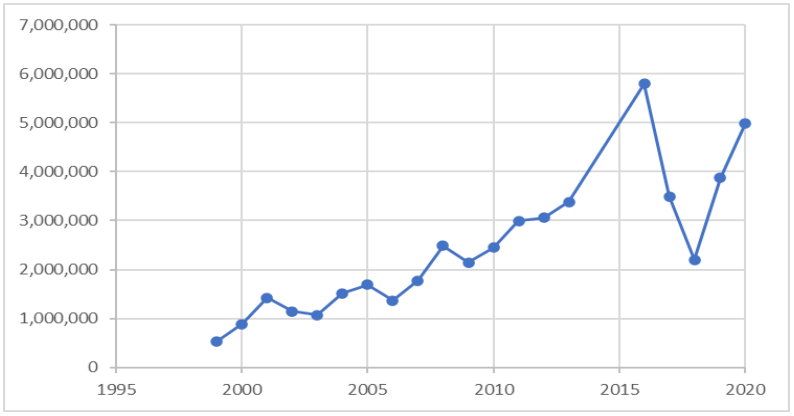

Figure 1. Feral goat numbers west of the Great Dividing Range

Source: Legislative Council Questions and Answers September 2020. 2203 - Energy and Environment - Feral Goats.

More than any other invasive animal problem in New South Wales, the failure to manage feral horses in national parks illustrates the need for a more concerted focus on developing and maintaining a social licence for invasive animal control. It has taken 23 years for the NSW Government to overturn a ban on the aerial shooting of horses – the only effective control method over large areas and in inaccessible sites. There are now substantial feral horse populations in 13 sites in eastern NSW and 8 in central and western NSW, mostly within protected areas, including Kosciuszko, Yurragir, Guy Fawkes, Oxley Wild Rivers, Barrington Tops, Blue Mountains and Pilliga West national parks.[70] Now that the ban on aerial shooting has been lifted, there should be a concerted effort to rapidly reduce and eradicate (where feasible) the horse populations in national parks and state forests. The more rapid the reduction, the fewer the animals that will die, the lower the costs will be and the less the environmental damage. To optimise effectiveness, aerial shooting protocols (FAAST) need to be modified to allow the use of thermal imaging shooters.[71]

Recommendations to improve the management of invasive ungulates

4.15 Clearly communicate what New South Wales's general biosecurity duty requires of landholders with populations of feral ungulates on their property and use powers under the Biosecurity Act as needed to achieve compliance. This may require imposed control operations and cost recovery.

4.16 Develop a NSW feral deer plan that implements the zones specified in the national action plan. Appoint a state feral deer coordinator. Revise regional plans to align with the state plan and develop local plans to achieve area-specific objectives, including a containment plan for the Greater Blue Mountains and an eradication plan for the Northern Rivers exclusion zone. Strengthen deer farm controls to minimise and track escapes, modelled on South Australia's scheme.

4.17 Develop a NSW feral goat plan with a goal to reduce feral populations to less than 0.5 million

[70] Derived from 2023 DPI feral horse distribution map overlaid with protected areas.
[71] Currently the FAAST protocols do not permit a shooter and a spotter to be on the same side of a helicopter, which undermines the optimal effectiveness of this method.

within a decade. Appoint a state coordinator and provide funding sufficient to achieve the target.

4.18 Repeal the Kosciuszko Wild Horse Heritage Act 2018 and develop eradication plans for feral horse populations in other protected areas including Barrington, Oxley Wild Rivers, Guy Fawkes, Yuraygir and Torrington national parks.

4.19 Revise aerial shooting protocols in New South Wales to optimise their effectiveness, including to enable the use of thermal imaging shooters.

4.2.3 Invasive predators

One of Australia's most difficult conservation challenges is to manage populations of introduced predators to enable the survival and recovery of numerous threatened species. While it is possible to significantly reduce fox populations over large areas by poison baiting, feral cat control is only feasible at a local scale (trapping, shooting, Felixer) due to the preference of cats for live prey.

Across most of New South Wales there is little or no management of these deadly predators. Foxes and feral cats are identified as priority species in all regional management plans but the extent of management and outcomes for biodiversity are unknown, due to a lack of reporting. The specified management expectations in regional plans are mostly asset-based protection or, for cats, limited action (reflecting the limited control options).

Opportunistic feral cat control, mostly by shooting or trapping, is undertaken in most protected areas, but acknowledged to be generally ineffective at reducing feral cat densities.[72] The extent of fox control in protected areas is not reported.

We commend the NSW Government for its recent focus on creating fenced havens for mammals threatened by invasive predators. Since 2000, in partnership with other organisations, the NSW Government has created 4 havens across a total area of more than 27,000 hectares (3 with the Australian Wildlife Conservancy and another with the University of New South Wales). This includes Australia's largest mainland fenced haven (in Mallee Cliffs National Park). A fifth smaller haven was created by an NGO. The havens are expected to provide refuge for at least 15 mammal species including 13 lost from New South Wales many decades ago (Attachment 9).

The NSW Government, along with all other state/territory governments, recently 'in principle committed to sign up to' the national threat abatement plan for feral cats when it is finalised in 2024.[73] We recommend that this commitment be realised through the preparation and implementation of a state strategy (threat abatement plan) focused on both feral cats and foxes. Work is currently underway in New South Wales to improve feral cat management, with a $30 million investment in research by the Environment Trust that includes assessing and refining feral cat control techniques, testing new control options, and developing online tools for feral cat and native species monitoring.[74]

[72] https://www.aph.gov.au/DocumentStore.ashx?id=aa9efe39-b2e0-4c9f-9068-3934f4de73d3&subId=690448
[73] https://www.dcceew.gov.au/sites/default/files/documents/emm-communique-10-nov-2023.pdf
[74] https://www.une.edu.au/about-une/faculty-of-science-agriculture-business-and-law/school-of-environmental-and-rural-science/research/life-earth-and-environment/feral-cat-project

Roaming pet cats in Australia are also a threat to biodiversity, killing more than 300 million native animals a year,[75] including an estimated 66 million in Sydney. Currently, NSW local governments are stymied by the NSW Companion Animals Act from mandating 24/7 cat containment. Numerous councils have passed motions seeking these powers.

Although the evidence is contested, dingoes may offer some potential for protecting threatened wildlife by suppressing fox and possibly cat populations – through 'direct killing, interference competition, competition for food and shelter, and fear-mediated changes in habitat use and activity patterns'.[76] However, while fox removal consistently benefits ground-dwelling and arboreal mammals, the results of studies testing the effects of dingo removal on species susceptible to predation by cats and foxes have not been consistent.[77] With much of the evidence for and against the 'mesopredator release hypothesis' equivocal or disputed, researchers have proposed a new experimental approach – assessing the effects of dingo reintroduction rather than dingo removal. One jointly proposed large-scale experiment is to realign the dingo fence bordering Sturt National Park to allow the reintroduction of dingoes and comprehensively and robustly test the effects over several years.[78]

Recommendations to improve management of foxes and feral and pet cats

4.20 Develop a statewide feral cat and fox strategy (threat abatement plan) aligned with the national threat abatement plans.

4.21 Amend the Companion Animals Act or use other mechanisms to require 24/7 pet cat containment. Mandate desexing for all cats by 4 months of age. Support these measures with funding for education, enforcement and assistance for low income households.

4.22 To help resolve important questions about dingoes, support a large-scale experiment to realign the dingo fence bordering Sturt National Park to allow the reintroduction of dingoes and comprehensively and robustly test the effects over several years.

4.3 Managing invasive plants

According to a recent analysis under the National Environmental Science Program, weed management counts by far as Australia's most expensive threat abatement challenge.[79] It is particularly challenging in New South Wales because of the scale of invasion and the number of sites

[75] https://invasives.org.au/wp-content/uploads/2023/06/Pet-cat-impacts-June-2023.pdf
[76] Mike Letnic, Euan G Ritchie, and Christopher R Dickman, "Top Predators as Biodiversity Regulators: The Dingo Canis Lupus Dingo as a Case Study," *Biological Reviews* 87, no. 2 (2012): 390–413.
[77] Geoff Castle, Malcolm S Kennedy, and Benjamin L Allen, "Stuck in the Mud: Persistent Failure of 'the Science'to Provide Reliable Information on the Ecological Roles of Australian Dingoes," *Biological Conservation* 285 (2023): 110234; CR Dickman, TM Newsome, and LM van Eeden, "The Dingo Dilemma: A Brief History of Debate," *Australian Zoologist* 41, no. 3 (2021): 298–321; Letnic, Ritchie, and Dickman, "Top Predators as Biodiversity Regulators: The Dingo Canis Lupus Dingo as a Case Study"; Daniel O Hunter et al., "Not All Predators Are Equal: A Continent-scale Analysis of the Effects of Predator Control on Australian Mammals," *Mammal Review* 48, no. 2 (2018): 108–22.
[78] Thomas M Newsome et al., "Resolving the Value of the Dingo in Ecological Restoration," *Restoration Ecology* 23, no. 3 (2015): 201–8.
[79] Chuanji Yong et al., "The Costs of Abating Threats to Australia's Biodiversity," 2022.

and habitats needing protection under an asset-based approach. Considerable work has been done to identify the priority sites for management (e.g. the biodiversity priorities for widespread weeds project[80] and through regional weed plans).

Following the 2014 NRC review of weed management, 5-year regional weed management plans were prepared in 2017 for each of the 11 Local Land Services regions. The plans identify regional priority weeds and describe how land managers can discharge their general biosecurity duty for each priority weed. Enforcement is the responsibility of local control authorities.

On the publicly available information, it is impossible to ascertain the effectiveness of regional weed management. Performance indicators were to be developed for each plan and reported against annually but there is no information to indicate this has been done.[81] The regional plans were updated in 2023,[82] but any reviews or evaluations that informed revisions have not been published. While there has been an increasing focus on 'monitoring, evaluation and improvement' in weed programs, the monitoring reports are not published. Public reporting on the outcomes and effectiveness of weed management is important not only for transparency and accountability but to share hard-won lessons. All weed programs should be treated as experimental with the potential to contribute not only to addressing a particular problem but to contribute to knowledge about weed management.

The Regional Weed Action Program provides funding for weed management projects through a 5-yearly grants process and contributes $100,000 a year for each regional weed coordinator. Of concern is that funding has not substantially increased over the past 10 years[83] despite increasing weed problems and rising costs. Funding in 2022–23 was $12.8 million, an increase of 19% over 7 years ($10.7 million in 2015–16) and of 47% over 15 years ($8.7 million in 2008–09), which is slightly less than the inflation rate for these periods.

Administration of the grants program needs improving. Funding is released 5 months or more into each financial year, without any contractual arrangements guaranteeing that future funds for multi-year projects will be provided. This makes the employment of staff and cash flow difficult for host organisations.

Much beneficial weed management is occurring in New South Wales. But given the limited resources and the focus on a small subset of invasive plants, we conjecture that the overall area being restored to native vegetation is exceeded by the area of new or expanded weed invasions. Greater ambition and public investment are needed if New South Wales is to arrest and reverse degradation.

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[80] https://www.dpi.nsw.gov.au/biosecurity/weeds/strategy/handbook/cmas

[81] A statewide monitoring and reporting framework was adopted in 2019. See DPI 2019 'A monitoring, evaluation, reporting and improvement (MERI) framework for Regional Strategic Weed Management Plans' available at https://www.lls.nsw.gov.au/__data/assets/pdf_file/0017/1416500/Master-MERI-Framework-Print-Final.pdf

[82] See https://www.lls.nsw.gov.au/help-and-advice/weeds-and-plant-diseases/regional-strategic-weed-management-plans

[83] In 2008-09, $8.69m was provided (per Weed Committee papers August 2010), in 2015-16, $10.74m was provided while in 2022-23, $12.8m was provided, This represents a 47% increase over 15 years and a 19% increase over 7 years, slightly under the inflation rate for these periods according to the Reserve Bank inflation calculator (https://www.rba.gov.au/calculator/annualDecimal.html). See DPI Weed Action Program 2015-2020 Report (NSW DPI 2021) for details of 2015-16 spending https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0004/1290082/NSW-Weeds-Action-Program-Report-2015-2020.pdf

The task of weed management is often extraordinarily difficult, not only because long-term and often unceasing persistence is needed to deplete a seedbank but because other factors (disturbance and nutrient enrichment) often operate to favour the replacement of weeds by other weeds[84] – 'Overcoming mechanisms that favour weeds above native species (weed persistence), and conversely re-establishing mechanisms that favour natives above weeds (ecological resistance), remain a foremost restoration challenge'.[85] Effective weed management often requires a broader land management focus than the 'noxious weeds' mentality of focusing on control of single target species.

The ideal approach is integrated landscape management (ILM), which takes a holistic, systems approach to restoring and managing ecological health with the goal of increasing biotic resistance to invasions and increasing resilience to climate change and other future shocks. ILM can be difficult given the challenges of coordinating large, disparate groups of stakeholders to carry out timely, consistent actions for multiple objectives on multiple fronts over the long time scales needed. Another challenge is a looming native seed shortage for ecological restoration. But much has been learned and new approaches have been developed that could ultimately revolutionise the way we carry out invasive species management. We encourage New South Wales to become an ILM leader and pilot new techniques in assisted natural regeneration.

For widespread weeds, often the only feasible management option is to reunite them with their natural enemies. Since 1901, at least 288 agents against at least 75 weed species have been released in Australia,[86] and at least 67 of these target weed species occur in New South Wales. About two-thirds of the releases resulted in the agent becoming established, and about one-third have resulted in variable-to-heavy impacts on the target weed.[87] Although the outcomes have been mixed, a few major successes and many partial successes have resulted in a high benefit-to-cost ratio for weed biocontrol.[88]

After a decline in biocontrol research in Australia earlier this century, there is now an encouraging resurgence. One of the outcomes of the NRC review of weed management in 2014 was the establishment of a NSW Weed Biocontrol Taskforce, which has commissioned biocontrol work by the CSIRO for the following target weeds:[89]

- Hudson pear (cochineal and high res machine learning mapping for distribution)
- salvinia (weevils, good success reported by Mid-Coast Council)
- Scotch broom (broom gall mite)
- sagittaria (fruit-feeding weevil)
- cabomba (weevil)
- African boxthorn (initial trials of rust fungus by CSIRO)
- African lovegrass (initial stage of biocontrol identification)

Other priority weeds have been investigated but no suitable biocontrol found.

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[84] Adele M Reid et al., "Does Invasive Plant Management Aid the Restoration of Natural Ecosystems?," *Biological Conservation* 142, no. 10 (2009): 2342–49.
[85] Suzanne M Prober and Georg Wiehl, "Resource Heterogeneity and Persistence of Exotic Annuals in Long-Ungrazed Mediterranean-Climate Woodlands," *Biological Invasions* 13, no. 9 (2011): 2009–22.
[86] RL Winston et al., "Biological Control of Weeds: A World Catalogue of Agents and Their Target Weeds," 2022, https://www.ibiocontrol.org/catalog/.
[87] Winston et al.
[88] AR Page and KL Lacey, *Economic Impact Assessment of Australian Weed Biological Control* (CRC for Australian Weed Management, 2006).
[89] https://research.csiro.au/nswweeds/

The community plays a significant role in reporting weed outbreaks and undertaking voluntary weed control and bush regeneration on public lands. A statewide local government reporting tool – Snap, Send, Solve – allows the public to send photos and coordinates of weed to councils who are responsible for enforcement. But, surprisingly, this tool has no weed category. Many individual council online incident reporting forms have the same limitation. These deficiencies should be rectified.

Recommendations to improve management of invasive plants

4.23 Accord continued high priority to research into biocontrol options for the most invasive environmental weeds.

4.24 Commission research to examine the costs, benefits and feasibility of different models of integrated land management models and trial new approaches.

4.25 Increase funding for the Weeds Action Program to $20 million a year and provide long-term multi-year funding certainty for regional weed programs.

4.26 Evaluate the adequacy of funding for the coordination of regional weed programs, enforcement and education. Increase funding where needed to optimise these important functions.

4.27 Add a 'weed' category for all local government and Snap, Send, Solve incident reporting tools.

4.28 On the sale of a property, require the vendor to declare the presence and extent of any priority weeds identified in the regional weeds strategy.

4.4 Eradicating island invaders

New South Wales has undertaken few island eradications – <30 on 12 islands and only 12 on 7 islands since 2000. This is far fewer than most other jurisdictions have achieved.

Most of the effort has been focused on Lord Howe Island. The recent eradication of rodents from Lord Howe was an outstanding achievement, expected to reduce predatory pressures on at least 22 animal species, 51 plant species and 12 vegetation communities, prevent 7 extinctions over the next 20 years and enable the reintroduction of 4 species.[90] This comes on top of several other eradications – cats, pigs, goats, myrtle rust, African big-headed ants – that have done much to protect the high conservation values of Lord Howe (Attachment 9). At least 68 weed species are being targeted for eradication over a 30-year period. Intensive control since 2004 has achieved an 80% reduction in weed density and 90% reduction in the presence of mature weeds.

Recommendation to support island eradications

4.29 Continue to support Lord Howe Island's exemplary weed eradication program.

[90] Lord Howe Island Board, "The Project," Lord Howe Island Rodent Eradication Project, 2022, https://lhirodenteradicationproject.org/the-project/.

4.5 Managing public lands

One of the important reforms resulting from the Biosecurity Act 2015 was the institution of a tenure-neutral approach to invasive species management, subjecting all land managers, whether public or private, to the same legal obligations. Previously, weed management obligations did not apply to public lands. However, there is a widespread view that this has not resulted in improved management. There is no evidence that the general biosecurity duty is being enforced on public lands and no meaningful public reporting on invasive species management on public lands. Insufficient funding is a major impediment to effective management.

Protected areas: The National Parks and Wildlife Service has prepared regional pest management strategies to guide management in national parks and reserves. But there has been no reporting on the extent of management or its effectiveness in protected areas for many years – a major deficit in accountability. A new method for evaluating management – Ecological Health Performance Scorecards – is being piloted in 8 sites (with $10 million funding over 4 years). These will provide annual snapshots of ecological health (native species and ecological processes) and threats, including invasive species.[91] Such evaluations are needed across the entire protected area estate.

The state of invasion evident in many protected areas makes clear that the current threat management capacity is deficient. More funding is needed to prevent decline of some of New South Wales's most precious natural assets. The 2023 election commitment by the NSW Labor Party to appoint 120 new dedicated NPWS pest and weeds field officers will significantly boost the management capacity.

State forests: The NSW Forestry Corporation appears to have a strong focus on detecting and managing invasive species that impact on tree health. It is part of a 2022 collaboration agreement to establish a national forest pest surveillance program (Forest Watch Australia) that will increase surveillance activities, community education, diagnostic support and performance reporting.[92]

Other invasive species management functions are mostly delegated to Local Land Services. There is no public reporting on the state of invasions in state forests or the effectiveness of management – a major deficit in accountability.

Many state forests are open to recreational hunting. This does not provide for effective management of invasive animals[93] and, perversely, probably stymies the use of more effective control methods – aerial shooting is rarely conducted in state forests.

In future, much more of the forest estate is likely to transition to conservation. This will require a strong focus on managing invasive species and restoring habitats damaged by invasive species.

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[91] https://www.environment.nsw.gov.au/topics/parks-reserves-and-protected-areas/park-management/national-park-performance-scorecards

[92] REF?

[93] https://invasives.org.au/wp-content/uploads/2014/02/fs_rechunt_NSWvfacts.pdf

Recommendations to improve management of invasive species on public lands

See recommendations 5.18-5.22 for additional recommendations relevant to the general biosecurity duty.

4.30 Undertake an audit of invasive species and the effectiveness of management programs on public lands other than protected areas. Identify the priority properties where invasive species threaten biodiversity values and require the development of management plans for these properties, with performance targets and measures. There should be independent oversight and regular public reporting on the effectiveness of public land management. This can be a role for the proposed GBD auditor (recommendation 5.19) or, otherwise, for the Biosecurity Commissioner.

4.31 Allocate sufficient resources for public land managers to discharge their general biosecurity duty. Disclose publicly how much funding is spent on invasive species management by each agency with public land management responsibilities.

4.32 Undertake aerial shooting of invasive animals in state forests where needed to protect biodiversity values.

4.33 Establish processes to foster collaboration with neighbouring land holders across tenures in public land management programs.

4.34 Include invasive species management as a core focus in any transition strategy away from forestry in public native forests.

5. Key barriers

Consultation question: What, if any, are the key barriers to effective management of invasive species?

5.1 Institutional barriers

5.1.1 Agricultural legacies

The current institutional arrangements for biosecurity are a historical legacy – from when the primary government concern was to prevent and manage invasive threats to agriculture. They no longer represent a rational allocation of government responsibility based on degree of threat, value of assets to be protected and needs for government intervention. The invasive threats to the environment are more numerous and complex than those to agriculture, far more difficult to manage, with a large reliance on public funding, and much more likely to be irreversible. The environmental and community stakeholders are more numerous and diverse. The area that may support biodiversity values needing protection from invasive species covers about two-thirds of the state while the area potentially needing invasive species management for production reasons covers about three-quarters (there is an overlap of about half the state with native vegetation that is used for grazing or forestry) (Table 3).

The current arrangements give rise to perceived biases in priorities and conflicts of interest. This is to be expected given the stated purpose of the Department of Primary Industries is to 'maximise outcomes for NSW primary industries, the communities they support and the resources they rely on…'.[94] The conflicts of interest seem evident, for example, in the failures to require management of feral goats and prevent the introduction of invasive pasture plants and garden plants, and in the prioritisation of the commercial interests of producers in dingo management. For a department with responsibility for promoting agricultural exports, there may also be pressures to compromise biosecurity protection in favour of fostering relations with valuable trading partners.[95]

In recent years, there has been considerable improvement in New South Wales in several aspects of environmental biosecurity – for example, in the identification of priority environmental weeds and pests in regional management plans and in responses to incursions of environmental concern such as yellow crazy ants.

But the priorities and culture remain dominated by agriculture. The ministerial foreword to the NSW Biosecurity and Food Safety Strategy talks only of agriculture, focused on the target to drive output to $30 billion by 2030. The ministerial media release for this NRC review focused on agriculture – 'The NSW Government is committed to the fight against pests and weeds, and supporting work to minimise their impacts to primary industries' – and contained no specific mention of the environment. The 2019 review of biosecurity risk management by the Audit Office of New South Wales found that 'DPI's biosecurity activities focus on risks to the economy but do not directly address emerging risks to the environment and community amenity' and there are 'gaps in its

[94] Stronger Primary Industries Strategy 2022–2030

[95] Such tensions were evident federally with white-spot syndrome in prawns, with domestic prawn farmers advocating that only cooked prawns should be permitted and prawn exporters and importers arguing that was unnecessary and would compromise the quality of imported prawns.

emergency response practice that limit its ability to identify and set priorities to respond to pests and diseases that impact on the environment and community activities'.[96]

Ideally, for all stakeholders – those concerned with protecting environmental, cultural, social and/or economic values – biosecurity would be administered by a Biosecurity Minister with an impartial focus on all sectors, rather than an agriculture minister. This would give biosecurity more prominence, reduce the potential for conflicts of interest and strengthen community engagement.

While biosecurity remains part of the Department of Primary Industries there is need for an environment-specific work unit to drive more focus on environmental priorities. The need for this was recognised at the federal level in 2018 with the appointment of a Chief Environmental Biosecurity Officer. The establishment of a similar role in the NSW Government would also foster more collaboration with the Department of Planning and Environment. The 2019 review by the Audit Office of biosecurity risk management found there was need for more formal partnership arrangements between the departments (section 5.3.1).

Table 3. Land use in NSW

Land use types	Hectares	% NSW
Nature conservation/minimal use	14,531,275	18.13
Production in native vegetation (grazing native pastures, native forests)	38,946,269	48.60
Modified pastures/intensive agriculture	22,877,580	28.55

Recommendations to strengthen institutional arrangements for environmental biosecurity

*5.1 Restructure the biosecurity portfolio to optimise the biosecurity focus on all values important to people in New South Wales – environmental, social, cultural and economic. This can be achieved by (a) creating a standalone title (Biosecurity Minister) for the minister administering the Biosecurity Act and (b) integrating the agency into a department with a broader remit or creating a standalone agency. To avoid perceived conflicts of interest, it would be best if the biosecurity minister was not also an agriculture or trade-focused minister.

*5.2 In the absence of a standalone biosecurity agency, establish a role for a Chief Environmental Biosecurity Officer in the Department of Primary Industries – as the equivalent of the Chief Plant Protection Officer and Chief Veterinary Officer – to focus on environmental priorities and ensure a strong voice for the environment in all biosecurity decision-making.

5.1.2 Accountability and transparency

The NSW biosecurity system lacks transparency and accountability mechanisms. It is difficult or impossible to tell from publicly available documents how biosecurity priorities have been determined in New South Wales – for example, the basis on which some species (and not others) have been selected for prohibition, restriction, eradication, containment or management and how funding

[96] https://www.audit.nsw.gov.au/our-work/reports/biosecurity-risk-management

allocations have been decided (see section 5.2.1). For decisions said to be based on risk assessment, the assessments are not published.

There are also few state-wide targets or objectives that clearly set out the intended outcomes and for which there are measurable performance indicators. The exceptions are 2 measures in the Stronger Primary Industries Strategy 2022–2030, which focus on a small subset of biosecurity activities:

- All reported biosecurity incidents are responded to within set timeframes by 2022.
- Effective response to all biosecurity incursions by 2030

New South Wales' state biosecurity strategy and invasive species plan seem increasingly to be turning into rhetorical instruments rather than drivers of action towards meaningful outcomes.

The previous biosecurity strategy (2013–2021) specified 10 outcomes, one of which was focused on an outcome relevant to invasive species: outcome 5 was 'reduced impacts from established pests, diseases and weeds'. But there was no baseline or progress tracking and the strategy was replaced in 2022 without any review to assess progress on the 10 outcomes.

The current strategy (NSW Biosecurity and Food Safety Strategy 2022–2030) contains even less for which the department can be held accountable for, with 4 vague objectives, an even vaguer outcome – 'increase the economic, environment, and community outcomes that benefit every person in NSW' – and no performance measures.

The NSW Invasive Species Plan 2023–2028 also does not specify any outcomes relevant to invasive species or performance measures. In these respects it is a considerable deterioration from the previous plan (2015–2022), which did specify some meaningful and measurable indicators – no new invasive species become established, reduced distribution and/or abundance of priority emerging species, success of eradication programs, success of control programs for selected widespread invasive species. But there was no reporting on progress under the previous plan and no public review. One of the specified actions under the 2015–2022 plan was to 'Provide clear benchmarks and processes to measure invasive species impacts and prioritise management actions.' If this was done, it has not been implemented into any public reporting on biosecurity progress.

However, New South Wales deserves plaudits for being the one jurisdiction in Australia to publish a regular state of biosecurity report, the first in 2017 and the second in 2021. These were intended to highlight 'progress in achieving the objectives of the NSW Biosecurity Strategy 2013–2021'. They provide valuable information, particularly on a range of indicators developed for the report, including basic statistics such as numbers of naturalised species, eradications and species being managed to reduce environmental impacts. They recount the activities and achievements relevant to each of the 4 strategy objectives. But only in the first report was there an evaluation of the effectiveness of biosecurity performance, based on a rubric with measurable thresholds. This found that performance on incursion management, eradication (1 indicator) and containment was 'fair' and performance on eradication (1 indicator) and asset based protection was 'good'.

Transparency and accountability are fundamental to driving effective biosecurity, particularly when so much of the emphasis is on partnerships. The new Biosecurity Commission offers the potential to greatly strengthen both. Important functions should include:

- evaluating biosecurity performance against meaningful measures reflecting the status of introduced species at each stage of the invasion curve and environmental as well as economic consequences

- overseeing regular reporting including preparation of the state of biosecurity report
- tracking the implementation of government commitments to adopt recommendations of reviews, including by the Natural Resources Commission and the Audit Office of New South Wales.

In 2018, New South Wales lost one body important for accountability when it abolished the Biosecurity Advisory Committee, with a membership representing agricultural, environmental and government bodies. This committee had overseen the implementation of the NSW Biosecurity Strategy and the Biosecurity Act and provided a forum to improve collaboration and develop shared solutions. This committee should be reconstituted.

Recommendations to strengthen transparency and accountability

5.3 Develop meaningful performance measures in the state biosecurity strategy and invasive species plan and require independent evaluation of the progress on implementation. Publish all evaluations.

5.4 Require the Biosecurity Commissioner to publish a state of biosecurity report every 4 years. Further develop the report indicators to better reflect the status of invasive species and their environmental impacts.

5.5 Publish all risk assessments, prioritisation assessments and other documents underpinning biosecurity decisions and funding allocations.

5.6 Reconstitute the NSW Biosecurity Advisory Committee with representatives from the NSW Farmers Association, Nature Conservation Council of NSW, NSW Aboriginal Land Council, Local Land Services, National Parks and Wildlife Service, Landcare NSW, Department of Primary Industries, and NSW Local Government Association, with an independent chair.

5.1.3 Partnerships

Biosecurity documents these days are replete with talk of 'partnership' (a word mentioned 29 times in the NSW Biosecurity and Food Safety Strategy). But this term can mean very different things to different groups and is not well defined in biosecurity. It is particularly nebulous when applied to the community sector.

Partnerships with First Australians: The Biosecurity and Food Safety Strategy 2022–2030 starts with an Acknowledgement of Country that says Aboriginal people are the 'first protectors' and have 'an inherent right to protect the land, waters, sky, and natural resources of New South Wales'. But there is little in the strategy to facilitate their meaningful involvement in biosecurity. The only relevant action in the strategy comes under the 'prepare and prevent' objective – 'Recognise the special land management roles of Aboriginal people'. There is no information about what this entails and no stated commitment to involve Traditional Owners in biosecurity policy-making or to protect Indigenous cultural values from invasive species.

To provide leadership and facilitate the meaningful involvement of First Australians in biosecurity and other natural resource issues, we recommend the establishment of a NSW Indigenous Commissioner for Country, either as part of the Natural Resources Commission or as a stand alone position. It would need to be adequately resourced to engage with Indigenous people and the wider public and provide independent advice to government and the parliament on all natural resources issues, including

invasive species. To better recognise First Australians as the 'first protectors', the NSW Government should also establish dedicated positions or set a target for indigenous employment when recruiting and contracting for biosecurity and invasive species management work.

Partnerships with 'community': The Biosecurity and Food Safety Strategy mentions 'valued partnerships' with key community stakeholders. While there are typically strong community partnerships at local and regional levels for management of invasive species, partnerships with the community sector have received little focus at the state level and there is often a narrow view in biosecurity agencies of the community role. Other than through public consultation processes, there are few formal mechanisms for community input into state biosecurity policy, particularly since the disbanding of the NSW Biosecurity Advisory Committee. Much work is needed to better understand the highly diverse community sector and how to optimise engagement across the spectrum of biosecurity activities, including policy development. One obvious focus area is surveillance (section 3.5).

Partnerships between government agencies: The 2019 review by the Audit Office of New South Wales identified that partnerships between the Department of Primary Industries and other agencies were deficient, particularly in the lack of formal agreements about roles and responsibilities. These are needed to ensure that:

- organisational planning and management of partner agencies considers their biosecurity responsibilities
- staff are trained and aware of their biosecurity responsibilities
- resources are allocated to meet their biosecurity responsibilities.

One positive development is that the Department of Primary Industries signed a memorandum of understanding in July 2019 with Local Land Services to formalise its working relationship.

Recommendations to establish and strengthen biosecurity partnerships

*5.7 Appoint a NSW Indigenous Commissioner for Country to facilitate First Australians' leadership and engagement in natural resource issues. An important focus would be biosecurity, including to advise the government on managing invasive species to better protect indigenous culture and country. This could be a co-commissioner role in the Natural Resources Commission or a standalone position.

5.8 Establish dedicated positions or set a target for indigenous employment when recruiting and contracting for invasive species management.

5.9 Include Indigenous cultural heritage protection as a focus area for invasive species management.

5.10 Establish an environmental and community advisory body to advise on and facilitate the more meaningful involvement of the community sector in biosecurity. This body should oversee work to identify the variety of community interests in biosecurity and their capacities to contribute (in all facets, including policy development), leading to the development of a strategy to establish genuine partnerships with communities.

5.11 Implement the recommendation of the NSW Audit Office for the Department of Primary Industries to 'implement formal agreements with partner agencies that it relies on to deliver effective biosecurity compliance activities and emergency responses'. One high priority should be a detailed MOU between the Department of Primary Industries and the Department of Planning

and Environment to clarify roles and responsibilities and ensure that environmental priorities are incorporated into all biosecurity decision-making.

5.2 Funding barriers

5.2.1 Biosecurity budgets and allocations

The allocation of funding is often the most telling way to determine government priorities. But apart from announcements about new funding for particular programs or grant opportunities, there is no way to discern the NSW Government's biosecurity priorities from the budget or other publicly available information. Unlike the federal budget and some state/territory budgets, the NSW budget papers do not include line items specific to biosecurity. There is a line item for Local Land Services ($272.3 million in 2023–24), much of which would be for biosecurity services.

In the 2023–24 budget papers, biosecurity is mentioned 6 times, mainly under the heading of 'Protecting our agricultural industries' with new funding highlighted for red imported fire ants ($80 million), supporting industries affected by varroa mite ($77.2 million), supporting businesses to respond to white spot disease ($10.2 million), feral pig control program ($13 million), good neighbour program ($10 million) and a Biosecurity Commission ($2.3 million). Under Environment and Planning, there is $30.7 million to enhance biosecurity for Lord Howe Island. But none of this reveals overall what the public is investing in biosecurity and how it is being spent.

There is no way for the community to determine the overall public investment in biosecurity, how the funding is allocated, trends in funding, and levels of staffing and trends. There is no publicly available rationale for funding allocations. While the government emphasises the much greater returns on investment in prevention, there is no information to verify that investment levels are aligned with that.

This lack of transparency undermines trust that decisions are based on what will return the greatest public benefit – particularly given that most biosecurity funding is labelled as agricultural funding and that much of it is spent on dingo control for private producer benefits.

There is a widespread perception around Australia that public biosecurity funding and capacity have declined, including in the states and territories, and are unable to keep pace with growing biosecurity risks. This was highlighted in the 2017 review of the Intergovernmental Agreement on Biosecurity, which noted that most submissions to the review agreed that the national system was 'increasingly underfunded'. The review noted that funding pressures were arising from a combination of:[97]

- competing funding priorities
- inefficient resource allocation (investments with low returns)
- immature cost-sharing arrangements (leading to over-reliance on public funding
- increasing biosecurity risks
- increasing demands for biosecurity services.

[97] W Craik, D Palmer, and R Sheldrake, "Priorities for Australia's Biosecurity System. An Independent Review of the Capacity of the National Biosecurity System and Its Underpinning Intergovernmental Agreement" (Canberra: Australian Government Department of Agriculture and Water Resources, 2017).

As a result of this and other reviews, there has been a clear acknowledgement at the federal level that biosecurity funding is insufficient, which has led to a recent strong focus on developing new models of sustainable funding, including by ensuring that risk creators contribute to the system.

The NSW Biosecurity and Food Safety Strategy proposes an activity to 'Secure sustainable funding arrangements'. This should be an extremely high priority. A review of biosecurity funding, and how it is sourced and allocated, is an essential basis for determining the levels of investment needed and the funding priorities and options for achieving a more robust biosecurity system in New South Wales.

Recommendations to increase funding and optimise the returns on investment

*5.12 Commission a review of biosecurity investment in NSW and new options for sustainable funding. The review should analyse current sources of funding, including private and public, and how the funding is allocated across different biosecurity functions – prevention, eradication, containment/control, research – and for different purposes, including for environmental, social and production benefits. It should analyse trends in funding and staffing levels compared to trends in biosecurity risks and impacts. The assessment of options for new funding sources should include cost recovery, contributions from risk creators and beneficiaries and insurance options.

5.13 Invest in new frontline jobs in invasive species management to secure additional capacity of 180 FTE, comprising:

- 110 new pest and weed officers (10 in each Local Land Services region)
- 50 new local government weed control positions
- 20 new DPI biosecurity officers

*5.14 Develop a statewide investment strategy to optimise the returns (durable public benefits) on investment. The strategy should include clear criteria and a prioritisation algorithm (including cost, public benefit and feasibility) to guide decision-making. Funding allocations should be guided by advice from an independent expert body on where the best outcomes, including for biodiversity, can be achieved. Funding decisions should be transparent and justified.

5.2.2 Costing interventions and valuing outcomes

To allocate public funding to achieve optimal biosecurity returns requires information on the costs of different types of intervention and methods for valuing and comparing the returns on investing in different interventions, including the environmental outcomes.

There is little available information about the funding needed to abate major invasive threats in Australia – most management and threat abatement plans lack budgets and most conservation investments 'occur without a repeatable approach for estimating the costs and the cost-effectiveness of investments'.[98] A recent study under the National Environmental Science Program has compiled costings for 18 strategies for managing threats to biodiversity, including 9 wholly or mainly focused on managing invasive species.[99] Based on median costings, to collectively manage invasive predators, large herbivores and rabbits (using the available best-practice methods) costs about $3,000/km^2 a

[98] Yong et al., "The Costs of Abating Threats to Australia's Biodiversity."
[99] Yong et al.

year. The median cost for managing weeds is 10 times higher at about $37,000/km^2 but this was based on very limited information (and can be as low as $220). To manage phytophthora costs about $140,000/km^2 and for invasive fish the median cost is $59,000/km waterway. Overall, invasive species management is the most expensive category of threat abatement, with weed management the most costly of all due to the scale of invasion.

These figures enable some comprehension of the funding challenges – to manage just 1% of New South Wales (about 8,000 km^2) for invasive predators, large herbivores and rabbits would cost about $24 million a year. We recommend that the NSW Government compares its internal costings with these to develop a set of median costs for interventions that can be used to inform budgets and funding prioritisation.

Another major impediment to defensible prioritisation is a lack of robust methods to compare and rank economic, social and environmental impacts and outcomes. How should an invasive species with the potential to cause declines in threatened species be ranked in comparison with one that causes several million dollars worth of damage to farmers each year? The greater ease of determining and ranking economic impacts means they are more likely to influence decision-making than the less well-studied and more complex environmental or social impacts – even disregarding the greater weight often afforded economic impacts in government decisions. Such methods should take into account the often irreversible nature of environmental impacts.

For designation and prioritisation processes, it is important to develop comparable impact categories. This has been done for the IUCN-endorsed methods known as EICAT (Environmental impact classification of alien taxa) and SEICAT (Socio-economic impact classification of alien taxa), which specify detailed criteria for ranking invasive species in 5 categories ranging from minimal concern to massive. One of the challenges, particularly with environmental invasions, is a lack of data. In some decisions it is important to accord weight to data-deficient species by applying the precautionary principle.

Biosecurity prioritisation is also challenging because of the need to compare the value of interventions along the invasion curve, by estimating the returns on preventing new invasive species, often with limited information about potential impacts, to the returns on managing established invaders that are causing evident damage. The invasion curve diagram featured in the NSW Biosecurity and Food Safety Strategy lists the following returns on investment: 1:100–1,000 (prevent and prepare), 1:25 (eradicate), 1:5–10 (contain) and 1:1–5 (manage). These are guestimates based on limited data that presumably do not include environmental benefits. To better inform funding priorities, we recommend a research project be commissioned to assess the environmental returns on investments across the invasion curve.

Recommendations to strengthen methods for estimating and comparing returns on biosecurity investments

5.15 Develop, publish and regularly update a set of standard costings for the range of biosecurity interventions, including for the abatement of major threats to biodiversity.

5.16 Commission research (by the Centre of Excellence for Biosecurity Risk Analysis) to assess the relative environmental returns on investments in interventions across the invasion curve.

5.17 Commission research (by the Centre of Excellence for Biosecurity Risk Analysis) to evaluate and recommend methods to compare and rank economic, social and environmental impacts and

returns on investment. These should appropriately weigh the irreversible nature of some environmental impacts (extinction, ecosystem transformation).

5.3 Barriers to compliance

5.3.1 Discharging the biosecurity duty

Since mid-2017 when the Biosecurity Act 2015 began operating, there has been a heavy reliance on the concept of duty. The general biosecurity duty (GBD) is intended to promote a shared responsibility by 'placing a duty on a person to prevent, eliminate or minimise a biosecurity risk, so far as is reasonably practicable'. Effective implementation of the GBD will require cultural changes across different sectors of society and that will undoubtedly take many years.

The 5-year statutory review of the Biosecurity Act (published in June 2023) reported GBD-driven improvements in the agriculture sector since 2017 – for example, 67% of primary producers had a biosecurity management plan or industry accreditation plan in place compared to 46% having a plan in 2017. But it reported there is 'still a gap in the wider community in knowing how to discharge their duty effectively'. We suspect that the gap is very large. The review reported that:

> Many internal, industry and community stakeholders expressed the view that it was not clear when a person had a duty to discharge and what actions were required to discharge the duty. Authorities and authorised officers tasked with ensuring the duty was discharged also expressed uncertainty as to when and how to undertake enforcement actions.

Consequently, recommendation 1 of the review was:

> Identify options to improve accessibility to biosecurity information relevant to each stakeholder group that will assist them to discharge their biosecurity requirements, including the General Biosecurity Duty.

It is relatively straightforward to identify the duties necessary to reduce agricultural risks on farms and there is strong self-interest for farmers to discharge their GBD for risks to agriculture. One important question is whether they are also discharging the GBD for risks to the environment given the risks of spread of weeds and invasive animals from farms. It is not at all clear what those non-agricultural responsibilities comprise. Presumably, a landholder fails to discharge their GBD if a sown pasture grass spreads from their property, but that is not made explicit in any materials we have seen. There is substantial work needed to more comprehensively identify the risks likely to be encompassed by the GBD.

It is more challenging to identify and promote the duties of other sectors, particularly those labelled 'community'. Given the daunting array of risks and the difficulties of inculcating responsibility in a diffuse mass of people who may only occasionally have cause to consider biosecurity (and may not understand the term), we recommend that the proposed priority pathways focus (section 3.2) includes for all priority risk pathways identification of the relevant general biosecurity duties and strategies to foster compliance in the relevant risk-creating groups, including education, facilitation, incentives, amnesties and enforcement.

The NSW Government has an essential role in facilitating and fostering compliance with the GBD in ways that are optimal for each sector. For example, it is not sufficient to identify and communicate

that the GBD requires aquarium keepers to safely and humanely dispose of or rehome fish rather than tip them into a creek. Compliance needs to be facilitated by providing easy options for aquarium keepers to do this – for example, by subsidising or supporting aquarium businesses to provide and promote rehoming services. Each pathway strategy needs the advice of social scientists about how to optimise compliance. This should also be a key focus for social science experimentation.

One of the major ways being used to identify land management duties is the specification of expectations in regional weed and pest animal management plans. However, the review of the Biosecurity Act reported concerns:

> that the Plans are too specific in targeting certain species, and that they do not provide enough weight for effective compliance as they are not a legislated requirement.

We also have concerns that the specified expectations may not be sufficiently robust to 'prevent, eliminate or minimise' some important environmental risks and that measures to address a wider range of risks are 'reasonably practicable'. The extent to which landholders are implementing the expectations specified in regional plans is an important focus for assessment.

Farmers are encouraged to prepare biosecurity plans. This should be a fundamental element of discharging the GBD for all managers of land exceeding a certain area. In Queensland one innovative local government in 2018 introduced a scheme with a pest management levy that was not required to be paid by landholders who prepared a property pest management plan that identified all declared invasive plants and animals on their property, and described the control methods for each invasive species and the timeline for control works.[100] Properties could be inspected to verify that the approved control works had been completed.[101]

One priority should be to assess the extent to which government agencies and local governments have identified and are discharging their GBD as land and water managers. They should be exemplars – by publishing biosecurity plans for all properties they manage and for priority species, and reporting annually on their implementation of these plans. The opposite to this occurred when the Wollongong City Council recently dropped its collaborative deer management policy on the grounds that feral deer would be managed by private landowners each individually discharging their GBD.

Government agencies should also comprehensively identify and discharge their GBD in other roles – for example, by ensuring that:

- development approvals stipulate measures to minimise biosecurity risks
- fish stocking does not exacerbate the risks of invasive fish
- biosecurity risks are identified and minimised for prescribed burning and fire management
- management of waterways and irrigation do not exacerbate biosecurity risks (e.g. by water transfers)
- activities approved for protected areas do not exacerbate biosecurity risks
- public funding does not support the breeding or release of potentially invasive taxa (e.g. new pasture plant varieties).

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[100] C Magnussen and M Warren, "Invasive Pests Control Scheme -- a New Approach to Managing Pests at the Local Government Level," in *Proceedings of the 1st Queensland Pest Animal and Weed Symposium* (Weed Society of Queensland, 2019).

[101] Unfortunately, the scheme was revoked in 2021 by a newly elected council with less commitment to biosecurity.

Auditing government agencies and local governments for their GBD performance should be part of the role for the Biosecurity Commissioner or an independent GBD auditor.

Recommendations to improve implementation of the general biosecurity duty

5.18 As a high priority, develop more effective strategies to improve public understanding of the general biosecurity duty and the measures it requires.

*5.19 Appoint an independent GBD auditor within the Biosecurity Commission to undertake audits of different sectors to assess compliance with the general biosecurity duty. This should include a particularly strong focus on government agencies and local governments.

5.20 Require each government agency and local government to publicly identify their obligations under the general biosecurity duty. This would apply to activities with biosecurity risk (e.g. land management) and functions that influence the risk behaviours of industries or community members (e.g. the approval of developments or regulation of industries). Each entity should prepare a plan specifying how they propose to discharge their GBD with respect to these risks and report annually against performance measures. Some GBD responsibilities will require the development of guidelines – for example, on measures to mitigate biosecurity risks for new development approvals.

5.21 Specify the measures needed to comply with the general biosecurity duty for all people active on high-risk invasion pathways. This should be a focus in the development of the proposed pathway action plans (section 3.1). Develop strategies to foster compliance in the risk-creating groups, including messaging specific to different cultural groups. Each pathway strategy needs the advice of social scientists about how to optimise compliance. This should also be a priority research focus.

5.22 Evaluate whether the management expectations specified in regional weed and pest animal management plans reflect a defensible interpretation of the general biosecurity duty. Assess the extent to which landholders are implementing these expectations. Explore ways (e.g. by levy or rates concessions) to incentivise landholders to develop and implement biosecurity plans to identify and manage priority risks on their property.

5.3.2 Enforcement

Most environmental prosecutions in NSW are heard in the Land and Environment Court, a specialist court for cases to do with the environment, development and local government. The Land and Environment Court would be the most appropriate court to hear cases involving breaches of the Biosecurity Act, as its judges have the expertise to assess environmental evidence, appreciate the potential impacts of breaches and apply appropriate penalties. Having cases heard in the one specialist court would assist in achieving consistent outcomes and build a coherent body of case law.

New South Wales's most recent State of Biosecurity report lists the following compliance activities completed during 2018–21:[102]

- >50,000 engagements and actions with landowners to manage widespread weeds
- >36,000 audits and inspections of animal and plant industries
- >11,600 enforcement actions

[102] NSW Department of Primary Industries, "State of Biosecurity Report 2018-2021."

- ~189,000 state priority weed inspections, >4,900 biosecurity compliance actions.

This data indicates considerable enforcement activity, but does not reveal whether it was focused on the highest risk activities, including for the environment, and whether it was effective in improving biosecurity outcomes and inculcating a stronger biosecurity culture.

The 2019 review of biosecurity risk management by the Audit Office of New South Wales identified deficiencies with the compliance focus of the Department of Primary Industries. It found the department lacked policies directly addressing emerging risks to the environment (or to community activities and infrastructure) and that compliance activities tended to focus on the highest risk activities impacting market access for trade. It also found that a lack of formal partnerships with other state agencies limited the sharing of data and information relevant to compliance:

> DPI does not collect and analyse data from the compliance activities conducted by its key partners. As a result, it has an incomplete picture of key or emerging biosecurity risk areas. This means that DPI may not be focussing its compliance activities on areas of highest risk.

Recommendations to strengthen enforcement

5.23 Shift jurisdiction for offences under the Biosecurity Act to the Land and Environment Court.

5.24 Implement the recommendation of the NSW Audit Office for the Department of Primary Industries to 'establish a data collection and reporting system that enables data sharing with LLSs and LCAs that allows them to better target their biosecurity compliance activities'.

5.25 Implement the recommendation of the NSW Audit Office for the Department of Primary Industries to 'publish annual data on performance targets and outcomes for its biosecurity compliance and emergency response activities'.

5.26 Implement the recommendation of the NSW Audit Office for the Department of Primary Industries to better meet its obligations to protect the environment by revising its compliance procedures and emergency response practices to address risks to the environment and the community.

5.4 Barriers to control

5.4.1 Control methods

There are 4 main types of effective or sometimes effective methods that can be used to directly target invasive species over a substantial area (at least 10,000 hectares):

- aerial shooting – ungulates (deer, horses, goats, cattle, buffalo, camels, donkeys, pigs)
- poison-baiting (aerial or on-ground) – foxes, rats, pigs, ants and sometimes cats
- biocontrol – rabbits, some weeds
- exclusion by fences or natural barriers (off-shore islands) – cats, foxes, goats, rats etc.

There are also ecological approaches involving the manipulation of habitats or of other species to achieve either population suppression of the harmful species or boosted defences for susceptible native species:

- habitat management for refuge protection – e.g. patch burning or reducing grazing pressure to maintain vegetation cover for protection of native species against cats and foxes
- apex predator protection – e.g. maintaining dingo populations to suppress invasive animal such as goats and foxes
- control of species benefiting invasive species – e.g. biocontrol of scale insects benefiting yellow crazy ants, control of rabbits to limit prey availability for cats and foxes.

But for many species (the majority of invasive species) and in many situations we lack effective control methods. Of the utmost priority, therefore, should be research to develop more effective control methods (with a focus also on improving humaneness, see section 5.5.1). For widely established weeds and invertebrates, biological control is the only feasible option for large-scale control[103] and should be a very high priority focus for research.

Many of the widespread invasive species impacting on the Australian environment will only be effectively controlled through development of new technologies. We recommend that the NSW government calculates how much it invests in short-term management versus in research for long-term, cost-effective solutions such as biocontrol. We suspect the disparity is large in favour of short-term management. We urge more investment in developing long-term solutions – including new detection, surveillance and control methods, ecological management, and methods for motivating community involvement – as the best prospect for arresting and reversing deterioration in NSW's natural environment due to invasive species.

Recommendations

*5.27 Retain the use of existing control methods, including 1080 and glyphosate, while investing in the development of new technologies. These methods are essential tools for conservation with no viable alternatives in most circumstances.

5.28 Develop a biosecurity research plan to comprehensively assess and identify research priorities. It should include a strong focus on developing more effective control and ecological management options.

5.29 Substantially increase the investment in research on long-term solutions. Given the lack of effective methods for effective large-scale control of most invasive species, it may be justified to prioritise research over non-critical short-term management priorities.

5.4.2 Measuring progress

Much of the current control effort for invasive species across Australia is likely to be ineffective and a waste of public or private resources and effort.

A Tasmanian study testing the effects of cat culling at the low-level intensity typically achievable by natural resource managers found that the cat population at both study sites increased (by 75% and 211%), probably because the removal of dominant resident cats allowed subordinate and young cats

[103] Matt Liebman et al., "Ecologically Sustainable Weed Management: How Do We Get from Proof-of-concept to Adoption?," *Ecological Applications* 26, no. 5 (2016): 1352–69.

from surrounding areas to move in and greater resources increased the survival of young. After culling ceased, the cat population returned to previous levels.[104]

Weed control – often measured coarsely in terms of hectares treated – can be equally futile. For example, a study of the impact thresholds for the highly invasive *Tradescantia fluminensis* in temperate rainforest in the Dandenong Ranges found the condition of the plant community declined markedly after the weed coverage exceeded about 20%, making for a very demanding control target.[105] The impact threshold for other weeds is higher – about 85% cover for *Lantana camara* for impacts on native vine species – making it more feasible to achieve beneficial outcomes.

For such reasons, much of the effort to control invasive species on private lands is also ineffective, as acknowledged by land managers.[106] About three-quarters of agricultural land managers across Australia surveyed in 2019 managed 'pest animals' (although most were native animals or invasive animals not of environmental significance) and four-fifths controlled weeds.[107] Only 20% of those who used ground shooting (the most commonly used method) rated it as 'very effective'. About half the respondents used poison baiting, but only a third of those considered it very effective. Landholders were also critical of the overall effectiveness of feral animal management in their local area, with only 4% in 2019 judging it to be very effective and another 23% as moderately effective. These statistics indicate the limitations of control even when applied at a property scale for protecting agricultural assets.

Concerns about a lack of monitoring of and reporting on the effectiveness of invasive species programs have been raised persistently over the past 20 years. The first (and only) national survey of the extent of invasive animal control in Australia – which focused on the control of foxes, dogs/dingoes, cats, rabbits, pigs and goats from 1990 to 2003 – revealed that only about a quarter (<28%) of 1,915 documented control activities that were intended to benefit native biodiversity actually monitored the biodiversity outcomes.[108] Only 7% monitored both the targeted species and the biodiversity impacts and only 0.3% (6 control actions) were designed to 'yield the most reliable inferences about the effects' (with replicated, randomly assigned treatment and non-treatment areas and monitoring of both the invasive animal and at-risk biodiversity). Therefore, most control activities could 'yield only the weakest inferences about the effects' of that control.

Unfortunately, such a survey has not been repeated and there is no source of reliable contemporary information about the extent of invasive vertebrate management across Australia. There is also little information about the effectiveness of weed management. A 2009 review of the environmental outcomes for management of weeds of national significance, based on published papers and surveys of land managers involved in management, found little evidence for recovery of natural

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[104] Billie T. Lazenby, Nicholas J. Mooney, and Christopher R. Dickman, "Lazenby et al. 2014, Effects of Low-Level Culling of Feral Cats in Open Populations: A Case Study from the Forests of Southern Tasmania," *Wildlife Research* 41, no. 5 (2014): 407, https://doi.org/10.1071/WR14030.

[105] Luke S. O'Loughlin, F. Dane Panetta, and Ben Gooden, "Identifying Thresholds in the Impacts of an Invasive Groundcover on Native Vegetation," *Scientific Reports* 11, no. 1 (October 15, 2021): 20512, https://doi.org/10.1038/s41598-021-98667-5.

[106] Nyree Stenekes and Rob Kancans, "Pest Animal and Weed Management Survey 2016–19" (ABARES, 2021); Thomas M Newsome, Mathew S Crowther, and Christopher R Dickman, "Rapid Recolonisation by the European Red Fox: How Effective Are Uncoordinated and Isolated Control Programs?," *European Journal of Wildlife Research* 60 (2014): 749–57.

[107] Stenekes and Kancans, "Pest Animal and Weed Management Survey 2016–19."

[108] Ben Reddiex and DM Forsyth, "Control of Pest Mammals for Biodiversity Protection in Australia. II. Reliability of Knowledge," *Wildlife Research* 33, no. 8 (2006): 711–17.

ecosystems.[109] Of the 95 papers reporting outcomes, only 18 included an assessment of the response of other plant species. These and the responses of land managers who evaluated outcomes (most qualitatively) indicated that ongoing management would be required to manage other weed species replacing the targeted weed. Secondary invasion is a frequent 'bane' of weed management, highlighting the need for a stronger restoration focus.[110]

Due to a lack of transparency about the allocation of public funding for control programs, combined with the scarcity of reporting on program outcomes, it is impossible to determine the extent and effectiveness of publicly funded invasive species control activities in New South Wales and across Australia. Although most government grants require reports from the recipients on the outcomes, these are typically not published or analysed to assess the effectiveness of public expenditure.

In New South Wales, as across Australia, there needs to be a much stronger focus on monitoring to ensure that public (and private) resources achieve intended outcomes. That 13 invasive animal species and 350 weed species were being managed to reduce their environmental impacts and that 46,000 targeted weed control activities were carried out from 2018 to 2021, as reported in the most recent state of biosecurity report, is not helpful information for evaluating effectiveness.

Recommendations to improve monitoring and reporting

5.30 Review the current extent of and methods used for monitoring the outcomes of invasive species management in New South Wales.

5.31 Publish the reports of publicly funded control activities and undertake regular evaluations of the overall program outcomes achieved. Periodically review these programs to document the lessons learned and make recommendations to improve their effectiveness.

5.5 Social barriers

5.5.1 Social licence

Several important control methods for invasive species are known or perceived to be inhumane or unsafe for humans.[111] In some cases, the perceptions are unfounded or exaggerated. For example, contrary to widespread perceptions, aerial shooting can be humane if conducted by highly skilled shooters to achieve almost instant death (as long as pursuit times are short).[112] Likewise, the herbicide glyphosate has been assessed as safe for human health when used as recommended.[113]

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[109] Reid et al., "Does Invasive Plant Management Aid the Restoration of Natural Ecosystems?"
[110] Dean E Pearson et al., "Secondary Invasion: The Bane of Weed Management," *Biological Conservation* 197 (2016): 8–17.
[111] Carol Booth, "1080: A Weighty Ethical Dilemma" (Invasive Species Council, 2020), https://invasives.org.au/wp-content/uploads/2020/11/1080-Weighty-Ethical-Issue.pdf; Tim Low, "Glyphosate: A Chemical to Understand" (Invasive Species Council, 2020).
[112] Jordan O Hampton et al., "Assessment of Animal Welfare for Helicopter Shooting of Feral Horses," *Wildlife Research* 44, no. 2 (2017): 97–105; RSPCA, "Impacts and Management of Feral Horses in the Australian Alps," 2023, https://kb.rspca.org.au/wp-content/uploads/2023/05/2023-04-27-Impacts-and-management-of-feral-horses-Austr-Alps-RSPCA-SUBMISSION.pdf.
[113] Low, "Glyphosate: A Chemical to Understand."

But in other cases, there are sound reasons for concern. Several toxins are no longer available for use because they are inhumane (e.g. warfarin and yellow phosphorous), toxic to native wildlife (e.g. DDT) or unsafe for humans. Other toxins known or suspected to be inhumane such as 1080 are retained because they are regarded as essential for conservation or agriculture and there are few or no alternatives.[114] This adds to the necessity for Australia to invest much more in research for new methods. Unless more-humane methods are developed, the social licence for some methods will come under increasing threat.

Whether based on evidence or perception, social challenges to the use of particular methods can lead to constraints or bans on the use of methods that are important for conservation – as exemplified in Kosciuszko National Park for feral horses. And some local governments have banned the use of glyphosate, despite its importance for controlling environmental weeds.

In response to concerns about animal welfare or human safety, it is vital for governments to assess and be transparent about the potential for adverse impacts, and take these into account during decision-making processes. Where feasible, animal-welfare outcomes of large-scale control programs should be assessed and reported – as has occurred for aerial shooting of camels and horses.[115] Contentious techniques should not be excluded simply on the basis of public opinion.

But where there is evidence for or indications of adverse impacts, decision-makers should transparently weigh up the conservation and welfare outcomes. Despite the adverse impacts of certain methods on the welfare of invasive animals, there are often good reasons to proceed with control programs – not only to conserve threatened and declining species but to improve the welfare of native animals – for invasive species often cause much greater suffering (due to predation, competition or habitat degradation) than is inflicted by controlling them. As one extreme example, before cats were eradicated from Tasman Island, a population of about 50 was killing up to 60,000 seabirds annually.[116] A ban on control methods such as 1080 that are vital for conservation would often result in greater suffering.

But for methods that cause suffering should come responsibilities to ensure that the impacts are minimised, that research for more-humane methods is a priority and that control programs are effective. The ineffectiveness of many control methods also count as problems for animal welfare for they result in pointless animal suffering. These and other principles were developed in a 2003 workshop with biosecurity and animal welfare experts, including from federal and state/territory governments, focused on 'the development and selection of feasible control programs and techniques that avoid or minimise pain, suffering and distress to target and non-target animals'.[117]

Recommendations to maintain a social licence for controlling invasive animals

5.32 Prioritise research on the development and trialing of more-humane and more-effective ways of controlling invasive animals, with alternatives to 1080 being a high priority.

[114] Booth, "1080: A Weighty Ethical Dilemma."
[115] Jordan O Hampton et al., "Integrating Animal Welfare into Wild Herbivore Management: Lessons from the Australian Feral Camel Management Project," *The Rangeland Journal* 38, no. 2 (2016): 163–71; Hampton et al., "Assessment of Animal Welfare for Helicopter Shooting of Feral Horses."
[116] Susan Robinson et al., "Long-Term Protection of Important Seabird Breeding Colonies on Tasman Island through Eradication of Cats," *New Zealand Journal of Ecology* 39, no. 2 (2015): 316–22.
[117] Humane Vertebrate Pest Control Working Group, "A National Approach towards Humane Vertebrate Pest Control. Discussion Paper. Arising from the Proceedings of an RSPCA Australia/AWC/VPC Joint Workshop, August 4-5, 2003, Melbourne" (RSPCA, 2004).

5.33 In the absence of more-humane and effective alternatives, maintain and defend the use of important methods for conservation and the welfare of at-risk native animals. Make decisions about welfare on the basis of evidence, not public opinion.

5.34 Design long-term control programs that minimise the overall extent of killing of introduced animals – for example, by eradicating or rapidly suppressing their populations, and by intervening ecologically to help native animals withstand invasive pressures. Improve monitoring to ascertain whether programs achieve their defined conservation goals and are cost effective (it is unethical to kill animals if no conservation benefit is achieved and wrong to waste scarce conservation funds).

5.5.2 Social conflict

There is a high degree of social conflict in biosecurity, signalling the need for strategies and deliberative processes to reduce or resolve conflicts that threaten social licence or otherwise undermine the potential to effectively manage invasive species.

For decades, governments and hunting groups denied that deer could cause significant environmental harm. In a 2005 paper, employees of the Tasmanian Department of Primary Industries wrote that perceptions of damage by deer are 'often overestimated or wildly exaggerated', and that deer are often wrongly blamed for damage by native species.[118] But the recent rapid expansion of deer populations (from an estimated 200,000 in 2002 to 2 million currently) has led to belated recognition of the problem, resulting in a national action plan and $40 million investment by federal, state and territory governments in research and management since 2018.[119] The status of deer in NSW has gone from protected 'game animal' to 'pest'.

The slow response of governments to the invasive threats of feral deer is a familiar story in Australia. When influential sectors value an invasive species, governments tend to ignore the invasive consequences until they become too evident, by which time the species is beyond eradication or more difficult and expensive to control.

This sometimes also occurs even in national parks. The Kosciuszko Wild Horse Heritage Act 2018 overrode the required protection for native wildlife under national parks legislation and provided the means for the NSW Government to designate large parts of Kosciuszko National Park for horse protection, regardless of the environmental impacts. With control programs largely stymied, feral horse populations have surged – growing by an estimated 30% from 2020 to 2022. Although there is now a commitment by the NSW Government to significantly reduce feral horse populations, the delay will make that much more difficult to achieve.

The reluctance of governments to intervene to manage conflict-generating invasive species has impeded management of numerous highly invasive species – with the consequences particularly severe for invasions of pasture plants, trout, and some large herbivores (e.g. deer, goats and horses).

The problems arising from conflicts extend beyond the consequences of inaction on particular species. They 'drain resources and damage relationships, producing anxiety, antagonism, and

[118] Graham P. Hall and Kate P. Gill, "Management of Wild Deer in Australia," *The Journal of Wildlife Management* 69, no. 3 (2005): 837–44.
[119] Feral Deer Action Plan Working Group, "National Feral Deer Action Plan 2022–27. Draft for Consultation," 2023.

distrust'.[120] They can divert community groups' attention and scarce resources from other important issues. In many cases, such species also generate conflict within governments – particularly between agricultural and environmental departments. While agriculture departments are typically responsible for permitting or prohibiting invasive species, environment departments must try to manage the impacts of invasion on threatened species and in protected areas.

Values-based conflicts are particularly difficult to resolve.[121] The values underpinning objections to managing species as invasives have mainly been of the following types:

- utilitarian values – protection of species for their commercial (livestock, crops, pastures, garden plants) or recreational (hunting, fishing) values
- aesthetic values – protection of 'charismatic' species for their beauty, iconism or ornamental appeal
- ethical values – concern for the welfare of invasive animals, particularly those controlled by methods regarded as inhumane (e.g. aerial shooting, 1080 poisoning), moral objections to killing sentient animals, or concern about human safety (e.g. glyphosate).

An additional conflict type has been over dingoes, with many farmers wanting them managed as pests and many conservationists wanting them protected for their ecological benefits (e.g. the regulation of goat and macropod populations). The 2023 review of the Biosecurity Act 2015 noted that conflict from management of pests and weeds arising between neighbours, and between public and private landowners, remains an area to be addressed.

The prevalence and costliness of conflicts over invasive species demonstrate a need for proactive approaches to prevent or address them as early as possible before they become protracted. Managers 'need to be attentive to social, as well as ecological, contexts' and treat 'interests, ethics, and values' as integral rather than 'supplementary' to the technical aspects of management:[122]

> Deliberative models of engagement, as opposed to public education or simple consultation models, generally involve organized collaborations between expert and lay participants to develop and constructively evaluate a range of management options.

Because governments have often proven to be poor managers of conflicts over invasive species, often internally divided and subject to conflicts of interest, it would be useful in some cases to appoint an independent arbiter to manage resolution processes informed by transparent assessments of the costs and benefits of options. In a few cases there may be options to enable some carefully managed use of invasive species – for example, by requiring bonds or insurance to pay for eradicating escaped populations. But in most cases, credible cost-benefit analyses are likely to show that the long-term costs to society (environmental, social and economic) of a failure to manage an invasive species outweigh the benefits (mostly private benefits) of protecting or permitting use of an invasive species.

While there is currently widespread agreement in Australia that invasive species should be managed, broader conflicts are simmering that may in future change this – for example, some claims within academic circles that invasive species are not a major threat to nature, that native species should not be valued over alien species, that humans do not have ethical responsibility for the impacts of

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[120] Sarah L Crowley, Steve Hinchliffe, and Robbie A McDonald, "Conflict in Invasive Species Management," *Frontiers in Ecology and the Environment* 15, no. 3 (2017): 133–41.
[121] Rodrigo A Estévez et al., "Clarifying Values, Risk Perceptions, and Attitudes to Resolve or Avoid Social Conflicts in Invasive Species Management," *Conservation Biology* 29, no. 1 (2015): 19–30.
[122] Crowley, Hinchliffe, and McDonald, "Conflict in Invasive Species Management."

introduced species or that the welfare of invasive animals should take precedence over species conservation may become more influential in future.

The conflicts over particular species and the potential for broader challenges to invasive species management in future both speak to the need for a greater integration of social sciences into biosecurity. As has often been pointed out, biological invasions as a sociological as well as ecological phenomenon.[123]

Recommendations to manage social conflict

5.35 To more effectively manage the social dimensions of invasive species issues, invest more in social science research. Integrate best-practice conflict prevention and management into biosecurity programs.

5.36 For some conflicts, particularly those where there are conflicts of interest within governments, appoint an independent arbiter to manage deliberative processes for resolution.

[123] Estévez et al., "Clarifying Values, Risk Perceptions, and Attitudes to Resolve or Avoid Social Conflicts in Invasive Species Management."

6. Future opportunities

Consultation question: What opportunities do you see to improve the outcomes of invasive species management in the future?

There is a need for greater involvement of the community in the NSW and national biosecurity systems. There are many potential roles for the community – conducting surveillance to detect newly arrived invasive species, minimising the risks of introducing and spreading invasive species and contributing to the development of progressive policies.

The Decade of Biosecurity (biosecurity2030.org.au) is a collaborative national initiative led by the community and industry that seeks to build a biosecurity mass-movement. The aim is to create a stronger biosecurity system by enhancing understanding of the system and improving surveillance and response capacity. It is guided by a 3-year implementation plan with 6 priority projects, including a national biosecurity communications strategy, biosecurity champions and supporters program, national biosecurity partnership agreement, general biosecurity surveillance program and biosecurity response network. The Decade of Biosecurity consists of 18 lead partners including the NSW Government and the Invasive Species Council. The NSW Government has part-funded coordination of the Decade of Biosecurity.

Recommendation for participation in the Decade of Biosecurity

6.1 Support the Decade of Biosecurity initiative by providing 3-year partnership funding and nominating as a lead or supportive partner for one of the 6 priority projects.

7. Attachments

- Attachment 1. NSW data (not for publication)
- Attachment 2. The status of non-native species in New South Wales
- Attachment 3. Extinctions and imminent extinctions
- Attachment 4A. Invasive species and climate change
- Attachment 4B. Climate change and invasive animals
- Attachment 4C. Climate change and weeds
- Attachment 5. Proposed considerations for biodiversity and carbon markets
- Attachment 6. Strengthening regulation of plant pathways
- Attachment 7. Strengthening regulation of pet pathways (excluding fish)
- Attachment 8. Strengthening regulation of the aquarium fish invasion pathway
- Attachment 9. Eradications – mainland, island, havens
- Attachment 10. Averting extinctions – the case for strengthening threat abatement