MID-TERM REVIEW

Managing the impacts of deer on riparian vegetation and water quality

Healthy Waterways Strategy 2018-2028
Port Phillip & Westernport, Victoria

Melbourne Water

THE UNIVERSITY OF MELBOURNE

Strategic alignment

Regional Performance Objectives (RPOs):

- RPO 31. A risk-based approach is adopted to prevent, eradicate and contain pest plants and animals (including deer) and protect waterway assets.

Key Research Areas:

- Streamside vegetation and instream habitat: Understanding the impact and effective management of pest plants and animals on riparian vegetation.

Summary

Deer threaten native vegetation, revegetation outcomes, and water quality along many of our waterways. This project aimed to develop survey methods and models to predict deer density and impacts across the Melbourne Water region, identify ecological values at highest risk and assess appropriate actions to control or mitigate the risks posed by deer.

Feral deer populations and their impacts are increasing across Australia (Davis et al. 2016). Deer, including sambar, red deer and fallow deer present a risk of introducing pathogens to Melbourne's drinking water supply by faecal contamination (Nolan et al. 2013) and cause substantial impacts to native vegetation and revegetation efforts within catchments managed by Melbourne Water (Bennett 2022; Moser and Greet 2018). Consequently, deer have been recognized as a major threat across the region during the Healthy Waterways Strategy (HWS) co-design workshops, with the strategy indicating the need for a risk-based management approach for the prevention, eradiation and containment of pest animals (including deer).

Melbourne Water aims to eradicate deer from the closed (fenced) Cardinia and Silvan catchments and reduce deer density within the open (unfenced) Upper Yarra catchment. These works, which are guided by the Healthy Waterways Strategy and Silvan System Deer Management Plan, will be completed over the next 5–10 years. Strategies for deer impact mitigation more broadly are also being developed via collaborations with DEECA and others e.g. under the Victorian Deer Control Strategy, Peri-urban Deer Control plan (both from DEECA). However, deer control programs often do not meet their primary objective to reduce deer impacts because the method of control, location of control, or control frequency and intensity are lacking (Bengsen et al. 2020).

Recommendations

- Predictions from our deer density/impact models highlight that water supply reservoirs and forest-agriculture interfaces should be priority areas for deer impact mitigation efforts (Figure 1). Deer and their impacts are most abundant in the vicinity of large waterbodies due the availability of lush forage and water, and they prefer locations with access to both open and forested habitats.
- Aside from deer exclusion fencing, the applicability of non-lethal deer impact mitigation measures are likely to be limited in spatial scale and to locations with relatively low deer density (Table 1).
- A combination of exclusion fencing and lethal control will likely be required to achieve deer mitigation objectives.
- To maintain the deer population within specific peri-urban reserves at lower densities, ground shooting needs to be frequent and sustained. Frequency and intensity will be context dependent.
- To achieve an overall deer population reduction, a landscape wide approach is required, incorporating coordinated deer control across both public and surrounding private land, and sustained effort over long time frames.

What did we do?

- Collated data from over 50 datasets of deer faecal pellet counts (deer density) collected between 2005–2022 by multiple agencies comprising of 1,788 transects from across Victoria.
- Conducted targeted surveys of deer density and impacts at over 200 locations across the Melbourne Water region including impact assessments of 20,000+ woody plants.
- Developed spatial models that predict deer density and vegetation impacts across the region to enable Melbourne Water and other land managers to prioritise assets for protection (e.g. drinking water supply, priority waterways, revegetation works) and identify locations for control (e.g. for upcoming control at Tarago State Forest) (Figure 1).
- Identified ecological values at highest risk from deer impact by integrating maps of predicted deer impact maps and critical values identified by our partners (e.g. DEECA's Strategic Biodiversity Value, Healthy Waterways Strategy priority waterways).
- Undertook a literature review of the effectiveness of lethal and non-lethal deer impact mitigation strategies (Table 1).
- Assessed the effectiveness of deer control programs at Yellingbo and Warramate NCRs in reducing deer densities and impacts to native vegetation.
- Surveyed deer exclusion plots in the Upper Yarra established

in 2015 to determine deer impacts (from kangaroo & wallaby impacts) and inform thresholds for deer impact mitigation.

- Surveyed deer density and vegetation impacts within Melbourne Water's water supply catchments prior to the first year of deer eradication/control as part of the Silvan System Deer Management Plan.
- Surveyed deer density and vegetation impacts prior to the control of deer in the Tarago State Forest.

What did we find?

- We mapped predicted deer density and impacts across the Melbourne Water region (Figure 1). This model predicts that deer densities are greatest in close proximity (<1km) to large waterbodies and at intermediate to high (40–80%) levels of forest cover. At low deer densities, deer impacts increase with small increases in deer density while at moderate to high densities, impacts are dependent on environmental and landscape context e.g. elevation and rainfall.
- We reviewed the scientific literature to assess the effectiveness of different deer impact mitigation strategies. We found that most non-lethal strategies are only effective over the short-term (weeks) and those that are effective, generally reduce impacts but do not mitigate them entirely (Table 1). Exclusion fencing remains the most effective non-lethal method to prevent impacts by deer, but it is costly and thus usually limited to small and medium sized projects. Lethal control using ground shooting can effectively reduce deer densities and impacts only if sufficiently resourced.
- We assessed the effectiveness of deer control programs at Yellingbo and Warramate NCRs in reducing impacts to native vegetation. We found that these programs were not successful, there was no difference in deer abundance before and after the control program, and although there was evidence of a short term effect of ground shooting, this was not maintained over time.
- Our surveys of fenced exclosures within the Yarra Ranges NP clearly demonstrated the impact of deer on wet forest vegetation composition and structure. Impact to individual plants was dramatically reduced, particularly for tree ferns, inside exclosures. Comparisons between the partial and full exclosures indicate that deer are largely responsible for impacts on tree ferns, as well as the reduced cover of climbers, while both deer and native fauna (e.g. wallabies) contribute to impacts on understorey trees and shrubs. Combined, deer impacts reduce vegetation cover between 1–2 m high by ~20% in the study area, with likely adverse consequences for forest biodiversity and ecosystem function.

Future direction and Knowledge gaps

- We are currently using LIDAR data to assess the relationship between deer density and changes in vegetation structure at a region wide scale. We also intend to investigate the potential for LIDAR data to inform and validate our deer density and impact models. The eradication programs being implemented for the fenced Cardinia and Silvan catchments provide a unique and rare opportunity to assess the accuracy of density estimates obtained from methods used to estimate deer density with a total known number of deer. This project will examine the relationships between known total deer populations, deer density estimates obtained from different methods (e.g. camera surveys, thermal imaging surveys, and faecal pellet counts), and vegetation impact across a range of deer densities. Understanding these relationships will validate appropriate deer density estimation methods and greatly improved our ability to manage deer populations and risks to water supply and

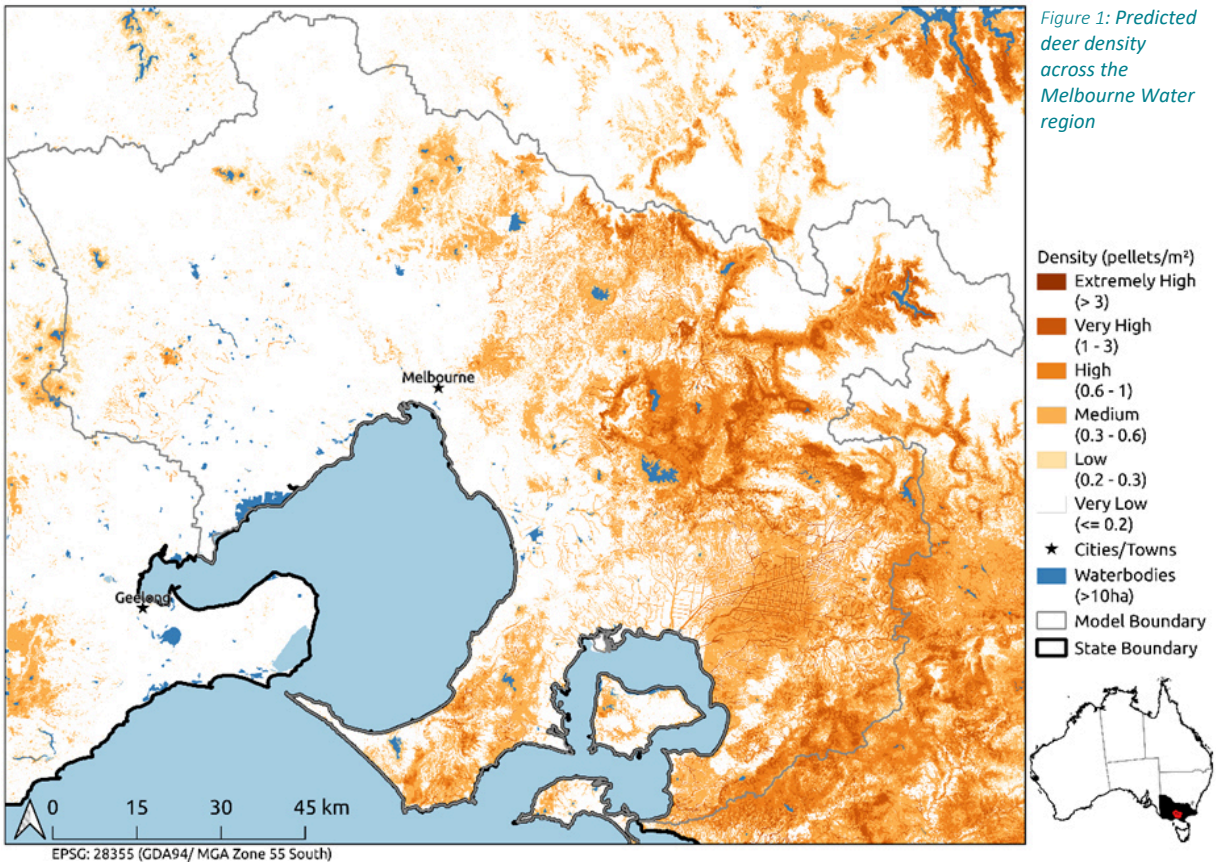

Figure 1: Predicted deer density across the Melbourne Water region

Table 1. Comparison of method ability to protect vegetation. The density of browsers, available budget, scale and effectiveness at which the method can be expected to perform is categorised relative to other methods, where L=low; M=medium; H=high; VH=very high; Unk=unknown; n/a=not applicable; S=Small; Lg=Large. *applicable in limited circumstances e.g. agricultural settings; **dependent on frequency, intensity and strategy of ground-shoo□ng program. Indicative available budget L=low (<$5000); M=medium ($5000–$10,000); H=high (>$10,000–$100,000); VH=Very high (>$100,000) and scale S=Small (<100 ha); M=medium (100–1000 ha); Lg=large (>1000 ha).

	Efficacy	Deer density	Available budget	Scale	Native herbivore density
Exclusion fencing (high spec)	H	L-H	H	S-Lg	L-H
Exclusion fencing (low spec)	M	L	M	S	M-L
Plant guards	L-M	L	L-M	S-M	M
Companion planting	L-M	L-M	L	S	M-L
Guardian dogs	M*	Unk	H	S	Unk
Lethal control	L-H**	L-H	VH	S-Lg	n/a

native vegetation in open (unfenced) catchments such as the Upper Yarra.

- We aim to develop rapid surveys of tree ferns to monitor levels of deer impacts in the riparian zones of wet forests at broader spatial scales than possible with fenced exclosures alone and to assess the effectiveness of culling efforts in the Upper Yarra.
- We will use these deer control programs to better understand: i) the best method to estimate deer density and risks to water supply in the Upper Yarra, and ii) associations between deer density and vegetation impacts.

How are we sharing findings?

Publications

- Bennett A, Fedrigo M, Greet J (2022) A field method for rapidly assessing deer density and impacts in forested ecosystems. Ecological Management & Restoration 23, 81-88.

Partnership Reports

- Joe Greet, Mel Fedrigo and Ami Bennett. Report 22.2: Deer density and vegetation impact pre-control survey, Tarago Reservoir Catchment.
- Joe Greet, Mel Fedrigo and Ami Bennett. Report 22.3: Deer impacts on the vegetation composition and structure of wet forests in the Yarra Ranges.
- Bennett, A. Fedrigo, M. & Greet, J. (2021) Are current deer control programs effectively reducing deer densities and impacts on native vegetation? Final report, April 2021. Report to Department of Environment, Land, Water and Planning. Waterway Ecosystem Research Group. The University of Melbourne
- Bennett, A. (2020) Review of knowledge on the effectiveness of non-lethal deer impact mitigation strategies. December 2020. Report to Melbourne Water. Waterway Ecosystem Research Group. Technical Report 20.9. The University of Melbourne.
- Fedrigo, M., Bennett, A. & Greet, J. (2020) Managing deer impacts within the Melbourne Water region. Melbourne Waterway Research-Practice Partnership. Technical Report 20.7. The University of Melbourne.
- McKendrick, S., Greet, J. and Ede, F. (2020) Deer impacts on threeyearold revegetation following fence removal. Melbourne Waterway Research-Practice Partnership Technical Report 20.11. The University of Melbourne
- Hazel, L., Greet, J., & Bennett, A. (2019) Predicting deer impacts in riparian areas. Melbourne Waterway Research-Practice Partnership. Technical Report 19.5. The University of Melbourne.

For more details on the research outcomes of this project, or other projects of the MWRPP, please contact:

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- Moser, S., and J. Greet. 2018. Unpalatable neighbours reduce browsing on woody seedlings. Forest Ecology and Management 414: 41-46.
- Nolan, M. J., A. R. Jex, A. V. Koehler, S. R. Haydon, M. A. Stevens, and R. B. Gasser. 2013. Molecular-based investigation of Cryptosporidium and Giardia from animals in water catchments in southeastern Australia. Water Research 47: 1726-1740.