AUTHOR'S MANUSCRIPT

Horse Welfare 12: A Human Behaviour Change Framework For Improving Horse Welfare

Karen Luke[1], Jo Hockenhull[2], Tamzin Furtado[3], Naomi Ainley[4], Meta Osborne[5]

[1] Independent Researcher, Melbourne, Victoria, Australia
[2] University of Bristol, Langford, Bristol, UK
[3] University of Liverpool, Wirral, UK
[4] Northumberland College, Newcastle Upon Tyne, Northumberland, UK
[5] Independent Researcher, Naas, Co. Kildare, Ireland

Corresponding author: Karen Luke (karen.luke@cqumail.com)

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ABSTRACT

To improve horse welfare do we simply need more science or a different approach to science? Horse welfare is determined by human behaviour, and for over 40 years researchers have called for change to improve horse welfare across all sectors of the industry. During this time, publications related to horse welfare have grown exponentially. These efforts have improved understanding of horse's needs and raised awareness of the need for change, but some would argue the translation of science into practice is too slow. And while it is acknowledged that more than information is required to create change, there is scant research specific to the horse industry to guide the development of human behaviour change strategies. To assist behaviour change efforts, this paper recasts the influential systems thinking framework, the Meadows 12, for the horse industry as the Horse Welfare 12 (HW12). Founded on systems thinking, the HW12 identifies 12 places to intervene in the system (horse industry), ranking them from least to most effective. The HW12 framework provides researchers with an accessible and practical translation of Meadows' highly regarded systems thinking tool, that can be adapted for any species or animal use industry. The HW12 is based on the authors' extensive lived industry experience including equestrian organisation management, rider coaching, horse ownership and competition experience, plus horse welfare and systems thinking research. The HW12 provides an industry-specific map that could accelerate science translation into practice, perhaps the missing piece of the welfare science puzzle for creating meaningful horse welfare improvements.

Introduction

Domestic horse welfare is determined by human actions (Wolframm et al., 2023) with an estimated 121-million horses globally relying on people for their health, safety and wellbeing (*FAOSTAT*, 2023). Most domestic horses are working horses and other equids, such as donkeys and mules, found working in the Global South (Grace et al., 2022). Conversely, in the Global North, most horses are bred and used for sport (including racing), leisure riding and recreation (Crossman & Walsh, 2011) and increasingly, therapy (Baxley et al., 2024). We acknowledge that while there is much overlap between the welfare challenges of working equids and domesticated horses kept in the Global North, these likely represent distinct horse-human realms or systems. As such, this paper will focus on domesticated horses in the Global North, as defined above, and all references to horses and the horse industry hereafter refer to horses in this context. It is suggested that the framework proposed in this paper could be extended to all horses, equids and other animals, especially those trained and used to fulfil a specific human function, such as working dogs.

For over 40 years researchers have documented the need to improve horse welfare (Houpt & Waran, 2003; McLean & McGreevy, 2010; Waters et al., 2002), and during this time, horse welfare publications have grown exponentially (Benedetti et al., 2023). Most research in this field has come from the natural sciences such as veterinary and agricultural science, and increasingly psychology (Luke et al., 2022; Lund et al., 2006; MacKay, 2020), disciplines that rely heavily on reductionist, quantitative scientific methods built on linear thinking (Bawden, 1991; Capra, 2014; Fang & Casadevall, 2011). These efforts have improved our understanding of horse's needs and raised awareness of the need for change, but despite this, the pace of change remains slow (Holmes & Brown, 2022). The misalignment between the growth of knowledge and the pace of change highlights that something is missing in our approach to this problem. For example, it is acknowledged that more than information is needed to create change (Abunyewah et al., 2020; Miller & Prentice, 2016; Podosky, 2021), yet there is scant research specific to the horse industry to guide the development of human behaviour change strategies. A central insight from systems thinking, and one that runs throughout this paper, is that the behaviour of individuals within an industry is largely an emergent property of the system itself. Riders, owners, breeders and officials act within a dense web of incentives, norms, rules, infrastructure and inherited assumptions. As such, what looks like individual choice is, to a substantial degree, system behaviour expressed through individuals. This reframing has important implications: it shifts the locus of intervention from 'fixing' people to redesigning the conditions that shape their actions. Addressing these dual needs and to assist human behaviour change efforts to improve horse welfare, this paper adapts an influential systems thinking framework, the Meadows 12 (Meadows, 1999), for the horse industry.

Wicked problems and systems thinking

The challenge of horse welfare in the horse industry has recently been recognised and constructed as a complex problem (Hockenhull et al., 2024; Luke et al., 2022), which some describe as a 'wicked' problem (Ross et al., 2025). Wicked problems are characterised by having many stakeholders and decision makers often with conflicting values, and 'solutions' that while potentially improving one aspect of the problem, may make other aspects worse (Churchman, 1967; Lönngren & and van Poeck, 2021). The conflicting interests of horses and humans within the industry, such as owners, riders and breeders (Dashper, 2014; Hogg & Hodgins, 2021; Luke et al., 2024), equestrian organisations (Anonymous, 2022), the gambling industry (Bergmann, 2015) and governments (Shachtman, 2025; Thole, 2012), lends weight to the proposition that horse welfare in the horse industry is indeed a wicked problem. Other industries beset by complex or wicked problems, such as agriculture (Tourangeau &

Sherren, 2020), public health (Luna Pinzon et al., 2024) and education (Garira, 2024), have adopted systems thinking approaches in their search for better outcomes.

Systems (or systemic) thinking has been referred to as the fifth discipline (Flood, 1998; Senge, 1990), and has long been the backbone of human behaviour change strategies in areas such as business management (Senge, 1990), sustainability (Ostrom, 2009), agriculture (Bawden, 1991), public health (Allender et al., 2015; Bagnall et al., 2019; Durham et al., 2018) and sport (Hulme & Finch, 2015). Arguably, systems thinking is better suited to addressing some problems than traditional reductionist approaches because of its focus on understanding complexity and recognising networks of interrelationships between factors relating to behaviour change (Bawden, 1991; Capra, 2014; Stroh, 2015). However, rather than seeing one approach as superior or inferior to another, it is increasingly recognised that every scientific approach has strengths and weaknesses and for wicked problems, a diverse range of approaches are needed (Canty-Wilson, 2014). Reductionist approaches rely on the fidelity of breaking up the world (system) into small, static parts and this approach is well suited to studying mechanical-type problems (Capra, 2014). In contrast, the horse industry is more accurately characterised as a complex adaptive system: a system composed of many interacting agents (riders, owners, breeders, officials, organisations, horses) whose behaviour at the system level emerges from the local interactions among those agents, rather than from any central design (Cilliers, 1998; Holland, 1992; Mitchell, 2009). Several properties follow from this. First, system-level behaviour is emergent – patterns such as the normalisation of tight nosebands or the persistence of stabling cannot be reduced to the choices of any individual participant, but arise from the interaction among many. Second, self-organisation is itself an emergent property; the industry's apparent capacity to maintain and reproduce its current form is not directed from a central authority but arises from the collective behaviour of its parts. Third, complex adaptive systems exhibit non-linearity and path dependence, meaning small interventions at the right point can produce disproportionate effects, while large interventions at the wrong point can produce little change. These properties are precisely what make systems thinking, and frameworks such as the Meadows 12, useful for understanding and intervening in the horse industry. This characterisation also aligns with the Cynefin framework (Snowden & Boone, 2007), which distinguishes complicated problems, where cause and effect are knowable through expert analysis, from complex problems, where cause and effect are only apparent in retrospect. Decades of high-quality parameter-level research have built an essential evidence base on horse welfare. That this work has not, on it own, produced industry-wide change reflects not its quality, but the mismatch between a complicated-problem method and a complex-problem domain.

Systems-based approaches to human behaviour change, as previously mentioned, are well established in other areas. For example, systems approaches have been used to address difficult public health challenges such as obesity (Bagnall et al., 2019; Garside et al., 2010) and within agriculture, systems thinking has been used as a means to maximise production efficiency, for example, in intensive meat production operations (Cummings et al., 2023; Stanislaw et al., 1991). Conversely, systemic thinking has been used to encourage more sustainable farming practices that protect our biophysical environment (Bawden, 1991; Norton et al., 2024). However, despite some clear parallels between intensive animal farming and common horse keeping practices, such as individual indoor housing, standardised management (Maes et al., 2020), highly restricted space (Tauson, 2005) and a diet comprised largely of grain (EFSA Panel on Animal Health and Welfare (AHAW), 2012), the use of systems thinking approaches in relation to horse welfare has so far been minimal (Luke et al., 2022; Stephens, 2021). To accelerate the adoption of systems approaches in other fields, researchers have developed industry-specific versions of various systems thinking frameworks and tools (Bolton et al., 2022; Malhi et al., 2009; Nobles et al., 2022; Ostrom, 2009). The development of industry-specific systems tools could increase the accessibility and utility of systems-based approaches for the horse

industry and encourage their use. A horse industry-specific systems-based framework to guide human behaviour change research is one such tool that could help scholars and stakeholders: categorise past and future research; identify potential leverage points and develop multi-level interventions; and finally, more accurately predict the likely effect of proposed interventions.

A framework for navigating systems

The Meadows 12 (see Figure 1) is an influential systems-based framework that outlines places to intervene in a system, identifying leverage points of varying strength, from strongest to weakest (Meadows, 1999). While Meadows outlines discrete levels in the framework, it is important to note she acknowledges the proposed levels are fluid, and that there is overlap between them. The Meadows 12 identifies *parameters* as the weakest leverage points within a system. Parameters are individual elements of a system such as weight limits for riders or noseband tightness and are the easiest places to intervene in a system, but interventions at this level *alone* 'rarely change behaviour' (Meadows, 1999, p5). Despite being relatively weak leverage points, parameters are the natural fit for the dominant (linear) scientific method and are the focus of most research and policy. Abson et al (2017) noted the relationship between traditional science and policy to be mutually reinforcing, highlighting the difficulty researchers face when seeking to move outside the traditional scientific approach. However, over-reliance on any single approach limits how researchers frame problems, and the solutions they pursue. As just one example, there has been extensive research around whips in racing. Researchers have investigated how many strikes (McGreevy & Ralston, 2012; Sandberg et al., 2025), when strikes are made during a race, where on the horse's body strikes are applied (Deuel & Lawrence, 1988; Evans & McGreevy, 2011; Sandberg et al., 2025), and whipping force (McGreevy et al., 2013). Such studies generally seek to provide evidence to determine the 'right' set of numbers within which a practice is deemed compatible with horse welfare or at least acceptable while allowing humans to achieve their goals. In the case of whipping horses, this has led to some racing jurisdictions limiting or banning whip use (Anonymous, 2021; British Horseracing Authority, n.d.; Riley, 2022). While parameter level research can provide critical evidence on the effects of practices such as whipping, this example illustrates Meadows' point that parameter level solutions *on their own* are weak and rarely lead to behaviour change (whipping of racehorses continues in most jurisdictions). Studies investigating parameters rarely explicitly address deeper drivers of the practice, such as the economic incentives that drive aggressive riding or how the industry generally views horses (horses are seen as athletic equipment) which renders whipping horses as acceptable. Therefore, when not part of a broader research programme that includes interventions at other levels within the system, an unintended consequence of parameter level research is it tends to maintain the status quo.

Moving beyond parameters

When seeking to create change, the Meadows 12, offers researchers a framework for examining and investigating the deeper levels of a system that may be contributing to a problem. Beyond the physical elements of the system (Levels 1 to 3), Levels 4 to 6 of the Meadows 12 examine *feedback loops* (information flow) within a system, for example, delays in receiving information, and system regulation via negative feedback loops. Levels 7 to 9 include the *design* of the system, how it is structured and its ability to re-structure (adapt) to a changing environment. Included in these levels are how information loops are structured which helps identify information gaps that can lead to some within the system not having access to critical information. Level 8 includes the rules of the system, for example, the rules permitting controversial practices such as hyperflexion and tongue ties, as well as determining who can use them, how they perform them and in what circumstances. Rules can be a powerful leverage point, especially when combined with solid, parameter level evidence to support a rule. Levels 10 to 12 relate

to the *intent* of the system. These are the deepest levels within the system and the most powerful leverage points, but are also the hardest to change. Included in these levels are the goals of the system (Level 10) and the worldview (paradigm) upon which the system is built. A paradigm is essentially a set of often deeply held beliefs, values and assumptions that form a person's worldview. It is the lens through which they see the world. The deepest level, Level 12, of Meadows' framework is the ability to transcend paradigms. This occurs when someone recognises there is not one 'true' way to see the world, and many paradigms are simultaneously possible. At this level, paradigms are viewed as helpful mental models that are necessarily incomplete. Taking this approach, it is possible to hold paradigms lightly, and consciously shift from one to another, selecting a paradigm that offers the information or perspective needed to address a particular problem. Achieving change at these deep levels is difficult, but can be transformational, and examples of transformational change do exist (see Cousquer (2023) for example of mule keeping and training in Morocco). That there is an urgent need for transformation in the horse industry is growing increasingly clear (Heleski, 2023; Wensley, 2024). What follows is an adaptation of Meadows 12 for the horse industry, called the Horse Welfare 12 (HW12). The HW12 provides detailed definitions, explanations and examples drawn directly from the horse industry. It is hoped that our goal of creating an industry-specific framework, the Horse Welfare 12, to guide future human behaviour change research and interventions to improve horse welfare is timely.

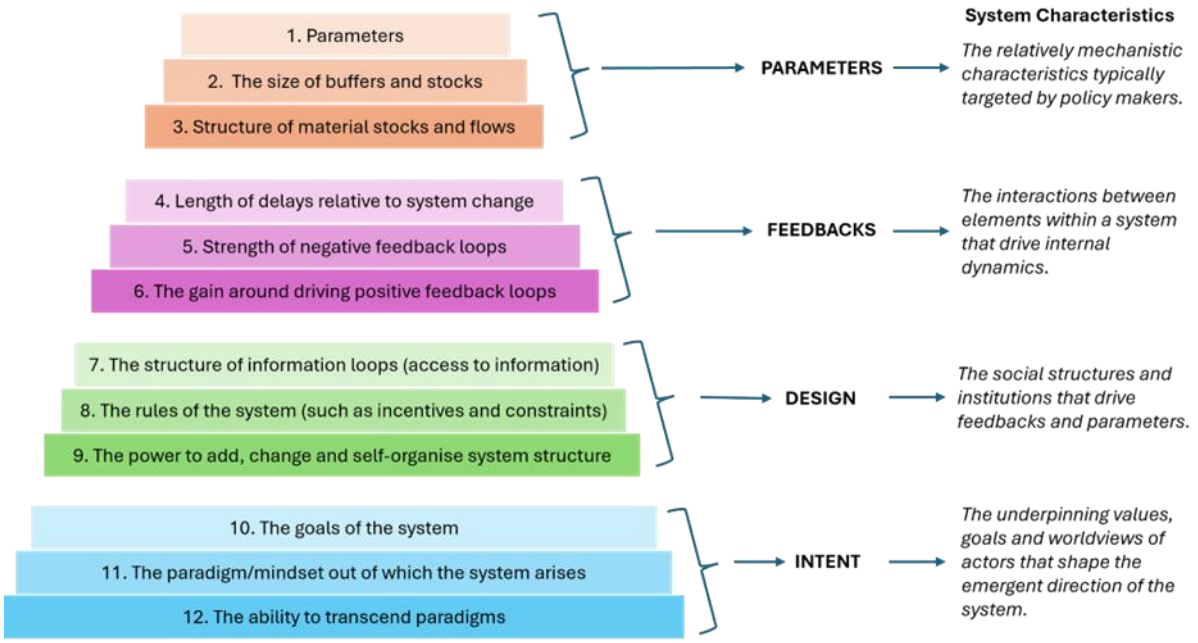

Figure 1. Illustration of the Meadows 12 showing the leverage points in a system from least effective (Level 1) to most effective (Level 12) adapted from Meadows (1999) and Abson et al., (2017).

Method

Context

This research is built on the extensive collective experience of the authors. Each author is or has been a horse owner/carer and has several decades experience working/participating in the horse industry. Authors' industry roles have included equestrian coach (KL, NA), equine reproduction veterinarian, racing regulator (MO), vocational curriculum manager, showjumping groom, and yard manager (NA),

endurance competitor (TF), competition organiser (KL, TF), welfare steward (TF), eventing competitor (KL), rider (JH, KL, NA), and Thoroughbred breeder (MO). Within the academic realm, authors' specialities include education (KL, NA), equine welfare (JH, KL, MO, NA, TF), systems thinking (KL, MO), human behaviour change (KL, TF, JH) and veterinary science (MO). As this is a conceptual paper based on the authors' experience and the literature, no ethics approval was required for this research.

Translating the Meadows 12 for the horse industry

This process was undertaken by KL and MO in the first instance, who met over several months to create a first iteration of a description and examples for each of the 12 levels. While developing the draft, the goal was to include highly relatable examples for those within the horse industry (as defined earlier). The first draft of the HW12 was then shared with all authors for comment, followed by a group meeting to discuss the comments raised. The draft was then revised to reflect the group's feedback. This process was repeated three times over the course of seven months to achieve consensus on the final version of the descriptions and examples presented below.

Results

The HW12 (Table 1) is a framework to raise awareness of the various intervention points within the horse industry (system) and help researchers, stakeholders and policy makers to better understand system behaviour, and use these insights to identify opportunities to design and implement interventions to create positive change. Table 1 outlines the 12 levels of the HW12, providing a definition, explanation and examples for each system level.

Table 1. The Horse Welfare 12 (HW12) including definitions, explanations and examples from the horse industry.

	Level	Meadows 12	Horse Welfare 12	Horse Industry Examples
Parameters	1	Constants, parameters, numbers (subsidies, taxes, standards)	Quantifiable elements (constants, parameters, numbers) of the horse industry	Jump heights, course distances, dressage test requirements Prize money and fees Whip strike limits Transport regulations Breeding restrictions - caps on mares per stallion, caps on frozen semen Weight limits for riders Noseband tightness
	2	Size of buffers and stablilising stocks	Size of stabilising stocks (buffers) that allow the horse industry to remain stable Note: too much buffer and the system is unresponsive, too little buffer and the system is chaotic and fragile	Financial reserves (wealthy people attracted to industry) Breeding population Industry workforce 'Active' horses within the industry (racehorses, sport horses, therapy horses, etc)
	3	Structure of material stocks and flows	The network of material stocks (physical infrastructure) and the flows through the network that allow the horse industry to operate	Horse infrastructure network: Physical facilities - stables, training tracks, racecourses, sale yards, spelling (rest and recuperation) facilities, abattoirs Horse flow: Consider how a foal enters and moves through the racing industry from being born at a breeding farm and moving through the various parts of the system to the end of his/her life Human infrastructure network: Physical facilities - clubs, livery yards, education providers, training stables Human flow: Consider how a jockey might enter the horse industry as a child at Pony Club, secure an apprenticeship at a racing stable and enrol in a training course, then work as a jockey
Feedbacks	4	Lengths of delays relative to rate of system change	Industry feedback delays relative to how quickly the horse industry is changing	Breeding response to market signals (if the market signals demand for a particular bloodline or type, even if breeders respond immediately, it

			(key word is 'delays'). If delays are too short, the industry will overreact, but if feedback is too delayed, the industry risks being so far outside what society deems is acceptable that it cannot recover.	takes years for those foals to reach the market) Training and Development Timelines - for most equestrian sports it takes many years to produce a competitive horse, so filling the production pipeline takes time and by the time the pipeline delivers, demand may have fallen Veterinary and Research Feedback - research takes time to produce evidence that a practice may be harmful Regulatory Response to Welfare Issues - from identifying a welfare issue to gathering evidence, developing policy and implementing regulations, can take many years
	5	Strengths of negative feedback loops	Strengths of negative feedback loops that regulate the system with the goal of retaining a successful horse industry. Negative feedback loops are self-correcting mechanisms that keep the system in the desired state. If negative feedback is too weak, slow or distorted the system can drift away from intended goals.	Regulation and enforcement to prevent harmful practices, eg: drug testing Competition judging that penalises training using harmful methods Sponsorship agreements that rely on the industry's good standing within the community Social licence to operate when welfare incidents are publicised, such as name and shame posts on social media, horse abuse documentaries, create pressure on the industry to reform
	6	Gain around driving positive feedback loops	Positive feedback loops are self-reinforcing and drive system growth - benefits (gains) from positive feedback loops must be constrained to ensure overall horse industry health. Unchecked positive feedback loops lead to system collapse.	Competitive escalation where extreme movement or a conformation trait is rewarded leads breeders to select for these traits and so producing horses that perform even more extremely which shifts judges' expectations further. Soring cycle in gaited horses where chemically or mechanically induced pain causes the exaggerated gait that wins, incentivising more soring, leading to the practice becoming normalised within industry subculture. Economic reward loops in racing where those that spend the most money win the most races and prize money, leading wealthy investors to spend even more money
Design	7	Structure of information flows (who does and doesn't have access to information)	Structure of communication flows determine who does and doesn't have access to information. The flow of information determines what options are available to the industry (eg: are alternative perspectives and new ideas allowed to flow through the industry?)	Riding: most riders do not receive welfare feedback, as the focus is horse compliance and performance. The information flow is disconnected between performance goals and horse welfare. Breeding: breeders who select for extreme characteristics, such as very long necks, exaggerated movement, etc do not receive feedback on long-term soundness, shortened competitive careers, injury Staff: the use of non-disclosure agreements (NDA) among industry staff is a legal mechanism for disrupting information flows, for example NDAs can prevent evidence-based welfare information circulating, denying the industry information it could use to self-correct (this is a mechanism for protecting the dominant paradigm by controlling what information can challenge it)
	8	The rules of the system (incentives, punishments, constraints)	The rules (or lack thereof) of equestrian sport and racing that create incentives, punishments, and constraints to shape participants' behaviour. Consider the relationship between system rules and the goals of the system.	Dressage: the rule making double-bridles compulsory shapes behaviour of elite riders by restricting their choice of equipment. Rules of racing shape jockey behaviour such that jockeys are compelled to whip their horses, or face penalties for not 'riding out the race'. Prizes and prize money structures that only reward top placements create pressure to push horses harder rather than incentivising sustainable, welfare-positive practices.
	9	The power to add, change or evolve system structures or self-organise	Self-organisation is an emergent property of complex adaptive systems, arising from the interactions among system components rather than from central direction. These interactions can	Alternative networks - groups of riders, colleges who adopt new horse-centric curriculum, diversify competition formats to include events that prioritise horse welfare - these are examples of the horse industry adapting to change by creating a new way of being, rather than waiting for the traditional horse industry to change.

			produce new structures and adaptation but can also reproduce existing structures and resist change.	Governance structures shape the conditions under which interactions among industry actors occur, including who can propose a rule change, electoral processes (who gets power to make decisions), what issues make it onto the agenda, whether dissenting voices can be influential and barriers to structural adaptation. Through this, governance shapes what self-organisation can produce within the system.
Intent	10	The goals of the system	The goals of the horse industry fundamentally shape all its feedback loops, incentives and behaviours. The goals of the system are powerful because all of the lower levels of the system (rules, information flows, buffers, etc) are configured to serve the goals of the system.	The dominant goal in the horse industry is to maximise competitive success where success is defined by ribbons and financial gain. This goal leads to breeding for extreme physical traits, justification of training methods that produce winning results, and welfare concerns placed secondary to competitive advantage. Changing the goal to one where equine welfare is optimised while maintaining athletic excellence would retain the essence of traditional equestrian sport, but would shift the industry to evaluate training methods for their welfare impact first, equipment and training innovation would focus on horse comfort and better horse-human communication, success metrics would include behavioural indicators, career longevity and soundness.
	11	The paradigm out of which the system arises	The paradigm from which the horse industry has emerged. This is the set of beliefs, values and assumptions that underpin all aspects of the industry.	The current dominant paradigm is that horses are athletic equipment or performance vehicles - that is, horses are animate tools that exist to fulfill human competitive and recreational goals. This worldview sees the horse's body as raw material to be shaped and the horse's mind as something to be overridden when it conflicts with human objectives. Evidence of this paradigm includes training methods focused on submission and compliance, equipment designed for human control rather than horse comfort, competition rules prioritising aesthetics over welfare, commodification of horses, research focused on performance enhancement rather than quality of life. An alternative paradigm views horses as sentient beings with their own interests, where human-horse partnership requires genuine two-way communication and mutual consent. The horse is subject, not object.
	12	The power to transcend paradigms	The key to this leverage point is helping people see they are operating within a paradigm. Recognising that everyone is operating within a paradigm, makes it possible to appreciate multiple paradigms are possible simultaneously (we don't all see the world the same way). It also allows people to see that shifting between paradigms is possible, and often desirable to gain more information and overcome blind spots.	Examples of different paradigms within the horse industry include an official operating from a 'sports governance' paradigm, a breeder working from a 'genetic improvement' paradigm, a traditional horseman operating from an 'inherited wisdom' paradigm. Each paradigm illuminates some things, while being fundamentally incomplete (because all paradigms are incomplete). An example of clashing paradigms is the hyperflexion debate - some argue it is horse abuse (sentient being paradigm) while others claim it is an advanced training technique (athletic equipment paradigm). Not all paradigms are equally valid for a given purpose, for example, defending hyperflexion as being a welfare neutral practice using an athletic equipment paradigm, may not be valid. Transcending paradigms can be cognitively difficult, for example, holding that there are multiple ways of understanding a system simultaneously. However, there is great power and freedom in having the mental flexibility to consciously shift from one paradigm to another, thereby redefining the fundamental beliefs, values and assumptions that inform all the lower-level system structures.

Worked examples

According to the FEI website, dressage is 'the highest expression of horse training…[where the horse] has to perform at a walk, trot and canter' (Federation Equestre Internationale, 2025) and riders are judged by their ability to influence and shape the horse's execution of these movements in a standardised test (McGreevy et al., 2018). Riders do this by applying aids (pressure) using their hands, legs and seat while mounted on the horse. The best riders will use light, transient aids to communicate with the horse, less skilled riders will use heavy or harsh aids, sometimes supplemented by equipment that can amplify the pressure applied to the horse. Such equipment includes leverage bits that enable the rider to apply pain-inducing pressure to the horse's mouth via the reins compelling the horse to adopt a particular posture or way of going (McLean & McGreevy, 2010, also see Mellor (2020) for a discussion on bit-induced mouth pain). In dressage, the horse must be 'supple and obedient' (Maynier, 2025, p.65). Synonyms for obedience include the words 'deferential' and 'submissive' (*Thesaurus.Com*, n.d.). Accordingly, dressage riders and judges expect the horse to show 'no resistance…to the Athlete [rider]' and the horse must 'accept the bridle with a light and consistent soft submissive contact' (Maynier, 2025, p.3). Horse behaviours such as a 'busy mouth', head tilt, mouth opening, tongue hanging out, tongue retracted in the mouth or over the bit, and tail swishing are recognised as faults in dressage, and as such, are penalised by the deduction of marks (Maynier, 2025). With the language of obedience, submission and resistance woven throughout the rules and judging of dressage, a mindset (paradigm) among participants is created. Among other things, the traditional 'dressage mindset' sees the horse as subservient to the rider, and horse behaviour that negatively affects a rider's score is seen as wilful disobedience.

In contrast, research suggests many behaviours that are scored negatively in dressage, such as mouth opening and tail swishing, rather than being displays of resistance or disobedience, are most often signals of discomfort, pain, or stress (Cook & Kibler, 2019; McLean & Christensen, 2017; Mellor, 2020). When the horse finds pressure from the bit uncomfortable or painful, the horse will likely trial several behaviours to relieve their discomfort (Mellor, 2020). These behaviours include, mouth opening, biting the bit, moving their head up or down, head shaking, pawing, and tail swishing (Eisersiö et al., 2023; Quick & Warren-Smith, 2009). However, because the rules of dressage frame such behaviours as 'resistances', riders and judges misinterpret these behaviours, and see the issue as a 'horse' issue, and as such, they look for a horse-related solution. In most cases, the solution is a tight noseband.

Tight nosebands *are* a simple solution to the common problem of horse mouth opening in modern dressage (Doherty et al., 2017). A sufficiently tight noseband can clamp the horse's mouth shut (Weller, 2020), and given mouth opening and other oral behaviours reduce the rider's dressage score, riders have a strong motivation for keeping their horse's mouths closed and quiet. Until recently, there have been minimal, if any, limitations on how tightly a noseband can be fastened around the horse's face. The FEI introduced an objective maximum noseband tightness limit in May 2025 for horses competing in international level competitions (Anonymous, 2025). However, adoption of the new rule by national federations of the FEI is voluntary, and at the time of writing, Great Britain was the only national federation to announce it will implement the rule for national level competitions in 2026 (Williams, 2025). Tight nosebands are an example of equipment that is designed to inhibit behaviour (mouth opening and other oral behaviours), thus masking pain and/or stress signals from the horse (Wilkins et al., 2025), and their design and use is informative about deeper structures within the horse industry (system).

Through unpacking the example of horse mouth opening, the connections between the various levels of dressage, and the horse industry more broadly, begin to emerge (see Figure 2). Dressage is built on the belief that horses are subordinate to riders, and irrespective of their level of comfort or

discomfort, horses should remain submissive and obedient. This set of beliefs or 'dressage mindset' (paradigm) is reflected in the language used in dressage rules and tests, which traditionally has prioritised submission of the horse (US Equestrian Federation, 2023). The language serves to reinforce the dressage mindset, which is further reinforced through the rules of the sport that penalises (punishes) riders whose horses are not 'supple and obedient'. Seeking to avoid punishment and maximise their scores, riders apply a tight noseband that acts to prevent or mask any disobedience. Moreover, enshrining the dressage mindset in the rules and judging of the sport, all of which are supported and defended by a large international organisation, provides external legitimacy for the internally held beliefs of those within the dressage community. Using the dominant scientific paradigm (a paradigm built on beliefs that largely align with those underpinning the dressage mindset), researchers have developed a noseband taper gauge. While intended to improve horse welfare through encouraging an objective standard of noseband fastening that is more comfortable for the horse (Doherty et al., 2017, 2025; McGreevy et al., 2012), one potential unintended consequence of the taper gauge is that it provides scientific endorsement and legitimacy to the use of nosebands, thus reinforcing the dressage mindset and the continued use of equipment designed to inhibit horse behaviour.

What follows are two worked examples illustrating how adopting a different scientific approach, built on different assumptions and beliefs, the HW12, can provide new perspectives which could allow researchers and others to develop coordinated, multi-level interventions, including interventions that tackle the deepest levels within the system, such as encouraging a shift from the dominant industry mindset (paradigm). Mindset or paradigm change could allow the essence of equestrianism to be retained while transforming its practice, thereby creating an ethically sustainable sport.

Worked Example 1 - Horse Mouth Opening in Dressage

(See Figure 2 for a summary of this worked example.)

HW12 Levels 1 to 3 (Parameters)

The current practice of applying a tight noseband to keep horses' mouths closed during dressage is an example of a parameter level intervention. The focus of the intervention is the horse, and the horse is compelled to change their behaviour through the application of a mechanical device (noseband). The beliefs, values and assumptions (mindset) underlying this intervention are consistent with the beliefs underpinning the existing system (dressage). It is assumed the horse bears the responsibility for the mouth opening problem and so it is the horse who must change. No change is required from the rider, and no change is required of riders generally or more broadly, the sport of dressage (the system).

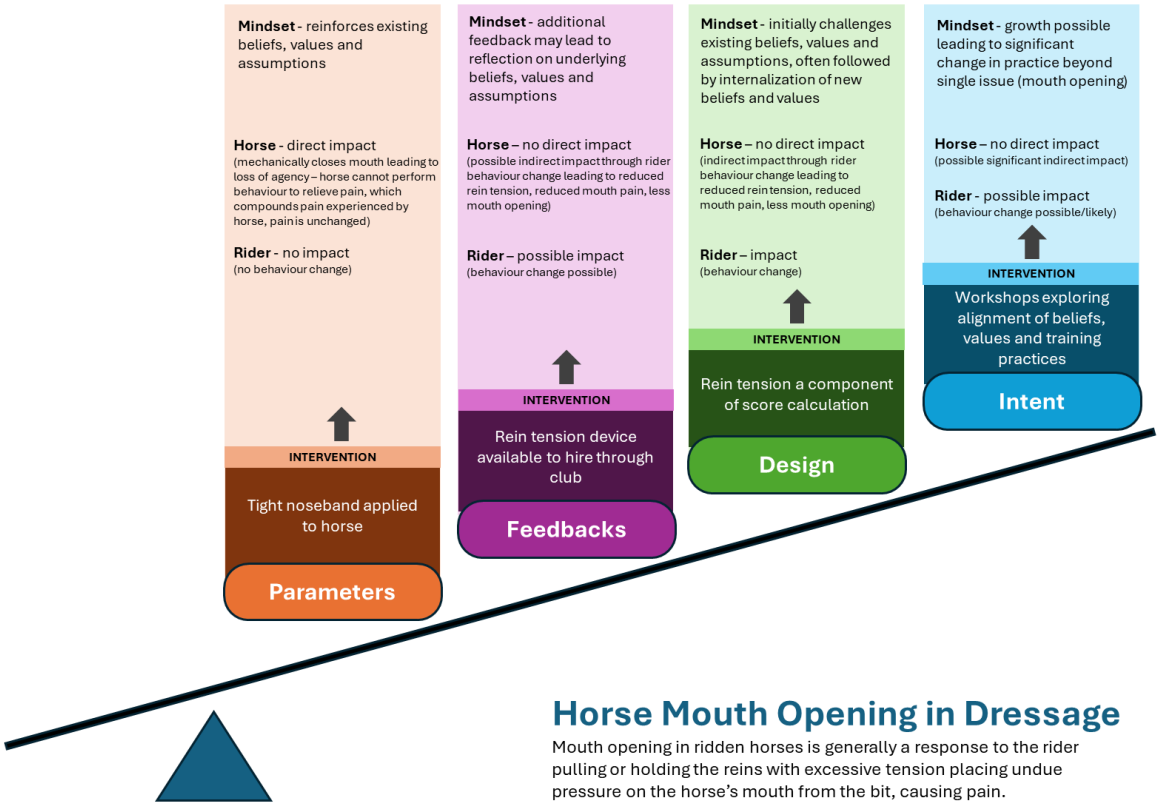

Figure 2. Application of the HW12 to illustrate interventions to address horse mouth opening in dressage.

HW12 Levels 4 to 6 (Feedbacks)

Applying a level of bit pressure via the reins that the horse can tolerate comfortably will reduce or eliminate the motivation for the horse to open their mouth. Therefore, an intervention where rein tension devices (RTDs) are made available to riders (for example, through equestrian clubs or other organisations) could help riders address the issue of horse mouth opening. Rein tension devices measure rein tension and provide feedback to the rider regarding the amount of pressure they are exerting on the horse's mouth via the reins. Receiving this information, the rider may choose to adjust the rein tension and consequently, the pressure on the horse's mouth. Providing RTDs to club members does not impose change on members, it simply creates an opportunity to receive more information about their current riding practice. New information is the key to interventions at this level, and the RTD is one of many opportunities to provide riders with new information. In complex adaptive systems, self-organisation emerges from the interactions among system components, and the resulting structures tend to resist change because they are continuously reproduced through those same interactions (Cilliers, 1998). When seeking to prime a system for change, some argue certain types of new information, such as making visible the gap between how participants understand their practice (people who love and care about horses) and how horses experience it (pain from rein tension), help create the conditions where the system is sensitised to change (Goldstein, 1988). Importantly, this is not about identifying individual rider as the source of the problem, riders are responding to the incentives, training norms and judging criteria the system has produced, but about surfacing information that the system has previously kept invisible or misconstrued.

HW12 Levels 7 to 9 (Design)

Interventions at the design level can be incredibly powerful, and it can be tempting to believe all problems can be fixed through the implementation of new laws or rules. However, as already noted, a key feature of systems is their ability to resist change (Meadows, 1999) so care must be taken to ensure such interventions have sufficient support to withstand pushback, especially if the change challenges a group's paradigm. Incorporating rein tension into the scoring of dressage, where rein tensions over a prescribed level are associated with score deductions, is a design level intervention that would change rider behaviour. It is likely many riders would initially find the new rule problematic because it would challenge the traditional dressage mindset. However, as long as there was a sufficient level of support for the new rule, plus the organisation was sufficiently committed to withstand any pushback and enforced the rule consistently, research shows that the dominant mindset within a group can shift relatively quickly. This is because mindsets are not held in individual heads alone but are sustained through collective practice - including the rules, the incentives, and the observable behaviour of other participants. When the conditions holding a mindset in place change, the mindset they were sustaining is freed to change with them. For example, Xie et al (2011) in a computational model found as little as 10% of individuals within a group who were committed to a new idea or practice are needed to overturn an established practice. Experimental data from Centola et al (2018) found just 25% of a group who were committed to change could shift an established practice. The process of mindset change is beyond the scope of this paper, however, see Grube et al (1994) for one explanation.

HW12 Levels 10 to 12 (Intent)

Interventions at levels 10 to 12, which include the goals of the system and system mindset (beliefs, values and assumptions), are the deepest levels of the system and the most difficult to change. Interventions at this level include initiatives such as workshops involving a wide range of participants, for example riders, organisation officials, academics, practitioners and horse welfare advocates to explore the existing dressage mindset and potential aspirational mindsets. Activities such as these invite individuals to re-evaluate their own beliefs and values (Grube et al., 1994) and consider the alignment between their beliefs and values and their equestrian practice. For some individuals, this type of activity can trigger 'a click in the mind, a falling of scales from eyes, a new way of seeing' (Meadows, 1999, p. 17). However, for most, it is likely a slower process that takes time, and the process is not linear (Betts & Bennett, 2023). Changes at this level can be transformational, leading to system-wide changes that bring all aspects of the system into alignment with the new mindset.

Worked Example 2 - Housing that Meets Horse Needs

(See Figure 3 for a summary of this worked example.)

Since at least the 19th century, veterinarians and animal welfare advocates have recognised and discussed the detrimental effects of housing horses in stables, as highlighted in excerpts from veterinarian James Lupton's book on horse management written in 1884:

> *The equine race, when in a wild state, are gregarious, or congregate in herds. Man captures such a quadruped and places it in a stable, built to enforce the extreme of solitary confinement…It [the horse] lives in so limited a space, that, in comparison with the dimensions of its abode, a man in a sentry-box dwells in a mansion *(originally published in 1884, republished by Lupton, 1985)*

Horses are social animals that live in herds, and spend the bulk of their time foraging for food (Goodwin, 2007), so it should be unsurprising that confining and isolating horses in a 3x3 metre 'box'

does not meet their physical, physiological or psychological needs. There is much evidence to support this. For example, researchers have long known that stereotypy is associated with poor welfare and suffering, and develops in animals housed in sub-optimal environments (Mason, 1991). The reported rate of stereotypy in stabled horses ranges, but a compelling study by Visser et al (2008) showed 67% of horses in their sample, stabled for the first time, developed stereotypy within two weeks. In the well-matched control group, who were kept at grass, no stereotypy was observed. Other work has shown that stabling negatively affects horse's immune function (Schmucker et al., 2022), respiratory health (Popescu et al., 2019), and gut health (Buchanan & Andrews, 2003; Vokes et al., 2023). Despite extensive investigation, knowledge and widespread awareness of the deleterious effects of stabling on horse welfare and horses need for turnout, stabling remains a common and accepted practice among most horse owners (Cheung et al., 2025; Werhahn et al., 2012; Williamson et al., 2007).

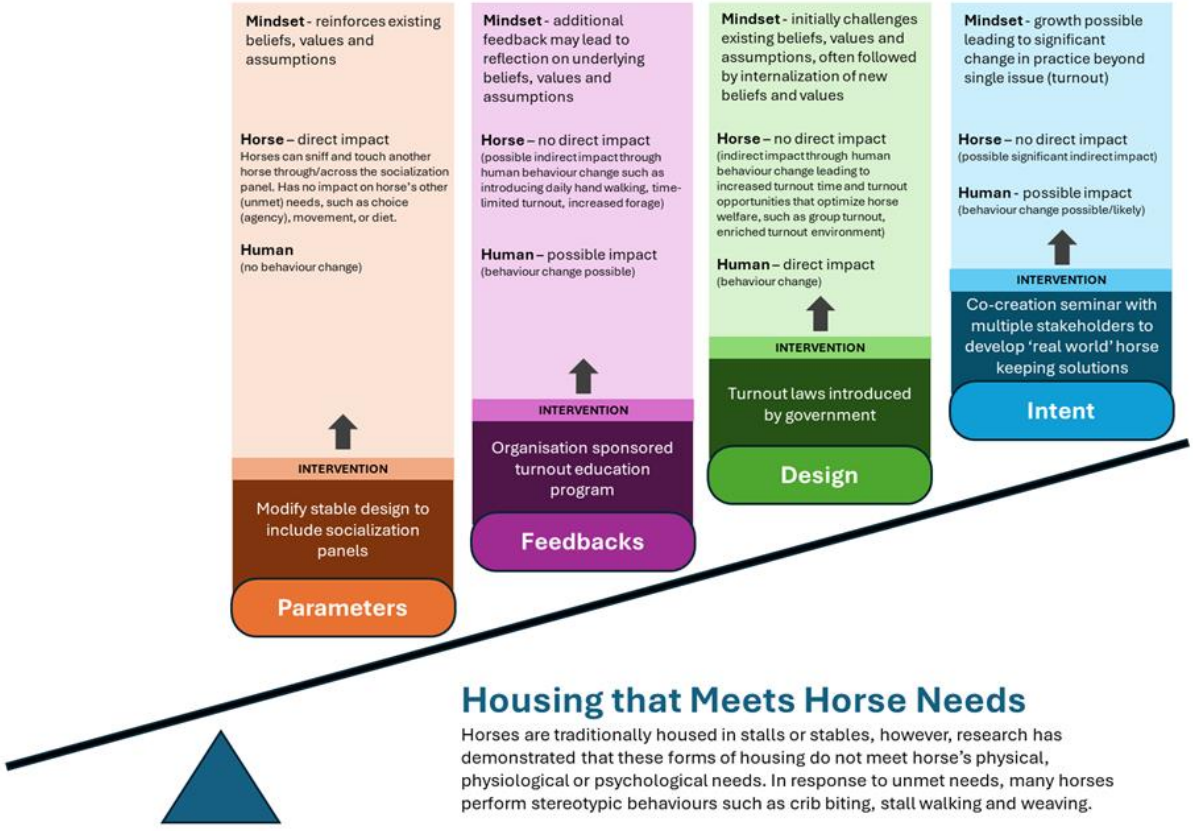

Figure 3. Application of the HW12 to illustrate interventions to provide horses with housing that better meet their needs.

As in the previous example, horse owners' horse housing choices provide insight into the various levels of the horse industry (see Figure 3). That horse owners are aware of the various welfare issues associated with stabling, yet trivialise or reframe these concerns (Cheung et al., 2025) is further evidence that many owners believe horses are subordinate to humans. The common parlance among equestrians refers to stables as 'boxes', which indeed is an appropriate term for a stable, but also reveals the dominant industry paradigm of the horse as athletic equipment or performance vehicle, because keeping a sentient being in a box likely sits uncomfortably for most. And like the development of the noseband taper gauge, researchers have sought to identify enrichment opportunities to improve the

welfare of stabled horses. Enrichments have included playing classical music (Huo et al., 2020), and providing a mirror or activity ball (Brauns et al., 2025). Again, an unintended consequence of this work is to reinforce common beliefs around human superiority to horses, legitimize stabling as a practice and facilitate its continued practice.

As in the previous example, the following illustrates how the HW12 can be applied to the issue of horse housing.

HW12 Levels 1 to 3 (Parameters)

As discussed, parameter level interventions, *on their own*, essentially maintain the status quo, as they seek to improve horse welfare while not challenging the practice of keeping horses confined in stables. The enrichment strategies mentioned above are an example of parameter level interventions, as are interventions such as changing stable design (Borthwick et al., 2023; Lesimple et al., 2019; Poochipakorn et al., 2024). Such interventions serve to reinforce existing beliefs and attitudes in relation to horses and require minimal to no human behaviour change, beyond modifying the stable or offering the horse a mirror or toy. Changes of this nature feel 'comfortable' as there is no challenge to internally held beliefs.

HW12 Levels 4 to 6 (Feedbacks)

Education programmes are an example of a feedback-level intervention. They introduce new information to the horse owner, which the owner is free to embrace or reject. From the perspective of the owner, they are passive recipients of information. Such programmes typically do not explicitly acknowledge the beliefs and assumptions upon which they are built, nor the system-level conditions that shape whether new information can be acted upon. Even when individuals are receptive, established practices are held in place by infrastructure, peer norms, regulatory frameworks and the dominant paradigm, meaning that information alone, without corresponding shifts at deeper levels, is unlikely to change behaviour at scale.

HW12 Levels 7 to 9 (Design)

Interventions that mandate turnout, such as the introduction of new laws, are tempting as a 'magic bullet' and can be very effective in the right circumstances. If such laws were to be introduced, they should be grounded in extensive scientific evidence showing both the harms of confinement and the benefits of turnout for horses (Duncan, 1985; Hockenhull & Furtado, 2021). However, to have long-term success, such laws must have a certain level of community, industry and political support. For example, it would be important to work with communities and industry to support the practical rollout of this change, such as the creation of appropriate turnout spaces for horses in places where space can be limited (such as the UK). In addition, simply putting horses outside in existing spaces could lead to new welfare problems, without adequate planning prior to the new intervention. Furthermore, promotion and enforcement of the law is key; laws that do not have a broad base of support generally do not lead to behaviour change (Akter et al., 2022; Alex, 2014). For example, laws have been in place since 1970 in the United States that prohibit the soring of horses (soring is a cruel practice designed to exaggerate the high-stepping gait of Tennessee Walking Horses used in 'big lick' competitions, see Dane (2011) for a detailed overview of soring), yet 55 years on, the practice remains ubiquitous within this sector of the US horse industry (Dane, 2011; Lynch & Genco, 2021; Medford, 2019; Sneed, 2014). Generally, for complex social problems such as transitioning from established practices like stabling to housing solutions that offer more turnout, a multifaceted, coordinated approach is needed.

HW12 Levels 10 to 12 (Intent)

As mentioned, interventions at the deepest levels of a system can be the hardest to implement, but they are also the most effective (Meadows, 1999). Applying a systems thinking lens to horse housing, it is helpful to understand the idea of 'deep ecology' as it is used in systems thinking. Until recently, the term ecology generally referred to shallow ecology, which is anthropocentric and views humans as being above or separate from nature (Capra, 2014). Alternatively, deep ecology sees humans as part of nature, appreciates the interconnection and interdependence of all things and recognises the intrinsic value of living beings. With this mindset at its core, systems researchers recognize the benefits of the process of co-creation, an activity where diverse stakeholders are engaged to understand complex problems and design and evaluate solutions (Vargas et al., 2022). Developing a co-creation problem-solving opportunity to discuss horse housing would allow diverse stakeholders to be exposed to a variety of perspectives on the issue. Through this process, participants are exposed to new ideas and knowledge, for example new harms they hadn't considered, and similarly, new benefits (Cousquer, 2023). Beyond seeing and hearing new information, a well-facilitated co-creation opportunity creates curiosity and open-mindedness in participants so they can take on new information (Cousquer, 2023; Goldstein, 1988). Moreover, such experiences can invoke introspection and cultivate seeing things through another's eyes and for some, may induce a new way of perceiving, and thus a paradigm shift.

Discussion

What did we do, and why did we do it?

In this paper we translated and updated the influential Meadows 12 (Meadows, 1999) to create a systems thinking framework, the Horse Welfare 12 (HW12), to guide human behaviour change research and interventions for improving horse welfare. Our goal was to create an accessible and useful systems thinking tool specific to the horse industry. As far as we know, this is the first attempt at adapting the Meadows 12 for the horse industry, although adaptation has been undertaken in fields such as public health (Bolton et al., 2022; Nobles et al., 2022), food production (Malhi et al., 2009) and sustainability (Abson et al., 2017). In the field of public health several attempts to adapt or translate Meadow's model have been undertaken (Johnston et al., 2014; Malhi et al., 2009; Nobles et al., 2022), including two adaptations that reduced the original 12 levels to just four (Nobles et al., 2022) or five levels (Johnston et al., 2014). Bolton et al (2022) argue that collapsing the Meadows 12 down to just four or five levels sacrificed much of the framework's nuance. We tend to agree, so our translation retains all 12 levels, however, like Abson et al (2017), we have included four groups of three levels each, as these groups can aid accessibility and workability, especially for those unfamiliar with systems approaches.

A key benefit of the HW12 is it will allow researchers and funding bodies to identify and categorise past and future research in terms of the level it targets within the horse industry (system). Researchers and funders will thereby gain insight into which level(s) are under- or over-represented within the existing research corpus, and can make deliberate choices regarding which level(s) they wish to target in future projects. Recent animal welfare literature reviews suggest much horse welfare research focuses on system parameters (HW12 Level 1), arguing the bulk of horse welfare research comes from the veterinary science, psychology and agricultural science disciplines (Benedetti et al., 2023; Luke et al., 2022), disciplines that prioritise quantitative research (Freeman, 2019; Prilleltensky, 1989; Strijker et al., 2020). Underpinned by reductionist methodologies, quantitative research is the natural fit for the study of parameters as it relies on breaking up a system into increasingly smaller parts, leading researchers to focus narrowly on parts of a system without context (Fang & Casadevall, 2011; Luke et

al., 2022). A further driver of parameter-level research is the increasing demand for an evidence base of 'facts' (Robinson et al., 2021). However, scientists from a growing number of fields now openly discuss the strengths and limitations of different scientific approaches and the need for a scientific effort that includes holistic (systems) approaches (Fang & Casadevall, 2011; Greenhalgh & Papoutsi, 2018; Uleman et al., 2024). By increasing the salience of system levels and their respective strength in creating change, and facilitating the categorisation of research in relation to the system level it targets, it is hoped the HW12 will encourage more research involving multi-level interventions and research investigating deeper levels of the system.

According to Meadows 12, the penultimate level to intervene in a system is at the paradigm level (Meadows, 1999). This is where the values, beliefs and assumptions from which a system arises are examined and attempts are made to shift these in order to create behaviour change. Social licence is a construct used to explore the level of acceptance of an industry within society (Douglas et al., 2022; Jijelava & Vanclay, 2017). This unwritten, largely unspoken acceptance (or otherwise) of an industry is based on the extent to which an industry's beliefs, values and assumptions (HW12, Level 11) align with those of the broader society (Douglas et al., 2022; Heleski, 2023). Should the mindset of an industry diverge too far from society, it is likely they will lose their social licence. Examples where this has occurred include the use of wild animals in circus (Born Free, n.d.), Thoroughbred jumps racing in some jurisdictions (RSPCA South Australia, n.d.) and greyhound racing in New Zealand (Morrah, 2024) and Wales (Irranca-Davies, 2025). Despite the clear risk faced by equestrianism of losing its social licence (Heleski, 2023), most social licence discussion remains focused on parameters, rather than exploring deeper and more challenging questions around the beliefs, values and assumptions upon which the social licence is built. The reluctance to scrutinise these deeper and more difficult questions can be seen in the stakeholder survey conducted by the FEI Ethics and Wellbeing Commission in 2023, which asked stakeholders about their top concerns (FEI, 2022). The options provided included: equipment, recognizing horse stress, education and rules, housing, commoditization of horses, horse health and doping (Heleski, 2023). That stakeholders, organisations and researchers consistently default to parameter-level framing is itself a systemic phenomenon produced by funding structures, scientific norms, regulatory traditions and the dominant paradigm, rather than evidence of individual reluctance to engage with deeper questions. Once again, it is hoped tools such as the HW12 will provide the context and language to facilitate greater focus on important questions around the paradigms (beliefs, values and assumptions) that drive the horse industry, as these more difficult reflections and conversations are more likely to deliver what most in the industry want - an ethically sustainable industry that prioritises horse welfare.

Limitations of the Meadows framework

In adapting the Meadows 12 for the horse industry, we also acknowledge limitations of the original framework. The most consequential of these concerns the framework's limited engagement with power, politics and values. Meadows' framework describes systems in relatively neutral terms, as if 'the system' has goals, information flows, rules and a dominant paradigm that can simply be identified and worked upon. In practice, each of these features is produced, maintained and contested by actors with unequal power (Fischer & Riechers, 2019; Riechers et al., 2022). Whose interests are encoded in the system's goals? Whose worldview is treated as the default paradigm? Who holds the capacity to propose, authorise or block intervention?

These questions are particularly acute in the horse industry. International federations, racing authorities, commercial sponsors and the gambling industry hold disproportionate influence over the rules, information flows and goals of the system, while grassroots participants, working staff and, most

consequentially, the horses themselves have little or no direct voice. We have signalled some of these dynamics throughout the paper, but we have not addressed them systematically, and the framework on which we have built does not require us to. Future applications of the HW12 would benefit from being explicitly paired with approaches that surface power asymmetries, plural epistemologies and contested values, and it is hoped others will take up this line of inquiry.

The framework has further limitations. Meadows developed the 12 leverage points from her experience rather than empirical testing (Dorninger et al., 2020), describing her own framework as 'tentative' with a 'slithery' order (Meadows, 1999, p. 18). The shallow-to-deep hierarchy can also imply that deeper interventions are always superior. In practice, parameter-level research often provides the empirical foundation that makes intervention at deeper levels possible, and effective change typically requires coordinated action across multiple levels (Fischer & Riechers, 2019).

Strengths and limitations of the HW12

As described earlier, a strength of this research is the authors' range and depth of experience in the horse industry and academia. Constructed to be accessible and practical, the HW12 can help create a research agenda with greater emphasis on deep leverage points that address the root causes of poor horse welfare. Moreover, the HW12 offers an overarching framework that can unite researchers, organisations, practitioners and policy makers, and facilitate greater intentionality when deciding where their efforts are best placed. The chief limitation of the HW12 is that it is yet to be tested. As a first attempt at creating a framework of this nature, it is likely refinements will be needed.

Implications for horse welfare

The key determinant of the welfare of all domestic animals, including horses, is human behaviour (Wolframm et al., 2023). Therefore, if the future of equestrian sport is at risk due to loss of social licence caused by poor horse welfare (Heleski, 2023), then the need for effective human behaviour change strategies cannot be overstated. Creating lasting, meaningful change is difficult and elusive, but is possible (Mariani, 2020). The Horse Welfare 12 is a first attempt at providing an updated, relevant systems-based framework for the horse industry that offers researchers and others interested in human behaviour change a tool they can use to: a) categorise past and future work, b) design effective, multi-level interventions, c) engage stakeholders in deep conversations, and d) create opportunities for community-led change initiatives. Constructed to be accessible and practical, the HW12 can help create a more balanced research agenda that builds on existing parameter-level research while expanding emphasis on deep leverage points that address the root causes of poor horse welfare in equestrian sport. Moreover, the HW12 offers an overarching framework that can unite researchers, organisations, practitioners and policy makers, and facilitate greater intentionality when deciding where efforts are best placed. Others have identified that frameworks based on Meadows' place to intervene in a system, such as the HW12, can help focus research efforts on deep level interventions with the potential to deliver effective solutions (Abson et al., 2017; Durham et al., 2018; Tourangeau & Sherren, 2020). It is hoped the HW12 will similarly provide researchers and others with a useful tool that stimulates research in new areas to create meaningful improvement to horse welfare.

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