Inquiry into Ecosystem Decline in Victoria - Responses to questions taken on notice

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Here, I address three questions taken on notice. Please note that I have addressed the second question last because my response to the third question provides relevant background information.

My responses to questions about alternatives to Schedule 7 poisons are based on peer-reviewed literature, my knowledge of field ecology, and discussion with expert reproductive biologists.

1. The role of glyphosate in ecosystem decline, because I know in urban areas it is sprayed around by land managers with pretty well gayabandon, and I am just wondering if you know or could supply any detail on the effects of it? As noted on page 6 of the transcript.

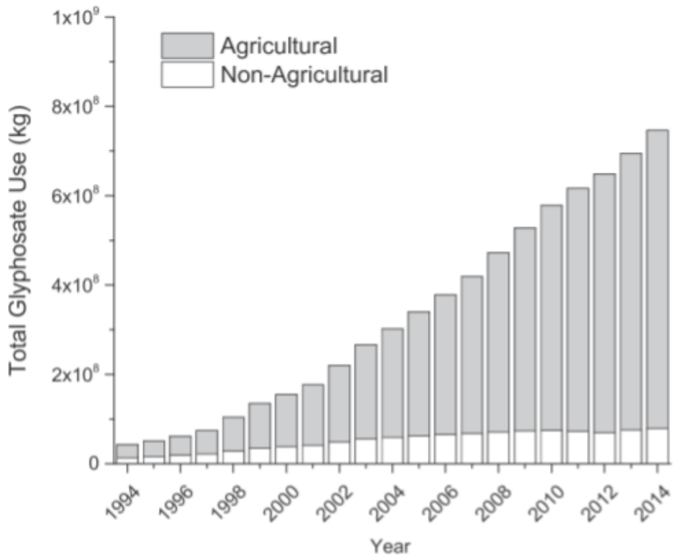

Figure 1. Global glyphosate use in agricultural and non-agricultural contexts. Source: Okada et al. 2020.

Glyphosate: what is it and why is it so popular?

Globally, glyphosate (N-(phosphonomethyl), commonly known as Roundup) is the most-used agrochemical herbicide weed killer. For many years, it was considered a benign alternative to banned chemicals such as DDT and parathion, which kill insects and harm people, and more than 8.6 billion kg of glyphosate have been sprayed on crops since 1974 (Peng et al., 2020). Currently, 10% of total glyphosate use is outside agricultural contexts; for example, it is used extensively to control weeds on pavements, driveways, lawns and golf courses (Figure 1).

Why is glyphosate banned in some countries?

Mounting evidence shows that glyphosate contributes to ecosystem decline and harms human health. Specifically, glyphosate:

- Disrupts the development, physiology and behaviour of insect pollinators, which are essential for ecosystem function (Farina et al., 2019).
- Leaves a toxic load in groundwater and waterways, where it kills aquatic life (Okada et al., 2020).

- Raises the risk of cancer in humans (van Straalen and Legler, 2018). The International Agency for Research on Cancer (IARC) of the World Health Organisation classified glyphosate as a “probable human carcinogen” following a thorough review by 17 independent experts from 11 countries (Guyton et al., 2015).

Several countries have implemented total bans on glyphosate and others have restricted its use (Baum Hedlund Law, 2021). Glyphosate remains widely used in Australia, with the exception of two councils in Sydney that have either banned or are in the process of banning it, and eight other councils that are reviewing its use.

Glyphosate use in Victoria

Glyphosate is the most commonly used herbicide in Victoria, and over 500 glyphosate-based products are registered for use by the Australian Pesticides and Veterinary Medicines Authority (APVMA, 2018).

Recently, glyphosate was measured in surface water from 49 wetlands or streams around Melbourne on five repeat occasions (between October 2017 and February 2018) (Okada et al., 2020). Glyphosate was detected in:

- 77% of urban stormwater wetland samples
- 79% of urban stream samples
- 4% of rural stream samples

The source of environmental contamination of glyphosate in areas of Melbourne was urban use.

Although glyphosate was ubiquitous, the concentrations detected by Okada et al. (2020) were not sufficient to constitute an environmental risk; but importantly, other herbicides and pesticides are present in stormwater, wetlands and streams (e.g. simazine, MCPA, diuron, atrazine and 2,4 D), and the toxicity of these compounds can increase in the presence of glyphosate.

The risk to aquatic ecosystems from glyphosate may be larger than expected based on glyphosate concentrations alone because glyphosate affects the toxicity of other chemicals. Frequent screening of urban stormwater for contaminants is critical.

Recommendations

To re-establish ecosystem services needed for arable and vegetable cropping systems (e.g. pollination), and restore healthy natural ecosystems, **we need to shift away from reliance on synthetic herbicides and pesticides, and ultimately eliminate their use**.

This may seem like a pipe dream given our current reliance on chemicals like glyphosate, yet growing restrictions on herbicide use are promoting the development of innovative weed-management alternatives (reviewed in Pesticide Action Network, 2018).

The heart of sustainable weed management is the integration of a wide range of methods, each adapted to the type of weed and crop (Appendix 1; Figure 1A). **There is great potential to apply Integrated Weed Management successfully in Victoria for the benefit of ecosystems and people** (Beckie et al., 2021)**.**

3. Alternatives to baiting as noted on page 9 of the transcript.

In Australia, most 1080 (sodium fluoroacetate) is used by farmers to kill dingoes, foxes and other predators, and it is also widely used by land management and conservation agencies to kill introduced predators and reduce populations of “overabundant” native species, including the pademelon, red-necked wallaby, common brushtail possum and dingo.

Rapidly growing community awareness of the suffering caused by 1080 has been triggered by reports from people who have watched their companion animals die from accidental poisoning. Domestic dogs commonly suffer vomiting, anxiety, and disorientation followed by shaking frenzied behaviour with running and screaming fits, drooling, uncontrolled paddling, seizures, and eventual collapse and death.

Campaigns to ban 1080 are gaining momentum (e.g. http://ban1080.org.au), and viable alternatives to poison are needed to protect native animals and farmed animals from predators.

Non-lethal alternatives to baits containing Schedule 7 poisons such as 1080 and PAPP (para-aminopropiophenone) act on:

1. Fertility - decreased reproductive rates will reduce population size and may eventually lead to removal of the species from an ecosystem or region.
1. Activity (e.g. predator attack rates) - a range of measures may help reduce rates of predation by introduced species; for example, appropriate shelter for farmed animals and exclusion fencing, which can also be used to limit habitat degradation caused by herbivores.

Fertility control offers the most viable replacement to poison in the long term.

Methods of fertility control

Asa and Moresco (2019) review non-lethal methods of limiting population size and distribution, including methods currently in use and those that are under development. Here, I describe two non-surgical approaches to fertility control; non-surgical sterilisation and immunocontraception.

Non-surgical sterilisation

Non-surgical methods of sterilisation that induce permanent and irreversible sterility offer the greatest promise (Hall et al., 2017). A cell- and species-specific sterilant that is effective following a single application would result in sustained reductions in population sizes.

How does it work?

The sterilant is a cell-ablation (removal) technology that wipes out non-renewable cell types in the reproductive system - sertoli cells in males and primordial follicles in females.

Current use in Australia

Non-surgical sterilisation is at the cutting edge of animal fertility control and is currently being developed for use on domestic cats and dogs. When initial development is complete (1-2 years), an efficient technology will be available for transfer to introduced animals in the wild.

Immunocontraception

Immunocontraceptives are the most extensively tested and used form of fertility control for wild animals. However, unlike non-surgical sterilisation their effects are temporary and reversible, so repeat doses are necessary to sustain reductions in population size. The efficacy, duration and side effects vary among species, and according to factors like age, gender, delivery mode and dose.

Immunocontraceptives have been applied successfully in many species (more examples are listed in Asa and Moresco 2019):

- A goat population in North Wales, UK, where the animals are considered part of the landscape having been present for 100 years, but were having negative impacts on a Special Area of Conservation and Site of Special Scientific Interest. Treatment of females with immunocontraceptives led to a halving of the population size (Figure 2) (Cowan et al., 2020).

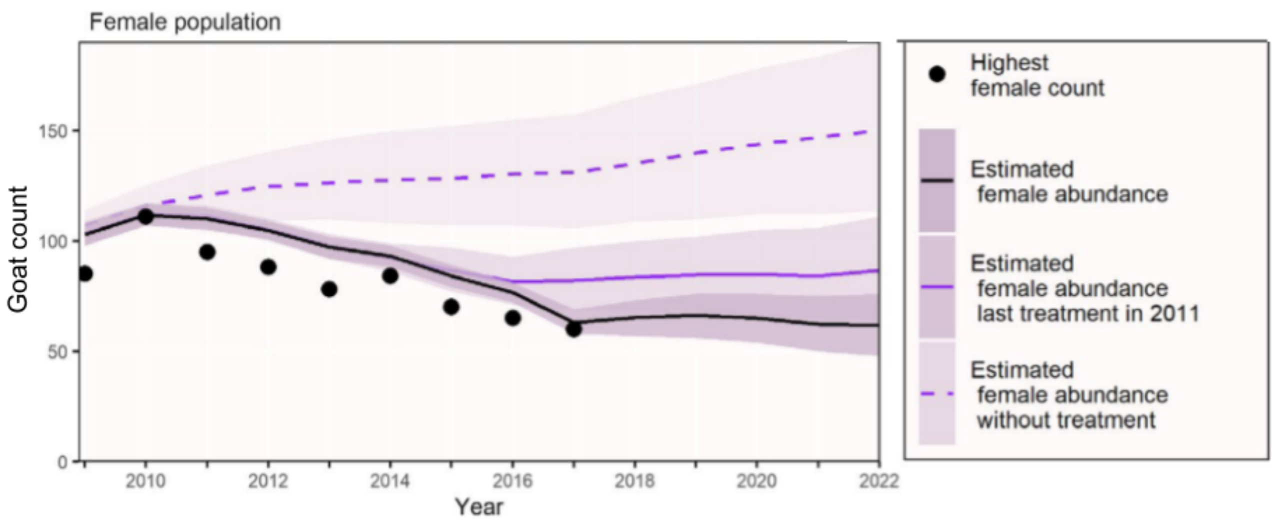

Figure 2. Goat population abundance on the Great Orme, North Wales, UK. The dashed line is the estimated abundance of females if they had not been vaccinated with an immunocontraceptive. Source: Cowan et al. (2020).

- Donkeys that have caused habitat degradation on the island of St Kitts (French et al., 2020).
- African elephants in several South African reserves (Bertschinger et al., 2008).
- Wild horses in Colorado and Utah, USA (Rutberg et al., 2017). Immunocontraceptives have also been used to reduce wild horse populations in Kosciuszko National Park, Australia, but an insufficient number of females were vaccinated to reduce the population size (Hobbs and Hinds, 2018).

How does it work?

Immunocontraceptives interfere with reproduction by promoting an immune response, and generating antibodies that block the reproductive process (Asa and Moresco 2019). The two most common vaccines for wildlife contraception are directed towards the:

- zona pellucida, which is the thick outer membrane of the mammalian oocyte that is penetrated by sperm during fertilisation, or

- gonadotropin-releasing hormone, which controls ovulation in females and sperm production in males.

Current use in Australia

To my knowledge, immunocontraceptives have not been used in populations of wild animals in Australia aside from limited use with wild horses in Kosciuszko National Park. However, they could be developed and implemented quite easily in Victoria (within 1-3 years, depending on the species) given their extensive use globally:

- **Horses:** Isolation of zona pellucida proteins in horses could begin immediately, along with development of suitable vaccine delivery methods (e.g. a weight-activated feed bin) and monitoring strategies. Horses require an initial shot of the immunocontraceptive vaccine followed by a booster 6 weeks later, and they can become fertile again after 3-4 years.
- **Smaller animals:** In theory, the same method could be applied to smaller animals. Suitable means of administering the vaccine would need to be developed for each species.

Recommendations

Immunocontraceptives suppress population fertility and buy time but are not a permanent solution. Nonetheless they are used in many species worldwide and could be developed and applied in Victoria as an interim measure.

Non-surgical sterilisation affects fertility permanently, and would reduce population sizes effectively in the long term. Its development and application would revolutionize the management of wild populations in Victoria and worldwide. Moreover, following initial development there would be dramatic reductions in the costs of managing introduced or "overabundant" animals.

Initial stages in the development of a non-surgical sterilant for domestic animals are approaching completion, and additional funding would expedite the development of a non-surgical sterilant for introduced animals.

I recommend that the Environment & Planning Committee supports:

- **funding for development of a non-surgical sterilant for controlling the fertility of introduced species**
- raising awareness among land managers, conservation agencies, ecologists and farmers about:
    - The extreme suffering caused by 1080 and PAPP
    - The risk of bait uptake by non-target species, including companion animals and native wild animals (Heiniger et al., 2018)
    - Build up of the toxin in ecosystems, particularly fresh water (Weaver, 2006)
    - Alternative measures to replace poison, such as:
        - Using protection animals (e.g. Maremas and alpacas)
        - Exclusion fencing
        - Shelter for farmed animals
        - Fox lights
        - Low-severity planned burns that leave unburnt patches of vegetation, providing better protection for native animals from introduced predators

2. The practicality and cost of immunocontraceptives and sterilants as noted on page 6 of the transcript.

Estimates of the cost of **developing a non-surgical sterilant**, including a suitable mode of delivery and population monitoring **for one species** are shown in Table 1. For each additional species substantial economies of scale will apply, but adjustments will be required to the non-surgical sterilant and modes of delivery.

Assuming adequate funding, reproductive biologists I've spoken to suggest that the laboratory development and testing could be completed within 2 years, and I expect the field trialling and delivery of the sterilant to take a further 2 years.

I emphasise that these figures are estimates, and precise figures depend on the species, the scale of application, current population density etc.

Development and application of an immunocontraceptive would be similar except costs associated with laboratory development ($1,500,000) and mode of delivery ($500,000) would be lower.

Table 1. Estimated costs of developing a non-surgical sterilant for use on one species (for example, the introduced fox), and delivering the sterilant within one region of Victoria (for example, the Barwon South West region).

	Estimated cost
Laboratory development and testing of the non-surgical sterilant	$4,000,000
Development and testing of a mode of delivery to animals in the wild	$1,000,000
Delivery to animals in the wild	$2,000,000
Monitoring of the population to evaluate the efficacy of the sterilant, and refine the mode of delivery as necessary	$2,000,000
TOTAL	**$9,000,000**

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Appendix 1

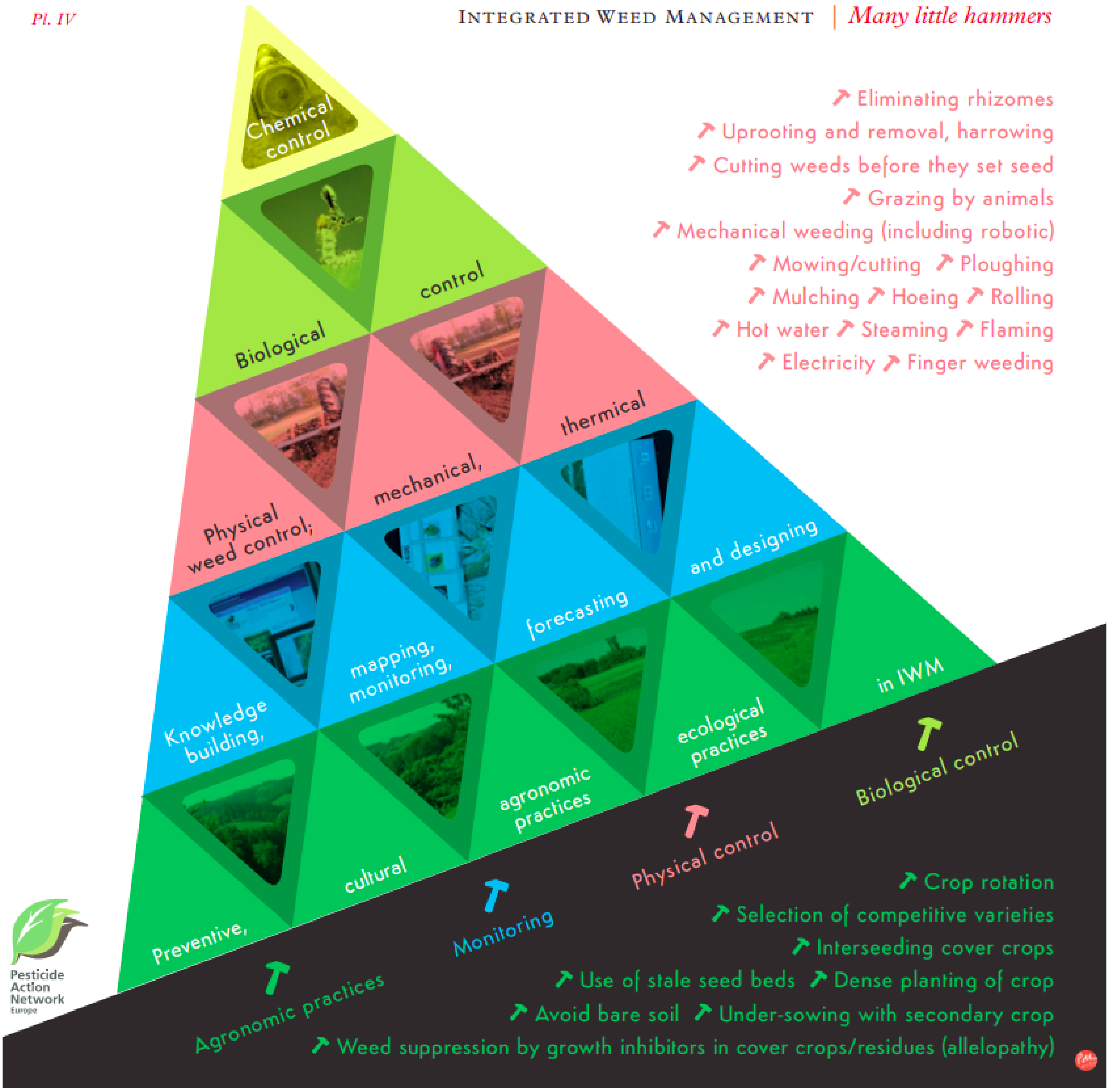

Figure A1. The Integrated Weed Management (IWM) Pyramid. Source: Pesticide Action Network (2018). The pyramid comprises five layers: (1 - *green*) preventative measures and agronomic practices (examples of suitable methods are listed in the bottom left); (2 - *blue*) monitoring to identify weeds, and selection of weed management actions; (3 - *pink*) physical control (possible methods are listed in the top right); (4 - *lime green*) biological control; (5 - *yellow*) chemical control, for use only when all other actions have failed.